Percezione e movimento nello sviluppo del pensiero matematico. Convinzioni e pratiche degli insegnanti in Italia e in Australia.

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Body movement and active learning in mathematics: Australian teachers' beliefs and practices

Research Report

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1. The body and movement in mathematics education

The relevance of perception and bodily movement for the exploration and construction of mathematical concepts is a central topic in much of the relevant literature in education, particularly in mathematics education. The roots of this tradition can be traced all the way back to the early 1900s, to the well-known Italian contributions of Maria Montessori (1934a, 1934b) and Emma Castelnuovo (1963), as well as to Jean Piaget (1952, 1953, 1960), John Dewey (1933,1938), and Jerome S. Bruner's (1966) theoretical works.

In the last three decades, the relevance of perceptual-motor aspects in mathematical learning processes has been evidenced by studies in experimental psychology (e.g., Carlson et al, 2007; Goldin-Meadows, 2005) and cognitive neuroscience (e.g., Dehaene, 2010; Nemirovsky & Borba, 2003; Looi et al., 2016; Seitz, 2000), thanks, in particular, to studies that have emphasized the *sensuous* and multimodal character of knowledge and learning processes (Rizzolatti et al., 1997; Gallese & Lakoff, 2005). Its relevance has been even more emphasized by theories from the cognitive psychology of *embodied and embedded cognition*, developed in the two pioneering works of Varela et al. (1991) and Lakoff and Núñez (2000).

More specifically, the theories of *embodied cognition* highlight the relevance of involving the sensorimotor apparatus for the development of cognition. These theories maintain that cognition and higher thinking should not be considered confined to the mind, but instead distributed throughout the entire body (Barsalou 2008; Lakoff & Johnson, 1999). Such argument carries with it two fundamental consequences for the teaching and learning of mathematics. The first one concerns the importance of promoting activities that stimulate perception and movement in the learning processes of the discipline. The second one regards the need to consider aspects that belong to the non-verbal language, such as gestures and perception, which play a fundamental role in teaching-learning processes, both in terms of communicative characteristics (Cook et al., 2012; Alibali et al., 2014), and the production of mathematical meanings (Cook et al, 2008; Alibali & Nathan, 2012; Cook, 2018). According to Chatelet (2000), gestures and metaphors are the way to transform the body's disciplined motility into signs. Moreover, as emphasized by J.A. Seitz, *"we do not simply inhabit our bodies, we literally use them to think with"* (Seitz, 2000). For instance, recently, research groups working on mathematics education have analysed the role of gestures and nonverbal language in teaching-learning processes, which do not represent simple communicative elements, but rather substantial aspects of the development of thinking (McNeil, 1992; Valenzeno et al, 2003; Goldin-Meadow, 2012; Rueckert et al., 2017, Congdon et al., 2017). One example is the *multimodal approach*, which analysed these aspects from a socio-constructivist perspective of learning (e.g., Arzarello & Robutti, 2009; Radford et al., 2017). Other studies were focused specifically on the inseparable nature of imagination in mathematics and the perceptual-motor aspects (Nemirovsky & Ferrara, 2009), on the role of gestures (Goldin-Meadow & Singer, 2003; Carlson et al., 2007; Edwards et al., 2014; Vale & Barbosa, 2017) or on *sensuous* cognition (Radford, 2013; 2014). *Embedded cognition* theories, however, emphasize how cognition is realized, and constrained, by the mutual interactions between the body and the environment. This highlights to what extent external artefacts and cognitive processes are deeply interdependent, and how learning processes and their effectiveness, depend on the coordination between students' bodily and environmental resources (Clark 2008; Pouw et al. 2014). Interesting studies in this direction, based on theoretical perspectives such as *inclusive materialism* (de Freitas & Sinclair, 2012; 2014), have also been conducted through the use of digital technologies and resources (e.g., Baccaglini-Frank et al. 2020, Ferrara & Ferrari 2020; Shvarts & Abrahamson, 2019).

These aspects are central in the *enactivist pedagogy* as well. *Enactivist pedagogy*, places its origins in *learning by doing,* theorized by John Dewey (1916), which found ample space in the *genetic epistemology* of Jean Piaget (1896-1980), according to whom, the ability to learn depends on our ability to absorb the world through meaningful engagement. Although Piaget's work has been criticized and superseded in its component concerning the order and progression of cognitive development that he theorized (Spencer & Darvizeh, 1981; Wallace et al. 1987), undoubtedly the perspective regarding the importance of the learner physical interaction with representations has instead found a fortunate following. Such a perspective was certainly embraced by Jerome S. Bruner (1915-2016), who was the first to use the term *enactive*, theorizing learning as situated on a

continuum between concrete and abstract, through the transition from enactive representations (such as manipulation) to iconic representations (such as pictures) to symbolic representations (such as words) (Bruner, 1966). The *enactivist* perspective on *embodied cognition* finds its origin in the contribution of Varela (1991), which emerged from Merleau-Ponty's phenomenological perspective (Merleu-Ponty, 2013). Researchers Abrahamson, Dutton and Bakker (2022) theorize an *enactivist pedagogy of mathematics* in the article *Towards an Enactivist Mathematics Pedagogy*, which provides a manifesto of this disciplinary pedagogical philosophy. The *enactivist* pedagogy focuses on the materiality of mathematical thinking, in opposition to commonly proposed teaching practices that ignore the *"psychological experience of thinking […] by denuding concepts of their corporeality"* (*ibidem*, p.157), that is, understating the relationship between body (movement and perception) and mind. According to Abrahamson et al., learning mathematics has a bodily and motor origin and is developed through conscious discourse involving descriptive processes of measurement, analysis, modelling, and symbolization, through which perceptual structures are transformed into mathematical entities that retain an active role. Therefore, how we make learning accessible, according to the researchers, should derive from thinking about how to enable students to actively experience mathematical concepts by designing an environment, artefacts, and assessment, aligned with this purpose.

Other perspectives considered in mathematics education with regards, in particular, to the role of body movement, come from research conducted by psychologists and philosophers such as Maxine Sheets-Johnstone (2011). In her work, she introduces the idea of *thinking in motion*, focusing on the kinaesthetic aspect of cognition, considering movement as both a means of thinking and of reproducing thought. Earlier, a focus on movement, more properly on the proprioceptive and kinaesthetic aspects of perception, was described by the physiologist of perception and action Alain Berthoz in the book *Le sens du mouvement* (1997). This book focuses on mathematics, and, more specifically, when addressing geometry, Berthoz explicitly refers both to the mathematical philosopher Chatelet (2000), who inspired many of the studies mentioned (e.g. those on gestures), as well as to the philosopher Poincarè and his statement, contained in the book *Le science et l'Hypothèse* (1908), which declares geometry as originating from the body and its actions. The philosopher of mathematics Giuseppe Longo (2005) also supports a similar position. In the following years, the discussion around research on the role of bodily movements in mathematics was not only considered from a cognitive point of view, but also centred around the epistemology of the discipline itself (Núñez, 2006). Indeed, from the reflections of these authors, the constitutive role that body movement plays for mathematics itself, both in concept and practice, has emerged. However, it must be pointed out that this aspect has been greatly underestimated throughout the last century in the Western tradition of mathematics education. This is evident, for example, from the presence of many Bourbakist definitions in mathematics textbooks (Munson, 2010), such as the ones referring to functions (Denbel, 2015).

A further area that is important to consider because of its profound entanglement with this theme is the use of manipulative materials and tools for teaching and learning mathematics. Many of the theoretical frameworks and studies presented so far have led to the development of educational materials and pathways for teaching-learning (e.g, Bussi & Maschietto, 2006; Baccaglini-Frank & Maracci, 2015; Baccaglini-Frank, 2015; Bussi et al., 2018; Carotenuto et al., 2020). Other theoretical perspectives, such as the Semiotic Mediation (Bussi & Mariotti, 2008) have explicitly studied these activities for the development of mathematical thinking. Specific studies have investigated the characteristics of manipulative representations (Belenky & Schalk 2014; Carbonneau et al., 2013), as well as levels of instructional guidance that made use of manipulatives (Marley & Carbonneau, 2014) or teachers' beliefs and practices toward their proposal in school (Carbonneau & Marley, 2015; Golafshani, 2013; Vizzi, 2016; Puchner et al., 2008).

1.1 Research findings and implementation in school

As briefly introduced in the previous paragraph, the research regarding the centrality of the body perception and movement in mathematics has a long and extensively debated tradition. Furthermore, in recent decades, the role of students' active, bodily experience in the exploration and construction of mathematical concepts has attained increasing attention in the research on mathematics education. As pointed out by Drijvers in the ERME-11 plenary (2019), the growing interest in research from this perspective is evidenced, for example, by

the fact that two special issues of *Educational Studies in Mathematics*[1], have been devoted to *embodiment* in mathematics education. Furthermore, several theories focused on perceptual-motor involvement in the mathematics teaching-learning process have been proposed. Encouraged by experimental findings, research embracing theoretical perspectives that highlight the centrality of students' bodily perception and movement has also recently developed a wide range of innovative educational artefacts and proposals.

However, this growing interest in research and developments on a theoretical level have not been matched by an equally ample resonance in classroom practice. The teaching of mathematics in schools, as pointed out by the OECD's international surveys (2009; 2016), is often far from these perspectives, being instead still largely anchored to a transmissive teaching approach. Dominant teaching practices, focused on strategies that aim at, for example, *clarity of instruction* (OECD, 2019), are often geared towards teaching procedural mathematics rather than promoting cognitive activation, usually supported instead by exploratory, active learning, and problem-solving practices. Thus, the presence of the aforementioned perspective in teaching practice is uneven. This gap between research findings and the uneven proposal of these activities in classrooms warrants a research interest in the implementation in school of active, bodily experience mathematics learning activities.

[1] N.57(3) Published in 2004, N. 70(2) published in 2009

2. The research project. Context, design, and methodology

As we have briefly outlined, over the years, many research findings, both experimental and theoretical, have emphasized, on one hand, the importance of actively engaging students in experiential activities and, on the other hand, the role played by perception and movement in mathematics teaching-learning processes. National and international educational policies have adopted, to a greater or lesser extent, research findings, implementing them according to the mathematical tradition and the culture of the specific contexts where teaching takes place. However, we do not possess adequate information concerning the nature and scope of educational proposals in schools that are aligned with what is indicated by research in this regard, other than the recognition of an uneven diffusion, for example, in Italy (Bartolini Bussi et al., 2010). In order to shed light on the gulf between research and school practice, it could be useful to investigate the actual design and implementation in mathematics classes of learning activities in which students are actively involved through their bodies and movement. In this way, it could be possible to describe the scope and nature of these proposals at school, including possible adaptations and omissions of key components, and to explore the possible presence of contextual factors that may support or inhibit such activities (Century & Cassata, 2016).

The variety of theories mentioned in the previous section corresponds to constructs resulting from the specific philosophical, psychological, and pedagogical roots. Analysing the implementation with an exploratory study aimed at understanding teachers' perspectives, the research needs to be based on a negotiation of meanings with relevant actors. Setting aside the theoretical differences, we identified a comprehensive construct, an overarching framework for the multitude of theoretical proposals developed, that could be clear and easily accessible to teachers, to be the object of our research on implementation. Thus, the terminology active, bodily experience mathematics learning activities, abbreviated hereafter in ABM activities, refers to activities designed according to the perspective of enactive-embodied learning or, more generally, to activities in which students are actively engaged in exploring mathematical concepts using manipulatives, tools (virtual or physical), or whole-body movements. Two main components are encapsulated in this construct: the students' active engagement in mathematical exploration and their perceptual motor involvement.

The present study explores the implementation of ABM activities at school (Century & Cassata, 2014), with a specific focus on teachers' views and beliefs. We will observe implementation from the perspective of teachers, assuming that they can give us precious insights on the current implementation as conducted in classrooms. The teacher's beliefs and experience play a significant role in educational change (Coburn & Talbert, 2006; Peterson, 2013), and their opinions on ABM activities could thus have a drastic impact on their implementation (Domitrovich et al., 2008; Ruiz-Primo, 2006), as highlighted in the specific case of the introduction of manipulatives by Golafshani (2013) and Vizzi (2013).

2.1 Research goals

This study investigates the proposal and implementation of *active, bodily experience mathematics learning activities* in Australian schools. Given the multiform and complex nature of the operational construct under investigation, it has been essential to clarify its components and to shape its attributes, possible declinations, and adaptations in different contexts. Therefore, the first objective of the research was to identify the elements that can characterize ABM activities and their implementation. To this end, in addition to reviewing the direction of research findings and official guidelines at a national and international levels, we conducted an exploratory study with academics in the field of mathematics education. Indeed, they hold a privileged position to pursue such a goal because, from a research perspective, they are in continuous dialogue with school contexts. Experts' opinions help recognise the core elements and expected outcomes of the ABM activities, and to classify determinant factors in and for their implementation.

Specific research questions to achieve this first aim were as follows:

- ***RQ_1a****. From experts' perspective, how are ABM activities conceptualized and characterized in Australia?*

- ***RQ_2a****. What are teacher's characteristics (knowledge, beliefs, awareness) that should come along with ABM activities implementation in school?*
- ***RQ_3a****. What are possible hindering / facilitating factors for ABM activities implementation?*

The research also explored the perspectives of both primary and secondary school mathematics teachers, with respect to the implementation in schools of ABM activities and the proposal in their teaching daily practice. This study is aimed at identifying factors that support or inhibit the implementation of ABM activities, inferring the possible relation between teachers' beliefs and their disposition to implement (or the current implementation of) ABM activities, as well as other influential teachers' characteristics or contextual factors. Furthermore, we sought to gain insights for the effective implementation of ABM activities surveying the current implementation, particularly identifying the factors that affect the practice, the existence of different models of practice, and classifying teaching profiles and characteristics that determine their teaching effectiveness.

The specific research questions that guided the inquiry have been as follows:

- ***RQ_1b.*** *What are teachers' beliefs (in terms of expected outcomes, limitations, difficulties, constraints identified) about ABM activities and possible/current implementation in daily practice?*
- ***RQ_2b.*** *Are there teaching profiles (educational background, teaching experience, beliefs on mathematics teaching and learning) or external characteristics (culture and characteristics of the school context, curriculum and directives on educational policies, research efforts) that may determine the readiness to implement ABM activities in school?*
- ***RQ_3b.*** *When ABM activities are implemented, to what extent are their proposal and accompanying teaching profile aligned with the indications provided by research findings and academic experts?*

2.2 Research design

The research is an exploratory mixed-method study on the implementation of ABM activities in Australian mathematics classrooms, and associated teaching practices.

Research design included:

- a desk audit of relevant research literature (theoretical perspectives and empirical research focusing on the involvement of the body and movement in mathematics learning activities, consistent with an active, experimental, and hands-on approach), and relevant national and international curricular documents, guidelines, and educational policies to identify the role of the body and movement in mathematics teaching and learning.
- semi-structured online interviews with academic experts on mathematics education aimed at documenting experts' views on ABM activities to identify a conceptual framework on the main issues outlined in the teachers' survey. Analysis of the narrative material has produced a conceptual framework that highlights the broader opinions, as well as those of various experts', on core elements, as well as what the expected outcomes of these activities are, and the factors believed to be determinant in and for their implementation.
- a survey addressed to primary and secondary teachers, which consist of:
  - an online questionnaire focused on teachers' beliefs and practices regarding teaching and learning mathematics in general, and particularly to ABM activities. The web-based instrument combines rating items, multiple-choice items, two vignette-items, and a few short open-ended questions, differentiating primary and secondary school teachers using filter questions. After completing the questionnaire, teachers interested in participating in an individual interview were asked to provide their email (in the form) for further potential contact by the researchers.
  - individual semi-structured interviews with a restricted number of respondents aimed at: providing greater insight into issues raised in the participants' survey responses; and at delving further into some topics for which the questionnaire might not yield sufficient information.

Participants

Participants in the project are:

- six academics in mathematics education involved in semi-structured interviews. Their participation was voluntary, and consent was required prior to starting the interviews. Further details of experts' description, selection and involvement in the research will be provided in subsection 3.1.
- a non-probabilistic sample consisting of 79 voluntary primary and secondary mathematics teachers working in several different schools and localities, recruited from around Australia via national and state mathematics teacher professional associations' Facebook pages/groups or association newsletters (e.g., Australian Association of Mathematics Teachers). Further details of recruitment strategies will be provided in subsection 4.1.

  Nine of these participants also participated in individual follow-up semi-structured online interviews.

The research underwent a review process by the Scientific Research Ethics Committee (ESRB) of the Free University Maria SS. Assunta, Protocol No. 14/2021, and the Human Research Ethics Committee of the Australian Catholic University (ACU HREC), Protocol No.2021-199E, receiving positive feedbacks from both. All documents provided to the ACU HREC are also included in Appendix 1.

2.3 The context: relevant excerpts from the Australian Curriculum and related educational policies on body and movement in ME

Describing the Australian context is particularly complex. Australia has only recently adopted a national AC:M curriculum, drafted in 2010, subsequently updated in 2020 (ACARA 2020), and very recently revised in April 2022 (ACARA, 2022) after an extensive consultation process[2]. It appears that the latest revision not only introduced a different organization in content areas, as the replacing of the domain *Geometry and Measurement* with the two interrelated strands *Space* and *Measurement*, but also in referring more explicitly to active and creative learner involvement:

> Mathematics provides opportunities for students to apply their mathematical understanding creatively and efficiently. It enables teachers to help students become self-motivated, confident learners through practice, inquiry, and active participation in relevant and challenging experiences. (ACARA, 2022)

Explicit reference[3] is also made, for instance, to learning that is based on *"experimentation through exploration and play-based learning in the early years"* in the strand *Probability*, and to *"the ability to make pictures, diagrams, maps, projections, networks, models and graphics that enable the manipulation and analysis of shapes and objects through actions and the senses"* in the strand *Space*. In addition, within the curriculum, a specific focus is on the dynamic use of digital tools for virtual manipulation, and also there are some general references to *"experience with mathematical concepts using multisensory methods to stimulate thinking skills"* and *"access to familiar objects to represent and solve mathematical problems"* in order to meet the needs of diverse learners. However, in our research, we will refer to version 8.4 of the curriculum (ACARA, 2020) since the one just approved (i.e., version 9.0) was not in use during the research.

Nonetheless, in addition to the national curriculum, each state follows regional educational policies, in some cases quite programmatic, that differentiate the way curricular directives are distributed and implemented. Especially in larger states, the authorities responsible for curriculum implementation in the region provide additional research-based support materials. Notably, the AC:M does not provide specific advice about teaching approaches and, depending on the state, specific programs, which follow different approaches to developing mathematical skills, are presented on websites (e.g., *Count Me In Too, QuickSmart, First Steps*, and *Scaffolding Numeracy in the Middle Years* (SNMY)). In addition, some quality research-based resources are provided in single states in packages that include recommended readings, classroom activities and tool tips (e.g., the *Fractions and Decimals Online Interview* available to Victorian government schools). Such proposals usually focus on the need to develop lesser-addressed curricular areas. Moreover, publicly available materials

[2] https://www.acara.edu.au/docs/default-source/curriculum/australian-curriculum-review/maths-final-report-australian-curriculum-review.pdf

[3] https://v9.australiancurriculum.edu.au/teacher-resources/understand-this-learning-area/mathematics#accordion-b499bacc02-item-79eac682e3

from other systems, as support for curriculum implementation, are commonly used in the school system. In terms of activities to be proposed, there are also platforms that provide resources and suggest activities, normally used by teachers, such as the Australian *Scootle*[4], as well as foreign sites such as the *Nrich*[5] platforms of the University of Cambridge or *Illuminations*[6] from the National Council of Teachers of mathematics in the USA. (Callingham et al., 2017)

In general, there seem to be no reference to, nor emphasis on, the importance of including students' body movement in activities aimed at learning mathematics within curricular directives and educational policies. However, within said directives and policies, there are references to the use of tools or materials (e.g., through links to reference journals and websites in which to find teaching resources) that are helpful in bringing mathematical concepts into the classroom from multifaceted perspectives, including involving concrete representations and manipulation. Even though there are no documents stipulating the need for students under the age of 16 to specifically undertake these activities, the *Report of the Developing an Evidence Base for Best Practice in mathematics Education Project* (Callingham et al., 2017) highlighted that, although there was no stand-out program or resource used in schools, successful schools used a wide range of resources and that *"Concrete materials were available in all schools, including high schools, and accessed as needed and appropriate"* (p.38).

As pointed out by Quigley (2021), under the impetus of internationally oriented policies, the introduction of concrete manipulative materials as models of mathematical concepts is promoted in Australian National education policies, both in the updated AC:M and the NSW Syllabus for the Australian Curriculum: mathematics K-10 Syllabus (NESA, 2019), from grade 1 to grade 8. However, compared to directives in other countries, such as educational policies in the United States (Common Core State Standards Initiative, 2020) which promote their use to develop problem solving, or in Singapore (Ministry of Education Singapore, 2012), where reference is made to the use of materials to promote the discovery and understanding of abstract mathematical concepts, the Australian approach seem to refer to their integration for representational use rather than from an active exploration perspective. Moreover, as the ACARA comparative study[7] points out, the indications on the integration of concrete materials for the introduction of mathematical concepts is much less pervasive than, for example, the Singaporean model, which is considered virtuous for its excellent results in international surveys. Finally, such materials seem to refer mainly to the area of algebra and numbers (Lowrie et al., 2012). In the same comparative analysis, it also emerges that there is a particular emphasis on the introduction of digital technologies in the Australian curriculum.

Previously, there seems to have been a greater focus in Australia on experiential mathematics, which also made use of concrete materials. This is evidenced by the widespread circulation among teachers in the mid-1980s of two manuals, the MCTP Activity Banks - Volume I, II[8] (1988). These are collections of suggested activities to be implemented in classrooms, which were considered key references in teachers' professional development courses. Within these manuals there is an entire section devoted to the physical involvement of students in learning mathematics. Although their use was not mandatory or expected by education systems, they have been widely adopted by teachers as examples of best practices in teaching and learning. More recently, in the wake of strong international interest, Australia has developed a strong focus on so-called inquiry-based mathematical practices (Artigue & Blomhøj, 2013) with reference to all age levels, for example, by developing projects such as *The reSolve: mathematics by Inquiry project*[9].

[4] www.scootle.edu.au

[5] http://nrich.maths.org/)

[6] http://illuminations.nctm.org

[7] https://www.australiancurriculum.edu.au/media/3924/ac-sc-international-comparative-study-final.pdf

[8] Lovitt, C., Clarke, D., Curriculum Development Centre (Australia), & mathematics Curriculum and Teaching Program (Australia). (1988). *MCTP Activity Bank: Volume 1*. Woden, A.C.T: Curriculum Development Centre.
Lovitt, C., Clarke, D., Curriculum Development Centre (Australia), & mathematics Curriculum and Teaching Program (Australia). (1988). *MCTP Activity Bank: Volume 2*. Woden, A.C.T: Curriculum Development Centre.

[9] https://www.resolve.edu.au/resolve-mathematics-inquiry-project

Thus, although there is no specific focus on the role of the body, we find indications of, on the one hand, the use of concrete representations and manipulable materials or tools (both virtual and physical), and on the other hand, the promotion of active, inquiry-based teaching aimed at the construction of mathematical meaning.

> Among the other support materials available through systems there is a strong emphasis on investigation, together with the use of concrete materials. Broadly, the approaches seem to take a socio-constructivist line with students experiencing different activities to develop understanding. The extent to which the activities build to a coherent mathematics program varies. (Callingham et al., 2017, p.28)

As *Numeracy* (and *Literacy*) are the main emphasized aspects in the mathematics taught, they are in the ABM activities as well:

> There is always a considerable emphasis on number and very little on geometry, and statistics is fairly undeveloped compared with other countries such as, for example, New Zealand. There is, however, little emphasis on the curriculum proficiencies of fluency, problem solving, reasoning and understanding other than some articles and presentations. (Callingham et al., 2017, p.28).

Already in the division of school programming in the three content areas *Numbers and Algebra, Geometry and Measurement,* and *Statistics and Probability*, the juxtaposition of the terms Geometry and Measurement, within the same content area, while seeming to emphasize the connection with practical aspects of geometry, underscores a marginalization of the theoretical aspects of geometric thinking not associated with numerical data. Criticisms of the lack of guidance regarding the development of visuo-spatial aspects, as well as the use of representations and learning experiences to accompany the path to the geometric domain beyond the very early school years, had already been raised when the ACARA document was being drafted (Lowrie et al., 2012).

To conclude, as it was point out for the use of manipulatives (Moyer, 2001; Carbonneau & Marley, 2013; Marley & Carbonneau, 2014), the reason for the uneven use of a certain instructional strategy may stem from the lack of precise directions that translate from research findings to practice. From this perspective, embodied and enactive learning has never been at the centre of the theory-practice nexus in Australia. Indeed, activities such as those provided by the MCTP were collections of examples for best practices, but there has been little justification beyond this vague argument. At the same time, references in educational policies often have been general and do not provide information on how to implement in educational practice.

3. Academics' perspectives on body movement and active learning in mathematics

Academics in mathematics education represent a *trait d'union* between research and school. Indeed, through experimental research conducted in the classroom and professional development courses for teachers and prospective teachers, they participate in the world of research by addressing the schools and their students. Thus, they play a significant role in identifying what directions should research take when analysing and interpreting the implementation of research findings in schools.

First, interviews with academics complete the literature review to provide a characterization of ABM activities by defining their essential elements, expected outcomes, founding principles, and possible different interpretations. As we have already pointed out, ABM activities represent an operational definition, constructed for exploratory purposes, including a variety of theoretical perspectives that can contain significant differences too. It is therefore essential to identify the principles that characterize them as the object of study. In doing so, the experts' inputs were pivotal references for envisaging connections and gaps between research directions and teachers' perspectives.

Secondly, their participation allowed a contextual characterization, that is, to describe the features of the specific teaching culture considered. This translates into identifying possible examples consistent with the object of study and a terminology for ABM activities familiar and easily recognizable by teachers. These communicative and linguistic choices proved to be crucial in designing the survey instruments aimed at teachers. Moreover, academics' involvement allowed to draw interpretive lines on possible differences in implementation related to the specific structural characteristics of the school system and the culture, both mathematical and educational, in which students and teachers are immersed.

3.1 Participants' description, selection, and involvement in the research

The experts in mathematics education who participated in the project were selected based on experience alongside teachers and for their research interests, which were akin to our research topic. The six experts in Australia are academics, belonging to MERGA (Mathematics Education Research Group of Australasia). Three of them are former secondary school teachers, with expertise in professional development courses aimed at mathematics teachers, experimenting in school teaching innovations. Their research interests range from initial and professional teacher education to inquiry-based learning; from the use of technology in mathematics education to mathematical Literacy and Numeracy; and from implementing teaching innovations in elementary school to reforms in curriculum and assessment. They all have experience in teacher education and international research.

The academic experts were recruited through an email invitation asking them to contribute to the research, and they joined the project voluntarily. After filling out the informed consent form for the interviews, we proceeded to schedule the interviews, which were conducted via Zoom, in the period between November 2021 and December 2021. The recruitment email addressed to the academics can be found in Appendix 1.

3.2 The interview protocol

In order to collect the academic experts' opinions, we conducted individual semi-structured interviews via Zoom, approximately one hour-long. The interview prompts were designed to assess the experts' views on key aspects of implementing ABM activities at school, especially in relation to teaching practices. The first goal of the interviews was to gather the researchers' opinions on the proper terminology to define the activities under investigation in a clear and accessible way for teachers. This exploratory phase should also provide a set of examples that might be commonly known and recognized by teachers, at different school levels. Furthermore, the interviews helped shape a conceptual framework of academic experts' views around the main questions underpinning the survey on teachers' perspectives. The prompts of the interviews are listed in the box below

(Tab.1).

I	*Whether and why is it important to implement ABM activities at school?*
II	*What are the beliefs that should guide teachers in proposing them?*
III	*Which levels of awareness and knowledge should accompany teaching when implementing ABM activities? (e.g., in terms of teaching strategies, assessment, etc.)*
IV	*Which characteristics concerning the implementation of ABM activities at school determine their teaching effectiveness?*
V	*What are the main limitations of the use of these activities in daily teaching practice?* *What are factors that could hinder/favour the implementation of these activities at school?*

Table 1. Prompts for mathematics education academic experts' interviews.

The complete interview protocol can be found in Appendix 2.

3.3 Data analysis

Transcriptions were done manually, by making use of the slow speech dictation mode provided by the free software for audio file playback *Listen N Write Free*. Transcriptions are in *Jeffersonian* simplified style (Jefferson, 2004) (Tab.2) to report as faithfully as possible the narrative from the interviewees, including emphases and uncertainties (Sacks et al., 1974). The whole transcriptions of academics' interviews can be found in Appendix 3.

Jeffersonian Simplified system of transcription	
[	Speech overlay
>text<	Accelerated speech
<text>	Slow speech
text	Emphasized word
wo:rd	: for sound lengthening
(0.5)	The number inside the bracket indicates the duration of a pause in seconds and tenths of a second
((action))	Double brackets indicate a description of an action
( )	A part of speech that is not understandable
=	Words spoken stuck together

Table 2. Legend of symbols for transcription (Jeffersonian simplified system)

The narrative material thus transcribed was imported for analysis into *MAXQDA Software* (*Analytics Pro 2022 version*). Interviews were analysed according to the *Qualitative Content Analysis* method, using inductive category formation procedure (Mayring, 2015). The so-called *open coding* in Grounded Theory (Cohen et al., 2017), was used in the first instance to refine the results with a focused, axial coding (Strauss, 1987; Ezzy, 2002). Diagrams were used in the analysis process to help thinking on a conceptual level, showing the relationships between concepts (Corbin and Strauss, 2008). In addition, concept maps (Daley, 2004) were used as a tool to represent the conceptual framework of the academic experts' perspective that emerged from the data gathered on each theme.

The first two questions, about the terminology and examples, where categorised using both a data-driven categorisation proposed by one researcher (Expert 4), and external criteria. For instance, terminology with the same linguistic root were grouped. The examples provided were categorised in the same groups according to the following criteria: if they were in the same area of contents, if they referred to the same school level, if students' physical involvement (e.g., whole body movement or handling) and tools used were of the same typology (e.g., virtual or digital).

The analysis of the other questions (illustrated above in Tab.1) produced a system of categories and subcategories, briefly illustrated in the table below (Tab.3). The main themes addressed by the interviewees in response to the protocol questions were coded and grouped in categories. The system of codes and sub codes generated represent the core of the analysis and of the interpretation of the results. It was conducted by making use of concept maps for each macro-category, in which the nodes consist of the codes' labels. Each code represents a *natural unit of meaning*, that is, a relevant theme that emerged in the narratives, and the codes are organized according to the categories and subcategories. For instance, within the category *Influential factors*, in the sub-category *Ambivalent factors,* we can find the code *FA1* with the label "*Availability of spaces and resources in the school"* (see Figure 1 in the subsection 3.4). This system of categories and sub-categories was created following criteria of *similarity or difference* (e.g., the set of opinions with respect to the same variable, such as the assessment of ABM activities when asking for instructional strategies), *concordance and opposition* (e.g., hindering or facilitating factors for the implementation of ABM activities in the classroom) or *inclusion* (this is the case of the creation of sub-categories from an original category) (Trinchero, 2002). In the procedure, we adopted a hermeneutic approach to refine the system of emerging categories and codes, on the basis of criteria of interpretive clarity and informational accuracy by rereading and cross analysing the narrative materials in several cycles.

CATEGORIES	SUBCATEGORIES	
IMPORTANCE (I)	Justificatory reasons (IG)	
	Operational reasons (IO)	
CHARACTERISTICS I (of the teacher) that should accompany the implementation	Beliefs (CCv)	To benefit from the introduction of the activities (CCvB)
		On mathematics teaching and learning (CCvM)
	Awareness (CCp)	On the specific activities (CcpA)
		On mathematics teaching and learning (CCpM)
	Knowledges (CCs)	
LIMITATIONS (L)	Inherent in activities (LI)	
	Due to implementation errors (LE)	
INFLUENTIAL FACTORS (F)	Ambivalent factors (FA)	
	Inhibiting factors (FO)	External (contextual) factors (FOE)
		Internal (teacher) factors (FOI)
	Facilitating factors (FF)	External factors (FFE) (which could facilitate the introduction)
		Factors that might affect teacher attitudes (FFC)
STRATEGIES FOR THE EFFECTIVENESS (SE)	For introduction (SEIn)	
	For effective implementation (SEIm)	The selection of the activity (SEImS)
		Students and classroom management (SEImG)
		The assessment (SEImV)
		The role of the teacher and teaching strategies (SEImI)
		The significance of the activity in teaching program (SEImO)

Table 3. System of categories from the analysis of academic experts interviews

Reliability of the Data-analysis process

Proceeding hermeneutically could ensure the *stability* of the analysis, however, it does not guarantee that the codes assigned to the text units will be reassigned in the same way by another independent coder. In order to get a measure of the trustworthiness, a fairly common method in educational research is to make use of *investigator triangulation* (Denzin, 2009). It consists of involving one or more external coders to triangulate the data analysis system, checking trustworthiness in terms of *inter-rater reliability* (Krippendorff, 2004) on a representative sample of narrative material. In the research presented here, a *reliability process* was planned, as outlined by Syed and Nelson (2015). We involved two external researchers in a refinement phase, for partial analyses of significant coding patterns, and two coders whose task was to conduct a final validation of i*nter-rater agreement*. According to Geisler and Swarts (2019), the protocols analysed by the two external coders correspond to 20 percent of the total narrative material. We report below the two accuracy indexes, which measure the degree of agreement of each external coder with respect to the coding performed, and the index of agreement (*inter-rater* or *intercoder agreement*) of the coding performed by the two external coders, thus providing a measure of the reliability of the analysis. Usually, it is believed that a good agreement index should reach at least 80 %; the closer to total coincidence in coding (100%) the more reliable the coding is considered to be (Mantovani & Kanizsa, 1998). In our case the percentile agreement index shows that the analysis is sufficiently reliable: $\mathrm{i}_{\mathrm{agreements(Cod.1,\,Cod.2)}} = \frac{100\times\ \mathrm{agreements}_{\mathrm{(Cod.1,\,Cod.2)}}}{\mathrm{agreements}_{\mathrm{(Cod.1,\,Cod.2)}}+\mathrm{disagreements}_{\mathrm{(Cod.1,\,Cod.2)}}} = 83\%.$

In addition, the accuracy indices $\mathrm{i}_{\mathrm{accuracy\ (Cod.N)}} = \frac{100\times\ \mathrm{agreements}_{\mathrm{(Cod.N,\,Code\ System)}}}{\mathrm{agreements}_{\mathrm{(Cod.N,\,Code\ System)}}+\mathrm{disagreements}_{\mathrm{(Cod.N,\,Code\ System)}}}$ of both external coders are quite good, respectively $\mathrm{i}_{\mathrm{accuracy\ (Cod.1)}}$ =85% , $\mathrm{i}_{\mathrm{accuracy\ (Cod.2)}}$ =96%.

Another issue for the reliability of the analysis method concerns the researcher's autonomy in creating the coding system, which could then be compromised by the presence of predetermined assumptions (Trinchero, 2002). We attempted to limit this effect by inductively eliciting analysis from text units and reverting to coding narrative texts based on code and category systems, questioning fidelity and interpretive clarity reshaping coding systems until no more inconsistencies or ambiguities were found. Finally, to further ensure reliability, we returned the entire interview transcript to each academic expert interviewee.

3.4 Results

This subsection will summarize the main findings from the interviews with academics. First, the insights coming from the analysis of the first two questions will be illustrated. Next, the main results from the analysis of the other questions, organized thematically according to the categories given in Section 3.3 (Tab. 3), will be briefly discussed.

For communicative purpose, we adopted the operational definition *Active, bodily experience mathematics learning activities.* From the analysis of the first two questions about the Terminology and Examples we derive some other suggestions for communicating in a clear and easily accessible way with teachers, such as to use the expressions like *enactive* (diverse from *enactivism* as a theoretical perspective) (Expert 6), *the use of the body* (Expert 2, 3), *the move from concrete* (Expert 3). *Expert 4* proposes a categorisation, «from the less disruptive to the most disruptive» examples of the involvement of students' body and movement in mathematics learning activities. Referring to this categorisation many other expressions are provided, as listed below:

1. *Level 1:* Hands-on activities / manipulation, sitting at their own desk (physical – virtual)

   Terminologies*: Hands-on activities* (Expert 1,4) / *manipulatives* (Expert 1,3, 4) / *representations* (Expert 3)/ [*physical resources, tools or even games* (Expert 4) – *virtual, technology, calculators, computers, software* (Expert 4) / *digital technology* (Expert 6)]

2. *Level 2:* Students moving around (2.1. inside the classroom / 2.2. outside the classroom)

   Terminologies: *Students moving around* (Expert 4)
   (*Inside the classroom – outside the classroom / outdoor experience*)

3. *Level 3*: Activities where students are using either gestures or the whole body to explore and embodying mathematical concepts

   Terminologies: *Activities where students are using either gestures or the whole body to explore and embodying mathematical concepts / activities that involve students using their bodies to create an understanding of mathematical concepts* (Expert 4).

The examples provided have also been organized into these categories. A table presenting all examples can be found in Appendix 4. Looking at the content areas they are related to, we noticed that most of the examples (especially for primary school) are in *Arithmetic* (14) and *Algebra* (2), followed by examples in *Geometry* (shapes, solids and Trigonometry) (9), representation and introduction to the Cartesian plane (3) and to the concept of function (1). Finally, the examples of *Probability and Statistics* (6), and *Real World Problem and Mathematical Modelling* (7) have been mentioned repeatedly by the experts.

The following bullet points illustrate the results of the other interviews questions (Tab. 1). The results presented are organized thematically in the categories that emerged during the analysis. The narratives are an expression of the main *natural units of meaning* that emerged from the experts' contributions. We include, in some cases, a reference to the academic experts and the paragraphs in the transcriptions where the unit of meaning appeared, that is, the segments of narratives which correspond to a same code. For some of the others, we provided a reference to the cumulative frequencies with which the codes are present within the totality of the contributions, or a direct quotation. In addition, we directly quote some examples of experts arguments that support the claims stated within the relevant category. At the end, for the category *Influential factors,* we will also present the relative map of codes (Figure 1).

- *Importance*

As reasons supporting the importance of bringing ABM activities to school, the experts highlighted theoretical justification and reasons related to the possible results of their effective implementation. *Justificatory reasons* they refer to included results from the research (both in cognitive neuroscience and psychology, and in mathematics education) and the following (cognitive) beliefs:

- Gestures and movement are part of the language, both for communicating and thinking:

  > So, I think, in the same way that we talk our way into reasoning, an aspect of that talk and communication, with each other or to ourselves, is about enacting or gesturing […] Certainly enacting and gesturing are seen as a key part of talking your way into reasoning and I think the younger you are - the younger the learner are, the more we need to encourage and help them to do that enacting physically, because later, as you get older, and you become able to then internalize and then just picture it. (Expert 6, p.33)

- Abstraction is built on the experience of concrete: e.g., *"it helps a conceptual understanding by having something real to hang on to"* (Expert 1, p.28), *"I couldn't see how can you build, build your expertise if you are only working in abstract space"* (Expert 2, p.70),

  > You know, it's like if you give directions to somebody to go some place. If they've been there before, then they can imagine the pathway. So, when you say to turn right, you know, at the gas station, they know what you're talking about, but if you said this, otherwise, to somebody who's never been to a place, it's sort of a list of words but they can't really imagine it themselves. So, it doesn't have the same kind of depth understanding of that place. When you read directions you actually can imagine, you know, going through this to a place you've been before. (Expert 2, p.32)

- Perception and movement are intertwined with conceptualization in learning process, "*if we work with learners in a way where they enact or they gesture along with their thinking, if we encourage that, we make it much more powerful"* (Expert 6, p.19)

Among the *Operational reasons*, they mainly highlighted the importance of deeper conceptualization / sense-making of mathematics concepts, e.g., *"the process of teaching and learning, for me, […] happens more deeply with the movement, and the gestures, and enacting"* (Expert 6, p. 33), and explicit connection between mathematics and the real world:

> So, it allows them, I think, mostly to manipulate in their mind the mathematical ideas, and connect those mathematic ideas to the context, so they are not just mathematical ideas in the air, or on a piece of paper, but they actually have meaning attached to a context that is familiar to them and that they have experienced. (Expert 2, p.38)

In addition, academics point out that ABM activities improve the interest and engagement of students: "*I think it would improve students' mathematical learning, (0.4) and probably also their enjoinment of maths"* (Expert 1, p.52),

> I think there's a range of possible reasons or explanations that might provide a justification for using these activities. One would be motivation, interest, engagement of students. […] You know, we know that many students don't enjoy learning mathematics, because they think mathematics is something else, lives in the textbook, it's boring, it's dry, it has no use in the real world. So, I think teachers are always looking for ways of engaging students with Mathematics and showing them that it's not what they think it might be. So, I think that's one- one important reason. (Expert 4, p.28)

- *Characteristics of teachers*

Teachers' beliefs, awareness, and knowledge in proposing ABM activities are crucial to their implementation.

- Beliefs

Following experts' opinion, firstly, teachers should have general beliefs about teaching and learning mathematics such as an educational paradigm that is constructivist or socio-constructivist, *"I think that they would need to have an understanding, a kind of general constructivist, socio-constructivist understanding of learners needing to actively construct the knowledge themselves"* (Expert 6, p.37), specifically aimed at promoting students' exploration, e.g., *"I think they need to have beliefs that are constructivist and support an enquiry-based approach"*(Expert 1, p.30). In addition, they have to beliefs that the construction of mathematical meanings and deep conceptual understanding is the ultimate goal, as well as to embrace the belief that this meaningful knowledge is to be promoted by including all students, as indicated by Expert 4 (p.34) and Expert 5:

> They have to believe that developing a conceptual understanding is the ultimate goal and then they should want all students to do that. 'Cause if they don't really want them to understand, [but] they just want them to complete worksheets for them, they might not see the value of the material. […] Probably we have to believe that there's a purpose sort, that they're not compromising the learning or that they are really focused on the conceptual understanding, and that is the goal that they [the teachers] should want for all students (p.30)

Furthermore, they have to hold specific beliefs with respect to the ABM activities: primary belief in the value of the activity (Expert 1, p.30,62; Expert 5, p.30; Expert 3,p.80; Expert 2, p.50), for example, the activity does not undermine learning and rather promotes the development of a deep conceptual understanding of the curricular content, e.g., *"what I guess is first that they need to believe in the value of material, that it is gonna be helpful in facilitating their understanding"* (Expert 5, p.30), or it does not benefit certain students (Expert 5, p.32, Expert 4, p.32-34):

> One belief that I've come across in my mind as teacher is: "What kind of students are these activities for?"[…] I think it's for all students, all students. But sometimes teachers will believe "Oh, I could only do something like this with a really good class, in a high-achieving students and well-behave class. It just wouldn't work for my lower achieving students", but on the other hand I've also work with teachers have said "Oh, you know, I would do this with my struggling students because they need to have this kind of, you know, physical activity, but I wouldn't use it with my older students, or my high achieving students. No, no, no, they can cope with the textbook." (Expert 4, p.32)

They also must feel capable of doing so without it being a waste of time, *"I may have certain positive beliefs about mathematics, but feel unable to teach in that way for a wide lot of reasons"* (Expert 4, p.32). For instance, *"they need to believe that they can manage the students, particularly if it involves students moving around"* (Expert 4, p.40).

- Awareness

Teachers need to be aware of the complexity of the teaching-learning process, such as the multimodality of the language with which one participates in a mathematical discourse, e.g. *"a broad kind of view of that*

kind of theory of the language and we talk away into reasoning" (Expert 6, p.37). They should also be aware that these activities require flexibility in response to the classroom's needs: *"Every teacher has to translate an activity that they find into something that will work for them. So, I guess in a way all teachers are creators of tasks- no as creators, but they're adaptors. They adapt the tasks"* (Expert 3, p.38). Finally, since these activities contribute to conceptualization, the results must be evaluated over the long term, using appropriate assessment strategies, as Expert 4 emphasizes:

> So, if you're trying a new teaching approach and you wouldn't know if it works, and then you'll see - But you're using the old assessment of students! So, why are you using the assessment that you use for your old pedagogical strategies? You change the way you teach, you have to change the way you assess! Because you're shifting what you're valuing in students learning, and that, of course, can be a big barrier for teachers, because some.. Often teachers don't have control over their assessment. So, if you're preparing students for an exam, you know, written by someone else, and that can be difficult. So, curriculum and pedagogy in assessment should always line up, be aligned; so, if one changes, then everything else have to change. (p. 34)

- Knowledge

To propose ABM activities, teachers should possess a strong epistemological and mathematical knowledge, e.g. *"they have to have a solid mathematical knowledge"* (Expert 1, p.30), otherwise *"teacher knowledge would limit the way in which they could bring appropriate actions into the teaching space*" (Expert 6, p.49), and know how to relate formal knowledge with real word activities and experiences, e.g. *"taking the formal knowledge they have done in the mathematics degree, […] and hands-on experience, because they never actually put those two together"* (Expert 2, p. 42). Furthermore, teachers should master the psychological and pedagogical instruments to link cognitive processes to mathematical concepts, e.g. *"teacher knowledge and pedagogical content knowledge is going to be key in terms of enacting things in a meaningful way"* (Expert 6, p.49), and a sort of practical knowledge for realizing them:

> And the other kind of knowledge they need to have is the practical knowledge of how do you manage these kinds of tasks in a classroom situation, for the particular group of students that you were teaching, in your particular school culture, with the resources that are available to (Expert 4, p. 36)

- *Limitations*

Possible limitations are represented by the inherent downsides of the ABM activity, like difficulties in classroom management (7). For instance, *"some teachers believe in very orderly and very quiet classrooms and, you know, and what you're proposing is probably not quiet […] we can get quite noisy"* (Expert 3, p.103), and another constraints could be *"the number of students that a teacher is looking after and the command they have around managing their classroom or their students, because there's more opportunities for students to get in trouble, I guess, you could say, in these activities"* (Expert 2, p. 58). Indeed, as highlighted by Expert 4, a great difficulty when implementing activities which involves students' whole body movement could be

> knowing how to manage students when they not sitting at their desks. It's easy to control students when are sitting at their desks. But it's completely different when they're moving around the classroom, it takes a different kind of ability to.. to plan, to anticipate […] And not just for the class as a whole, but individual students, and groups of students. (p.40)

Others are lack of confidence with artefacts (teacher – students) (6), e.g. *"I guess maybe the students might compel a bit lot the materials, […] It might be, you know, like management issues, I think, using materials"* (Expert 5, p.34), the time an ABM activity takes (5), both as time to design the activity and to implement it in the classroom: e.g., *"Time is a big one, because generally embodied activities take more time. And the curriculum is very packed"* (Expert 2, p.58).

Other limitations are due to implementation errors, i.e., presenting activities in a way that is inconsistent with the philosophy that support these approaches (constructivist or socio-constructivist / exploring and inquiring) (3):

> I think all these activities require time in the classroom, […] and less teachers are willing to devote an adequate amount of time to them, they can be rushed and they don't give time, time to the children or the students to think about what they are doing […], rather than giving them enough time to think through, and to do the problem-solving themselves (Expert 1, p. 38)

Another implementation error could be to focus only on students' physical engagement (3). Experts are particularly worried about primary school teachers' awareness of the mathematical goals:

> I watch […] my young new pre-service teachers, and they design these wonderful lessons, really creative, really exotic games and physical things for the students to do, but where they miss to draw the math that they have hidden behind the move. So, they don't have the skill, or the experience, to actually scaffold the embodiment for the students, what they are doing. So, often, the lesson is tend to be quite of a shallow day, you know: I find the lesson, but not necessarily mathematically embedded or embodied. (Expert 3, p. 62)

- *Strategies for the effectiveness*

For an effective introduction of ABM activities, researchers suggest moving gradually from teaching routine, in alignment with the curriculum and teaching program:

> .. familiarity with everything, I think, could be important as well [..] Because a class has quite a routine and they are going to work on routine and you are talking about disrupting the routine to a certain extent. Oh no, not to a certain extent, to a big extent possibly (Expert 3, p.92)

For an effective implementation, the academics suggest that the teacher:

- properly designs the activity while preserving the flexibility in class time: e.g., *"to be able to open all those plans on the run"* (Expert 4, p.40)
- to be a director, not a guide, in the classroom explicitly connect mathematical contents with the experience:

> the most important thing that comes down to, is making connections. And making connections explicit, and helping students make those connections.[…] Because, I think, that the mathematics is not lying on the surface, is often a bit below the surface.[…] But, that doesn't happen in a vacuum, I think it needs the guidance of a teacher, it needs experience, you know, making connections and discussing and elaborating with peers, and those elements (Expert 2, p.46).

- selects materials and tasks that are functional to the mathematical goals you want students to achieve: e.g., *"you need to be consistent and make sure that the materials you choose are going facilitate the concept that you want to do"* (Expert 5, p.26)
- integrates these activities within a broader educational proposal into the programming:

> for something like this to be effective, teachers need to be able to see the connection between doing this task and the learning goals that have for their students, or that the curriculum has for their students […] Then, they need to see that there is a pathway from teaching like this, to students learning the things that they are there to be learning (Expert 4, p.40).

- leaves time to the students to interact directly with the materials / tools involved and promotes peer interactions: *"we need to try to get all learners in the class moving, so just like with language, when you are doing whole class teaching and you're asking and one learner is answering at the time […] it can be quite limiting for all the other learners who are just listening"* (Expert 6, p.43), *"learners have concretely discover every concept for themselves, and they must do that at their own pace"* (Expert 6, p. 45) and *"discussing and elaborating with peers"* (Expert 2, p.46).

- *Influential factors*

The concept map below (Fig. 1) summarizes the main influencing factors for the proposal and implementation of ABM activities in school, identified by the academics interviewed. The number on each link indicates the frequency of each theme within the totality of the Australian contributions. Facilitating factors are illustrated on the left side: at the top, the external factors that could foster the implementation and at the bottom the actions that could change the teacher's predisposition towards the proposal of the ABM activities. On the right, we find the hostile factors: at the top, the external factors and at the bottom the teacher's internal factors (beliefs, awareness, and knowledge) that could hinder the implementation of ABM activities. In the middle, we can find the only ambivalent factor called out, which is also listed among the hindering factors at instances where academic experts refer to it by focusing on its hindering influence.

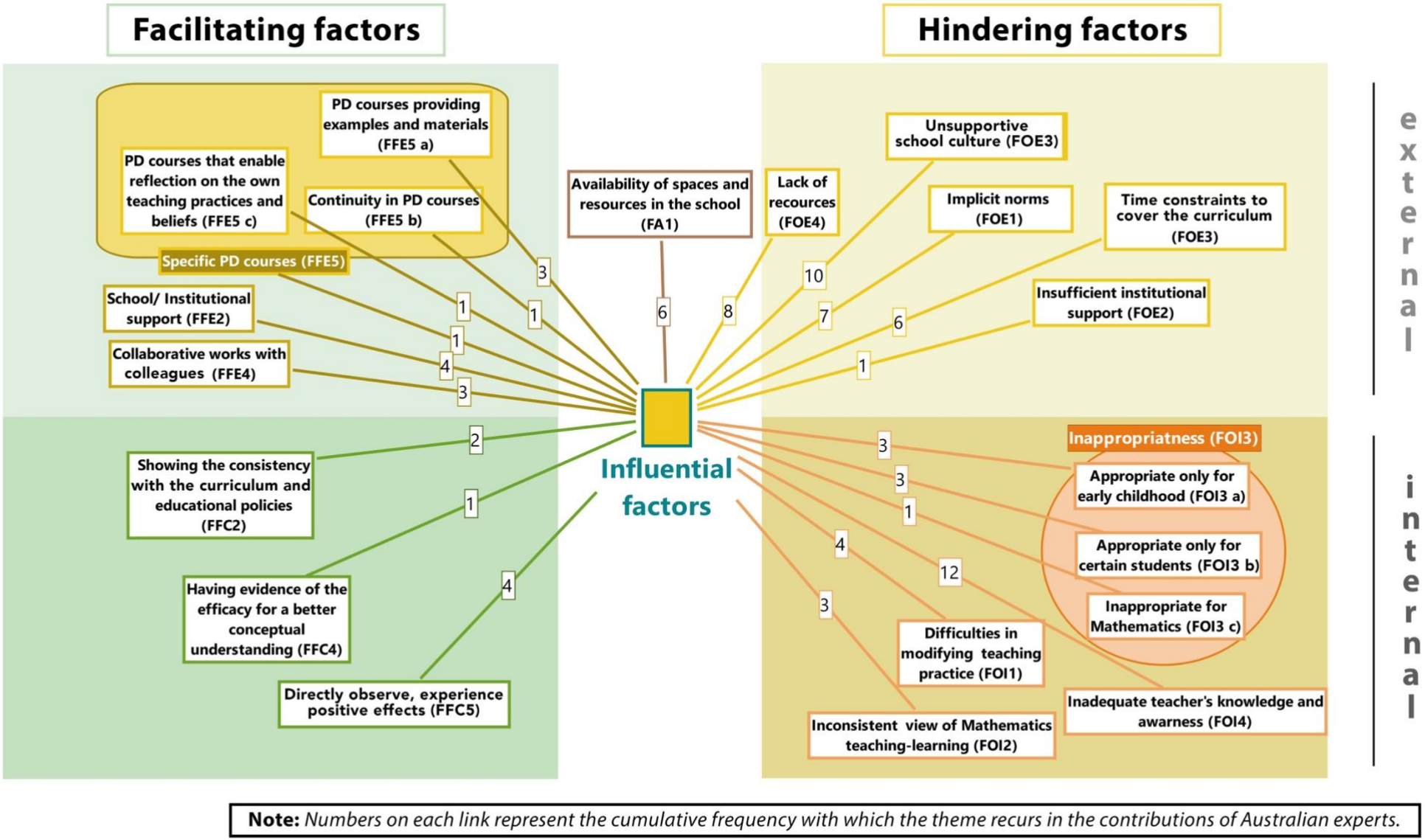


Figure 1. Concept Maps: Influential Factors for the implementation of ABM activities in school (Xmap, MAXQDA Analytics Pro)

4. Teacher survey on ABM activities

This section will outline the teacher survey we carried out to collect information on teachers' perspectives on ABM activities. Teachers were directly involved in the research by filling out an online questionnaire and, after completing it, they were asked if they would be willing to participate in an individual interview intended to elaborate on the issues raised in the survey responses. Firstly, in the following subsection, we will provide a description of the online instrument designed to investigate teachers' beliefs and teaching practices, dissemination strategies, data analysis, and a brief presentation of the results. Afterward, a second subsection will focus on the online follow-up interviews which involved a restricted number of teachers.

4.1 The questionnaire

Design

The survey items cover dimensions derived from the literature concerning teachers' beliefs on mathematics teaching and learning (Beswick, 2012; Van Zoest et al., 1994; Dionne, 1993; Ernest, 1989), conceptions of educational material usage (Skoumios & Skoumpourdi, 2021), and beliefs and instructional practices with manipulatives (Carbonneau & Marley, 2015; Golafshani, 2013; Vizzi, 2016). Other items were adapted from items on existing surveys such as OECD TALIS 2018[10] and IEA TIMSS 2019[11]. There will be additional items concerning new explorative dimensions specific to our research interests.

There are two parallel versions of the survey, one for primary school teachers and one for secondary school teachers, with minor adaptations to suit the teaching context. The survey consists of five sections:

1. *The School* – concerns general information about the current school (e.g., government / non-government school; traditional / school based on a specific educational method such as Montessori) and school level/s that the respondent is currently teaching.
2. *General* – designed to provide information about the teacher's educational background and teaching experience.
3. *Beliefs* (a) – including broad beliefs about teaching and learning mathematics (e.g., the role of the teacher or peers in the learning process).
4. *Beliefs* (b) – specific beliefs about the ABM activities (e.g., for which school level these activities are considered appropriate, what kind of educational impact is expected to be achieved, what factors can possibly limit their use, what kind of evaluation/assessment strategy may be appropriate).
5. At the end of the fourth section, a filter question concerning the actual use of these activities in daily teaching practices splits the questionnaire into two alternative parts on the basis of the teacher's use of these activities in their teaching practice (Yes/No). This next section asks teachers for additional information such as the reasons for this choice, what other teaching strategies they deem to be effective, and comment about their implementation in classrooms (if used).

The survey combines Likert-type, multiple-choice, short open-response, and vignette items. The Likert-type scales are commonly involved in research that employs questionnaires to gain information on complex variables like beliefs (Nunnally, 1994), although there are some risks to be taken into account when using Likert-type items in a survey. For instance, it is difficult to know how the respondent interprets the words used in the items, and, moreover, the main risk is that "*Likert items do not carry with them good ways for determining how important the issue is to the respondent*" (Ambrose et al., 2003, p.35). Consequently, it is difficult to understand the belief system of participants (such as the centrality of certain beliefs). The few short open-ended items allow participants to express ideas without the constraints of choosing one or more alternatives as in multiple-choice items. However, in the survey, we mostly use multiple-choice items,

[10] OECD (2019). *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*. OECD Publishing.

[11] https://www.iea.nl/studies/iea/timss

especially when asking about teaching practices, in order to obtain responses that are aligned with the variables we want to investigate.

Two vignette items are included in the questionnaire: the first to investigate teachers' beliefs on ABM activities, and the second to gain insight on the instructional strategies teachers use when implementing them in classrooms. Regarding the empirical study of beliefs, which has always presented difficult methodological questions for researchers (Finch, 1987), the use of a vignette could be a valid technique to be used. The criticism often levelled at questionnaires or interviews is that *"these techniques pose vague questions to respondents, who consequently answer in terms of their own mental picture of the task. Therefore, the information derived from such data is non-referenced, and cannot be standardised across all the respondents."* In this sense, vignette items are a good solution to reduce this misleading effect, because they present respondents *"with a more concrete and unambiguous stimulus to refer to"* (Poulou, 2001, pp.51-52). Research in mathematics education highlighted that vignette items are also a good instrument to be used to get information about instructional practice (Stecher, 2006). However, we have to take into account the possible inconsistencies that might exist regarding participants' descriptions of what they would do at an abstract level and what occurs in reality. Indeed, as Skilling and Stylianides have underlined, when using vignette items, it is important to be aware of *"participants' espoused beliefs are representative of their intentions rather than predictions of behaviours and are valuable for providing insights into their interpretations and perceptions"* (Skilling & Stylianides, 2020; p.554). Nevertheless, since our aim is to investigate teachers' perspectives, instead of teachers' behaviours, this fact is not a major limitation. The vignette items for the questionnaire were designed upon the framework of Skilling & Stylianides (2020).

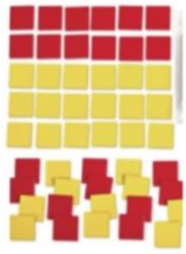
Vignette 1. Referring to the conception, the *capturing content* of the Vignette 1 (Fig.2, Fig.3) comes from practical experiences from the field. In particular, it concerns a hypothetical real-life situation, focused on a problem identified as common by many academic experts in mathematics education who work closely with teachers. Teachers trying to implement for the first time an *ABM activity* could encounter many difficulties. As a result, they may have the feeling of failure and believe that the proposed learning activity is not effective at all. Often, this bad initial experience influences teachers to such an extent that they reject the proposal of ABM activities altogether. In terms of the design description, the presentation is a traditional, well-structured narrative vignette (e.g., in Stecher et al. 2006), which unfolds through a series of stages (Jeffries & Maeder, 2005). The length of the vignettes is relatively brief in order to hold the participant's attention and increase the responses' likelihood, limiting the *carry over effect* which is frequent in online surveys (Skilling & Stylianides, 2020). Images are combined with the written text to help teachers focus on the vignette's content. As suggested by Stecher et al. (2006), more realistic responses can be obtained if a classroom context, in which situating the answers, is provided to respondents. We constructed a vignette presentation as a hypothetical classroom scenario in which a young teacher implements an *ABM activity* for the first time. Details are provided about manipulatives involved, instructional strategies, students' behaviours, and teachers' reflections on her practice. Skilling and Styliandes (2020) highlighted *"the importance of portraying vignette information in ways that resonate with participants so that they are able to respond in ways that are effective for capturing their views about the research phenomena"*. Following this suggestion, we designed two different parallel settings of the vignette-item, contextualized either for the primary (Fig. 2) or secondary (Fig. 3) school teachers. In both vignettes the same classroom scenario is presented. However, they differ for the topic of the learning activity proposed in the vignette presentation: for the primary school version, the learning activity presented is focused on distributive properties of multiplication (a typical arithmetical topic of primary school), for the secondary school, on the cube of a binomial (a typical algebraic topic of secondary school). The perspective from which participants are asked to respond to vignettes is the participant's personal viewpoint. The function of the vignette item is to identify teachers' beliefs on the proposal of ABM activities in classrooms, by expressing their agreement with statements that comment on the story presented. A set of Likert scales follow the presentation.

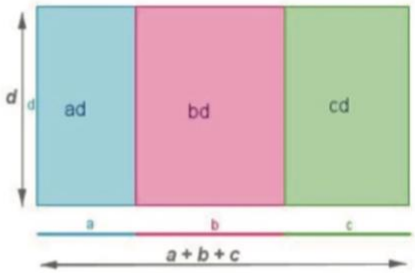
20) Please read the brief story before answering the following questions.

Monica is a young teacher who has decided to implement an active learning activity using manipulative materials, in her classroom, for the first time.

The activity requires the use of wooden shapes to solve arithmetic problems through geometric representations.

Distributive properties of multiplication





Monica shows the whole class the wooden shapes and explains how students can use them to solve arithmetic problems. Then, she asks the students to carry out a series of pre-defined tasks in scheduled timing, suggesting using the wooden shapes. She observes the students while they are carrying out the tasks independently.

Even though, at first, many students show interest and become engaged with the new way to represent arithmetical properties, the majority of students do not use wooden shapes to solve the tasks. Instead, they use traditional strategies (i.e., paper and pencil calculations) they are already familiar with.

Thus, Monica believes the activity is not effective, as most of the students did not use the wooden shapes and geometric interpretations to carry out the tasks.

a) The activity was indeed effective, as students got to know an alternative way of representing distributive properties. It doesn't matter if they solved the tasks with the already known solving strategies.

b) This type of activity takes a long time before students become familiar with a new way of working and become aware of how experience with wooden shapes can help them solve arithmetic problems.

c) Proposing exploratory tasks and open-ended problems make this type of learning activity more effective than solving predefined tasks in scheduled timing.

d) A high level of student interaction with the teacher and peers during the activity would have stimulated the use of wooden shapes to solve arithmetic problems.

e) The reason for Monica's failure is that she failed to convey to the students the goal of the activity: to explore and become familiar with geometric interpretations of distributive properties.

Figure 2. Vignette 1, for primary school teachers

20) Please read the brief story before answering the following questions.

Monica is a young teacher who has decided to implement an active learning activity using manipulative materials, in her classroom, for the first time.

The activity requires the use of wooden shapes to solve algebraic problems through geometric representations.

E.g. Cube of a binomial

Monica shows the whole class the wooden shapes and explains how students can use them to solve algebraic problems.
Then, she asks the students to carry out a series of predefined tasks in scheduled timing, suggesting using the wooden shapes. She observes the students while they are carrying out the tasks independently.

Even though, at first, many students show interest and become engaged with the new way of representing algebraic problems, the majority of students do not use wooden shapes to solve the tasks. Instead, they use the traditional strategies (i.e., paper and pencil calculation) they are already familiar with.

Thus, Monica believes the activity is not effective, as most students have not used the wooden shapes and the geometrical interpretation to deal with the tasks.

a) The activity was indeed effective, as students got to know an alternative way of representing algebraic problems. It doesn't matter if they solved the tasks with the already known solving strategies.

b) This type of activity takes a long time before students become familiar with a new way of working and become aware of how experience with wooden shapes can help them solve algebraic problems.

c) Proposing exploratory tasks and open-ended problems make this type of learning activity more effective than solving predefined tasks in scheduled timing.

d) A high level of student interaction with the teacher and peers during the activity would have stimulated the use of wooden shapes to solve algebraic problems.

e) The reason for Monica's failure is that she failed to convey to the students the goal of the activity: to explore and become familiar with geometric interpretations of algebraic problems.

Figure 3. Vignette 1, for secondary school teachers

Vignette 2. The design of Vignette 2 (Fig. 4) is inspired by an exemplar vignette illustrated in Skilling and Stylianides' paper (2020), which was developed in the mathematics engagement study the authors conducted in 2015 (Skilling & Stylianides, 2015). Similarly to Skilling and Stylianides', we constructed a presentation with two narrative vignettes describing the teaching strategies of two different fictitious teachers in implementing an ABM activity in the classroom. In particular, we focused on a manipulative-based mathematical activity. The two teaching strategies differ in many characteristics such as the level of instructional guidance and, more generally, the way they carry out the hands-on work (e.g., classroom management, timing factors) and stigmatise the polarised way of conducting this type of activity. The selected features, about the teaching strategies that accompany manipulatives-based learning activity, are broadly debated topics in mathematics education research (e.g., Carbonneau & Marley 2015). We drew on the literature specific to the central constructs of the research to outline the two contrasting profiles presented in the vignette item. We designed the vignette-item presentation in a written format, adding an image to each profile to characterize the

fictitious teachers. The descriptions of the two profiles provide similar details and are similar in length to appear equally valued (Huges & Huby, 2004). We avoided the use of technical terms and provided brief useful contextual information (e.g., class level) to make teachers, as quickly as possible, familiar with the narrative.

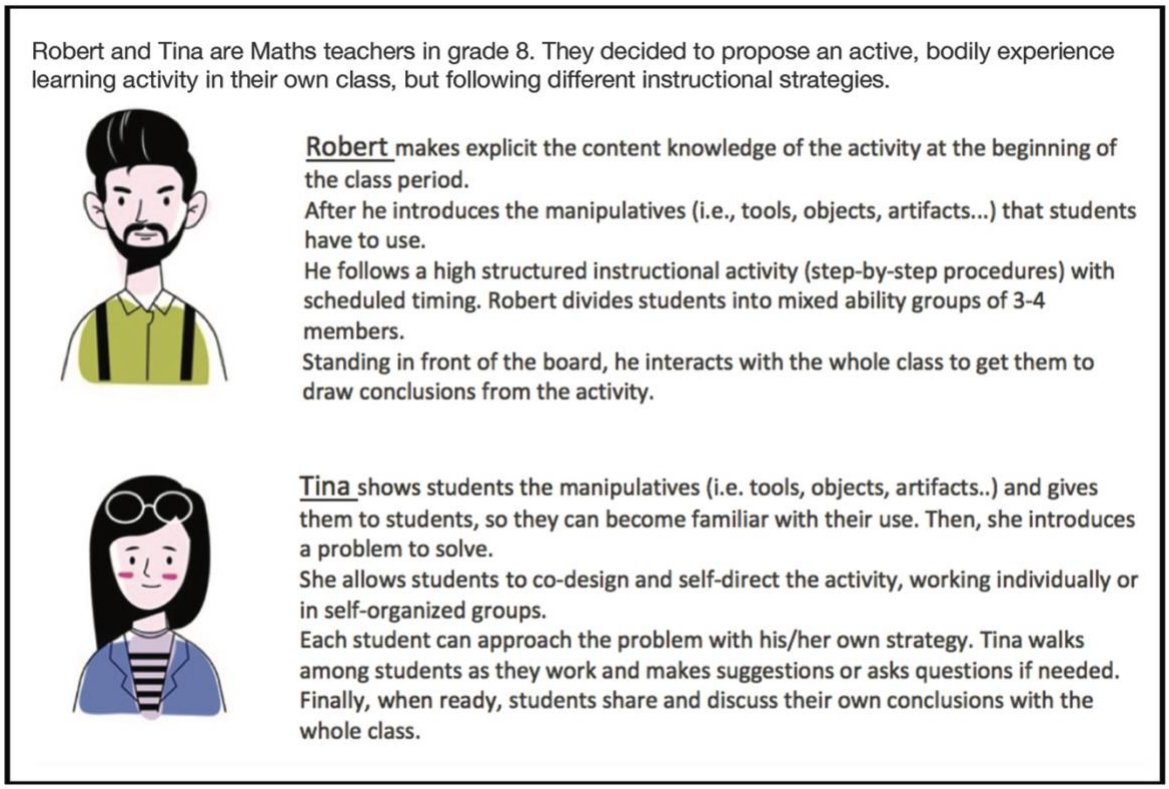


Figure 4. Vignette 2 (Text)

The purpose of Vignette 2 is to gain insight into teacher instructional strategies when implementing these activities in schools. First, we asked participants which profile they most identify with. Then we ask them to select from a list the characteristics they believed to be most relevant in increasing the efficacy of the learning activity, and to write down what they would have done differently from the chosen profile, to improve the activity's effectiveness. Participants were then asked to respond to this vignette item at the end of the questionnaire section concerning the description of their instructional practice when implementing an *ABM activity* in their classrooms. As already mentioned, they only have access to this section if they have declared to include these activities in their practice when answering the filter questions. Differently from Skilling and Stylianides' exemplar model, we mainly used closed-ended questions in our vignette items.

While, as illustrated above, Likert-type items are used in Vignette 1, Vignette 2 consists of two multiple-choice items and a short open-ended question. Although open-ended questions are perfectly suited for a vignette-item to be used in an exploratory instrument, "*responses may be elicited through closed and forced choice responses"* and, this kind of format, *"notably in surveys, allow for a broad range of variables to be incorporated into the vignette research design*" (Hughes & Hubi, 2004, pp.42-43).

Appendix 2 contains the questionnaire; all items are present, although the internal logic of the web-based instrument is not reported.

Administration strategies

The questionnaire is a web-based tool created with Qualtrics software, in the updated version available to ACU students and researchers. The estimated time for filling out the questionnaire is around 20 minutes.

Primary and secondary schools' mathematics teachers were recruited from across Australia, via National and State mathematics teacher professional associations' Facebook pages/groups, or associations' newsletters. Among them, the AAMT (Australian Association of Mathematics Teachers), the QAMT (Queensland Association of Mathematics Teachers), the MASA (Mathematics Association of South Australia), the PMA (Primary Mathematics teacher association of South Australia), the MTANT (Mathematics Teachers' Association of the Northern Territory), the MANSW (Mathematical Association of New South Wales), the MAV (Mathematical Association of Victoria), the MAT (Mathematical Association of Tasmania), the CMA (Canberra Mathematical Association), and the MSCA (Montessori Schools and Centres Australia) were contacted for outreach. These outreach, as well as the other recruitment strategies adopted, were consistent with Ethics Committee approval. This entailed posting an anonymous link to the questionnaire on Facebook pages/groups/newsletters with a request for it to be completed by participants. By clicking on the link, potential participants gained access to information about the project. Participants had then been required to provide consent prior to completing the questionnaire. In addition to advertising via Australian mathematics associations' Facebook organisations newsletters, we sought to advertise through umbrella organisations (for example, the Independent Schools Queensland; Catholic Education Offices), and broader teacher organisations bringing together Australian teachers, for example, through the Australian Teachers Association, the (AITSL) Teachers supporting Teachers, the Australian Prep Teachers, the Australian Primary Teachers, the Australian Secondary Mathematics Teachers 7-12, the Australian Year 7 Teachers, the Awesome Math Teacher Australia, the Western Australia Secondary Maths Teachers, the Melbourne Teachers, the QLD Teachers, the QLD Primary Teachers, the TwinkI Beyond Australia Secondary Teachers, the TwinkI Australia Primary Teachers, the Math Education Matters, and the Teacher sharing Ideas and Resources Facebook pages. Furthermore, we sent the questionnaire to a list of mathematics educators who have indicated their interest in participating in ILSTE (Institute for Learning Sciences & Teacher Education) mathematics research projects. We invited them to participate in this research by sending them the information sheet for this project, together with the link to the online questionnaire by email. The published posts and email advertisements are included in Appendix 1.

The administration of the questionnaire in Australia took place in 3 phases:

I. end of November (reaching less than 5 respondents)
II. first half of February (reaching around 15 respondents)
III. March to mid-May (reaching more than 60 respondents)

Data Analysis

Descriptive statistics (e.g., frequencies, percentages, cross-tabulations with Chi-squared test) and correlations resulting from recording the similarities and the differences among the basic variables of the sample have been used to analyse the Likert-type and multiple-choice item responses. Open-ended questions were initially coded following an analytic induction from the content (Cohen et al., 2017; e.g., in Hourigan et al., 2016). Then the initial codes have been grouped into categories or themes, which have been examined for patterns across school levels. The number of comments from teachers at each school level in each of the broad categories have been counted to provide an indication of the relative emphasis on each category/theme across school levels, to identify the main trends and recurring themes.

In the followings lines we will provide a summary of the main results. Furthermore, frequencies and cross tabulation are illustrated in Appendix 4.

Summary of main results

Sample

Respondents	
Total respondents:	81
Completed questionnaires:	39

The school	
School level	
• Primary school	15
• Secondary school	64
Total	79

School typology	On 74 respondents
• Non-government school: Catholic or Independent	45
• Government school	29
• Comprehensive (Open) school	58
• Streamed classes into attainment groupings	11
• Selective / Special / Specialist / International school	5
• Traditional method School	71
• Specific Educational Method school	3

Among Secondary school teachers, the **major subject taught** in the current school year (or majors, if two subjects are taught for the same number of hours) is **mathematics** (58), a small number (6) taught Sciences and 5 of them other subjects.

▪ Teachers' background and teaching experience

The highest level of formal education, for the majority of primary school teachers, was the Master's Degree, even if in some cases the degree was not specifically related to the education field, nor to a scientific discipline; whereas, for the majority of secondary school teachers, it was the Bachelor's Degree (Fig. 5).

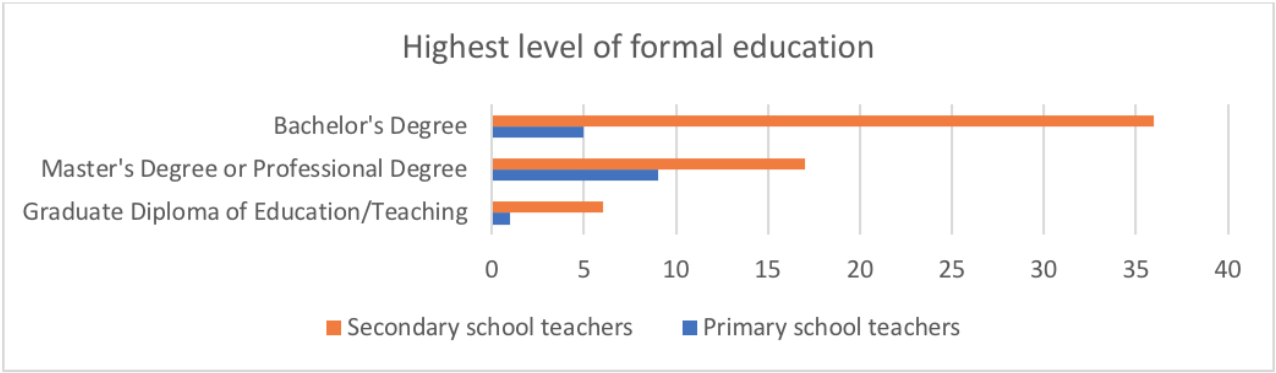


Figure 5. Q_7 Teachers' highest level of formal education (N_Primary=15, N_Secondary=59)

Among the **secondary school teachers**, 21 had a degree in mathematics (e.g., with a specialization in Geometry, Analysis, Numerical Analysis, Probability and Statistics, Algebra), 12 had degrees focused on mathematics education, 18 undertook other studies (scientific, but not on education), and 6 had degrees in other fields (in education but not specific to mathematics, or other studies). Thus, most secondary school respondents had the main disciplinary knowledge in a **science subject**, with a significant percentage of them having a **specialization in mathematics education**. As for primary school teachers, we find a predominantly

non-scientific background, in 5 cases not even specifically related to education. Figure 6 shows the main specialization of respondents during college/University education.

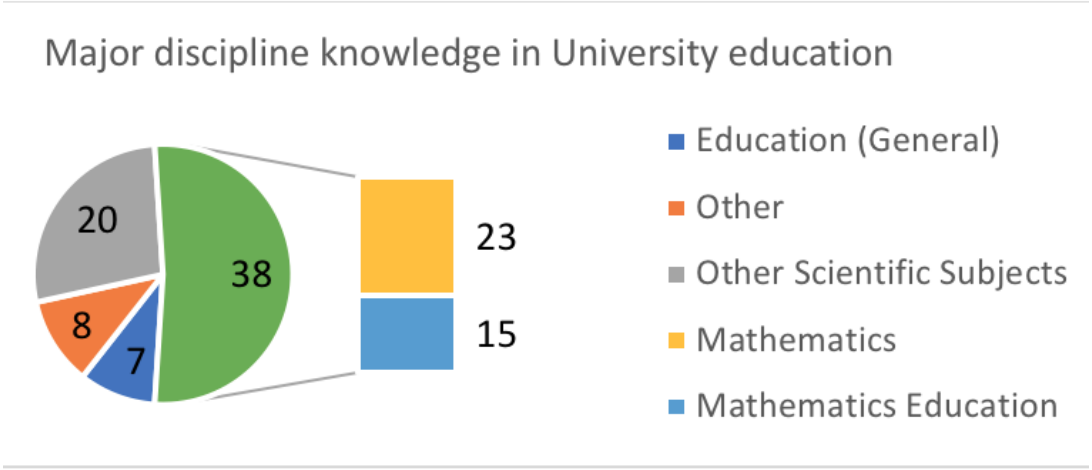


Figure 6. Q_8: Teachers' major discipline knowledge in College/ University education (N=73)

As shown in the Table 4, the majority of the respondents are **experienced teachers**, although 25 secondary school teachers have less than 10 years of experience.

School level	Newly employed Teachers (1-3 years)	Middle-expertise teachers (4-10 years)	Expert teachers (more than 10 years)
Primary	2	3	9
Secondary	13	12	34

Table 4. Q_9: Teachers' teaching experience (N=63)

Beliefs on mathematics teaching and learning

Looking at respondents' opinions on the role of the different actors within the classroom in the development of student's mathematical thinking (Q_10), we note that the **role of peers is considered to be much less incidental than that of the teacher and the student** themselves toward their learning (Tab. 5).

Q_10	*To a large extent*	*To a moderate extent*	*To a small extent*	*Not at all*	*I don't know*
a) **Teacher**'s role	**56**	**14**	**0**	0	0
b) **Peers**' role	**15**	**34**	**19**	0	**1**
c) **Student**'s role	**57**	**11**	**0**	0	0

Table 5. Q_10: Roles of different actors in the classroom in the development of the student's mathematical thinking. (N_10a=70, N_10b=69, N_10c=68)

For the majority of Australian respondents, the **role of teachers** (Fig. 7) in supporting mathematical development seems to be mainly providing students with the necessary scaffolding and teaching skills to think mathematically (***Facilitator***). Fewer teachers indicated the role of ***Explainer***, allowing students to comprehend and deeply understand mathematical concepts. Few Secondary teachers selected the role of ***Instructor***: preparing students to use and apply mathematics results and procedures correctly and efficiently.

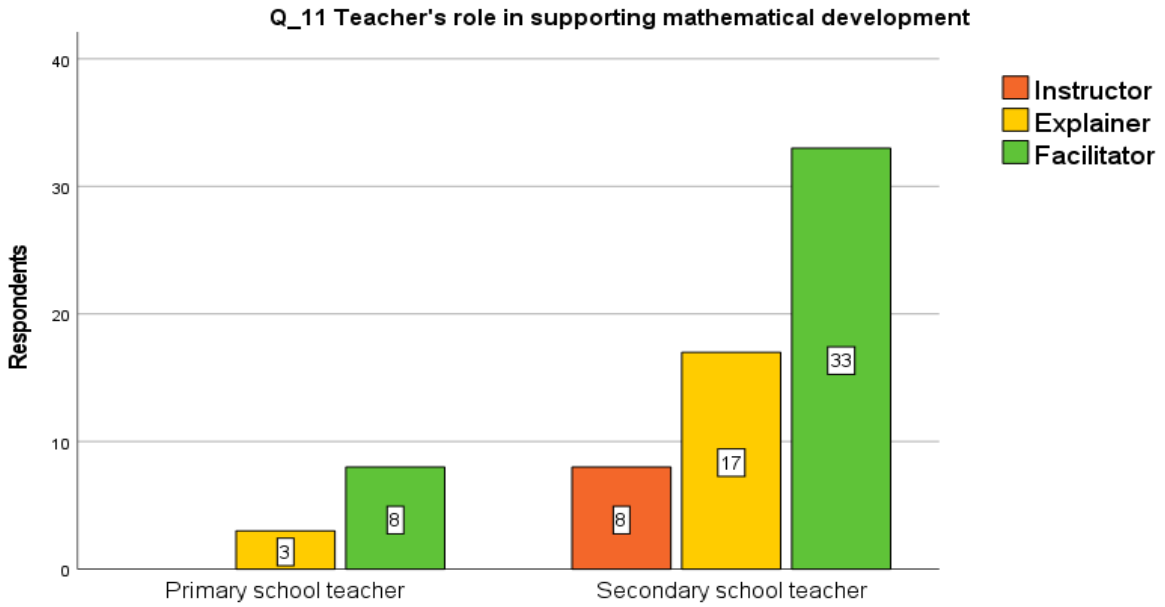


Figure 7. Q_11. Teacher's role in the development of mathematical learning, division by school level (N_Primary=11, N_Seconday=58)

Regarding the respondents' **view of mathematics,** teachers on average agree that mathematics is a beautiful and useful human endeavour that builds a pathway to knowledge and a tool for thinking (Fig. Q_12(b)). This is more frequent in Primary than in Secondary school probably as they often do not have a Science nor even a mathematics-oriented background.

Secondary school teachers fairly share a view of mathematical knowledge as a toolbox for problem solving (Fig. Q_12(a)) and, slightly less, of mathematics as a science of formal thinking and rigorous logic (Fig. Q_12(c)). Primary school teachers tended to agree less with these positions. This latter difference, if we polarize the responses, is statistically significant, albeit with very small numbers (Chi_square=4.272, df=1, *p=0.039<0.05).

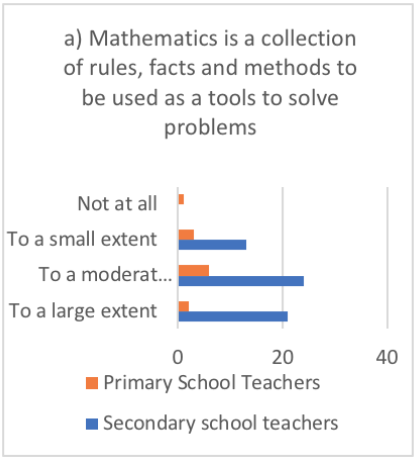


Figure. Q_12 a, Beliefs on Mathematics, its teaching and learning (N_Primary=12, N_Secondary=58)

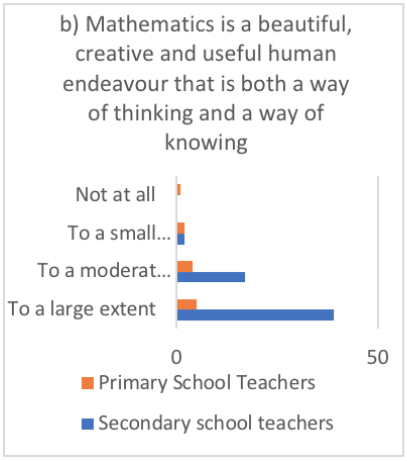


Figure Q_12 (b). Beliefs on Mathematics, its teaching and learning (N_Primary=11, N_Secondary=58)

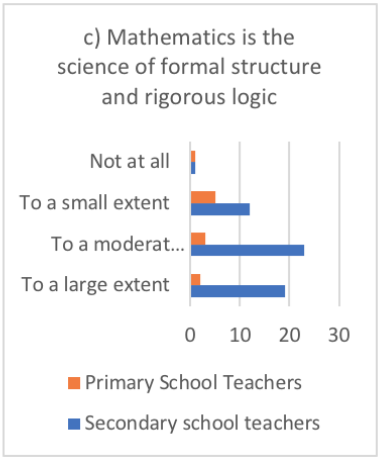


Figure. Q_12 c, Beliefs on Mathematics, its teaching and learning (N_Primary=11, N_Secondary=55)

Regarding the teaching-learning of mathematics, we note that **secondary school teachers are quite prone to a transmissive view**. In general, they are convinced that it is the teacher's responsibility to provide clear instructions and strategies for problem solving (Figure Q_12(d)) and that an expository style is the clearest way to present mathematics (Figure Q_12(e)). In contrast, they are less convinced that mathematics cannot be transmitted but must be constructed by the student; Figure Q_12(f) shows how they are distributed almost equally on this item between the lowest and highest values. Conversely, primary school teachers lean toward a more constructivist (or socio-constructivist) paradigm of learning, placing the student is more responsible

for his or her own learning and placing less emphasis on the teacher's transmission of mathematical knowledge.

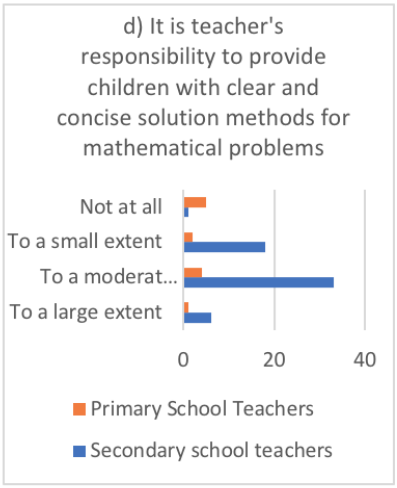


Figure. Q_12 d, Beliefs on Mathematics, its teaching and learning (N_Primary=12, N_Secondary=58)

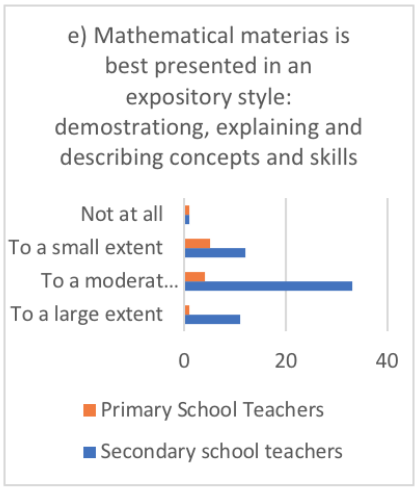


Figure. Q_12 e. Beliefs on Mathematics, its teaching and learning (N_Primary=11, N_Secondary=57)

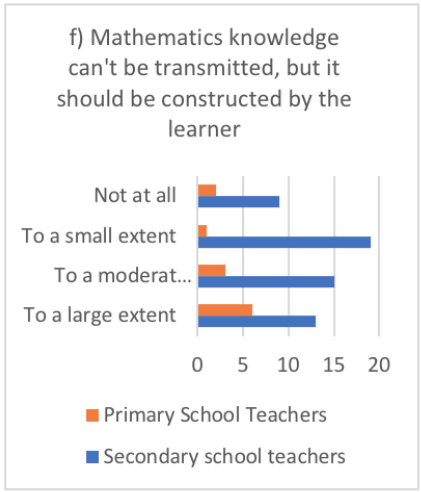


Figure. Q_12 f, Beliefs on Mathematics, its teaching and learning (N_Primary=12, N_Secondary=56)

Probably, a less transmissive view of mathematics teaching-learning process, is linked to teachers' subject of specialization (e.g., Tab. 6) in mathematics education.

Subject of specialization (Q_8)	Q_12e From moderate to large extent	Q_12e Not at all to a small extent	Total
Mathematics	16	5	21
Mathematics Education	6	6	12
Scientific subject (No math.)	17	1	18
Total	39	12	51

(Chi-square=7.906, df=2,*p=0.019<0.05)

Table 6. Contingency table between the major subject of University education (Q_8) and beliefs that expository style is the best to present mathematics (Q_12e)

Beliefs on ABM activities

The relevance

The majority of respondents agreed to a moderate extent that it is important to propose active learning activities involving students' body and movement in mathematics teaching practice, many to a large extent. Respondents distribution on this item is shown below:

20 of them indicated *To a large extent* |34 *To a moderate extent* |2 *To a small extent* |1 *Not at all*| N=63

In general, one might infer that this belief could be linked with what we can call as an educational paradigm less transmissive.

	Q_12f From Moderate to Large extent	Q_12f From Not at all to Small extent	Total
Q_13 From Moderate to Large extent	32	20	52
Q_13 From Not at all to Small extent	2	7	9
Total	34	27	61

Table 7. Contingency table between the importance of implementing ABM activities (Q_13) and beliefs that mathematics knowledge cannot be transmitted, but it should be constructed by the learner (Q_12f)

Similar response patterns can be found for Q_12d and Q_12e, regarding teachers' paradigm of mathematics education. However, please note that distribution in these contingency tables are not statistically significant.

Topics

In asking respondents for examples of content / topics that could be taught with ABM activities, they referred to both particular topics and general content areas. Table 8 categorises the main subject areas that were provided as examples. Mainly, they belong to the area of Number and Algebra for both primary and secondary school teachers, but Geometry and Measurement also cover a large proportion of the examples given. A fairly shared area is Probability and Statistics, and there are very few examples in the other areas, which are also more specific. Finally, some respondents indicate that all topics could be taught in this way.

Areas of the contents to be taught with ABM activities		*Secondary school*	*Primary school*	*Total*
▪ Number and Algebra		28	7	35
▪ Geometry and Measurement	Geometry	17	1	34
	Measurement	12	4	
▪ Statistics and Probability		13	3	16
▪ Percentages, ratio, scales and Financial Maths		5	0	5
▪ Functions and graphics		4	0	4
▪ Computational thinking and algorithms		2	0	2
▪ Problem solving		1	1	2
▪ All		5	2	7

Table 8. Results categorised in subject areas, Q_15 : topics/ contents to be taught with ABM activities

Appropriateness (school years)

In Q_14 we ask for which school levels respondents believe ABM activities are appropriate with a question in open-ended format.

Often Australian respondents gave specific responses with respect to the grades to which they refer (e.g., *"Y7 to 12", "Years 7 and 8", "Years 8-12", "Years 7-9 (but also most levels in junior school)", "P-10", "year 7-10"*). However, in the categorization we combined responses indicating individual grades with those including all lower grades as well, noting that it is nonetheless a recurring practice to include all the cases below (*"up to 10", "up to grade 12-depends on the learner", "kindy to year 9", "early to mid-secondary"*) and that the indication with respect to specific grades could also be a desire not to express oneself about what one does not know, as made explicit by one respondent with the phrase *"All levels that I'm aware of"*.

		Primary, Basic Class	(To) Middle School	(To) High School (Senior excluded)	All	Totale
	Primary school teacher	7	0	0	0	8	15
	Secondary school teacher	12	4	8	4	36	64
Totale		19	4	8	4	44	79

Table 9. Q_14 results, with respondents grouped in school levels (N=60)

Most respondents believe that they can be **appropriate for all school grades** with some differences between Primary and Secondary teachers (Table 9).

Secondary school teachers show moderate doubts about conducting such activities with adolescents and pre-teens, especially with reference to their level of mathematical ability: *"More depends on the level of the student I find. Lower kids usually need the hands-on experience. Abler children usually do well with expository stuff."*

Even in the responses that belong to the *All* category we can observe noticeable differences, for example, with respect to the topics to be covered (e.g., *"All but not for every topic", "All, but decreasing as mathematical knowledge increases"*) or as a preference for lower grade schools (e.g., *"Up to grade 8 is easier to incorporate, but after then it is still beneficial", "All level but especially in younger students", " All years, but particularly in lower school"*). However, the majority, and still the totality in Primary school teachers, show confidence in the activities without expressing limitations, e.g., *"All year levels and beyond (university courses)"*.

This confirms a trend, observed also in Italy, whereby Secondary school teachers believe that activities are not adequate or are **limitedly adequate especially for more advanced groups of students**, differently from Primary school teachers.

Expected outcomes

According to respondents, ABM have a **positive influence** on many goals related to the development of mathematical thinking (particularly with respect to ***mathematical visualization skills***, ***interest and motivation***, and ***deep understanding***). Less agreement can be seen on impact on attitudes, cross-curricular skills (problem solving, critical thinking and creativity) and on ***performance on standardized tests***.

In terms of the characteristics on which activities have an **impact**, we note that activities are considered important for ***increasing teachers' knowledge of the student learning process***, and, to a lesser extent, to create a ***supportive classroom climate, conducive to expression of opinions***. Even less shared among respondents was the impact on ***inclusion***.

Constraints

Three major **constraints** were identified by the respondents:

1. ***classroom management*** (42)
2. ***time factor*** (41)
3. ***availability of resources and space*** (36).

Those are followed by other limitations such as: being suitable *only for certain categories* of students (19), being *slightly effective* for the purpose of carrying out the curriculum (19) (which is aligned with the *time factor* limitation), the presence of a *hostile school culture* (6), and a *lack of adequate training* (2).

Assessments

Regarding **assessment** strategy or instrument appropriateness, teachers expressed a variety of possibilities. The most shared is ***observation*** (27), followed by ***project work*** (20), *self-assessment* (14) and *portfolio* (14), along with those who expressed that they do not consider it appropriate to use any type of assessment (13). Even fewer teachers chose ***written assessment*** **(only 11)** and finally *peer assessment* (6) and *oral examination* (5).

Vignette 1: Commenting on Monica's failure in carrying out ABM activity for the first time

Looking at the possible respondents' interpretation for the feeling of failure of the teacher Monica (Tab. 10), when conducting an ABM activity for the first time, highlights some shared beliefs on ABM activities.
Respondents mainly believe that these activities require time to be familiar with the proposed new way of working (b), that these activities require explorative tasks (c) and a high level of interactions with peers and students (d) to ensure their effectiveness. However, they mostly do not believe that a reason for the possible failure could be a lack of clarity as to the goals of the proposed ABM activity (e) and that using already known paper and pencil strategy to solve the task proposed is not a sign of the failure of the activity.

	From a moderate to a large extent	Not at all or to a small extent	I don't know
a) The activity was indeed effective, as students got to know an alternative way of representing distributive properties/algebraic problems. It doesn't matter if they solved the tasks with the already known solving strategies.	37	15	0
b) This type of activity takes a long time before students become familiar with a new way of working and become aware of how experience with wooden shapes can help them solve arithmetic/algebraic problems.	35	12	0
c) Proposing exploratory tasks and open-ended problems make this type of learning activity more effective than solving predefined tasks in scheduled timing.	31	13	3

d) A high level of student interaction with the teacher and peers during the activity would have stimulated the use of wooden shapes to solve arithmetical/algebraic problems.	33	12	1
e) The reason for Monica's failure is that she failed to convey to the students the goal of the activity: to explore and become familiar with geometric interpretations of distributive properties/algebraic problems.	21	26	1

Table 10. Vignette 1_ Results (N_min=48 , N_max=52)

Filter question: The activities in daily school practice

Almost in their entirety, primary school teachers implement ABM activities in their school practice, in secondary school the vast majority suggest them, but a significant portion do not (Tab. 11).

Q_21 *Do you include the ABM activities in your instructional practice?*	Total	Primary	Secondary
Yes	41	8	33
No	16	1	15
Total	57	9	48

Table 11. Q_21: Filter question_ Results (N=57)

In particular, we can observe that, among those who expressed that they believe, from a moderate to a high extent, in the ABM activities importance, 36 of them implement them while 12 of them do not. On the other hand, among those who consider them of little or no importance, 3 of them do not suggest them at school while 4 of them stated that they do.

Why not?

Main reasons for not implementing these activities in school are:

- ***lack of time*** (6) (which we see, however, is related to the lack of belief in the importance of the activities)
- ***lack of available resources and materials*** (5)
- ***difficulties in classroom management*** (5)
- the belief that they are ***not suitable for one's school grade*** (5) (which is related to the belief that they are only suitable for students in the lowest school grades).

When ABM is not implemented, 2 alternative strategies are mainly adopted: ***linking lesson content to students' world experience and previously developed content***. Thus, strategies where input comes primarily from the teacher tend to be preferred.

Proposal and implementation of ABM activities

Frequency and time spent on ABM activities

The majority of respondents declared to often propose in their practice an ABM activity (at least 1 time per month), while 15 of them does it weekly.

	1 a week or more	*1-3 times a month*	*5-10 times every year*	*Less than 4 times every year*	*Other*
Frequency	15	10	8	5	3

Table 12. Q_22: How often do you implement ABM activities in your instructional practice? (N=41)

Most respondents spent an adequate amount of time (1-3 lessons) on these activities although 16 teachers dedicated less than a lesson to these activities.

	Less than a lesson	From 1 to 3 lessons	More than 3 lessons
Time spent	16	22	2

Table 13.Q_23: On average, how much time do you spend implementing an ABM activity? (N=40)

Objectives of the proposal

Teachers propose ABM activities mainly to **introduce new topics** (32), as **consolidation activities** (28) and **to enhance students' motivations** (28). Few of them propose them as enrichment activities (15), remedial activities (10) or to revise topics (10).

Selection of activity and materials involved

The majority of teachers indicated using **interactive digital tools** (30) and **physical manipulatives** (31), **mechanical tools** (25) and **daily life objects** (26). Fewer indicated only using the students' body (20), computational devices (15) and gym equipment (11).

The majority of respondents **adapt commercially developed materials/tools** (28) or design and build materials/tools from scratch (24), although some teachers use commercially developed materials/ tools (17).

The majority of respondents select ABM activities on the basis of **their own experience** (as a teacher or student) (24), few of them **follow colleagues' suggestions** (10). Particularly, they pay attention to the **affordability/ accessibility / availability of resources** (15) and select them for **specific goals or students' needs** (18).

Difficulties experienced

The main difficulties experienced by students are ***to apply mathematical knowledge in the activity*** (14), ***to formalize what they have learned*** (15) and ***to transfer in new context what they have learned*** (15). We can then summarize that it is in the relationship among formal mathematics knowledge and what was learned during the activities.

Vignette 2: Selecting teaching strategy between high and low levels of instructional guidance

To analyse respondents' instructional strategies when implementing ABM activities, we asked them to identify themselves with a fictitious teaching profile (Figure 8). The majority of respondents self-identified the most with Tina, who is the teacher that implements a lower level of instructional guidance and a more explorative approach, while 11 respondents indicated Robert as their teaching model.

Robert makes explicit the content knowledge of the activity at the beginning of the class period.
After he introduces the manipulatives (i.e. tools, objects, artifacts..) that students have to use.
He follows an instructional activity (step-by-step procedures) with scheduled timing. Robert divides students into mixed ability groups.
He interacts with the whole class to get them to draw conclusions from the activity.

Tina shows students the manipulatives (i.e. tools, objects, artifacts..) and gives them to students, so they can become familiar with their use. Then, she introduces a problem to solve.
She allows students to co-design and self-direct the activity, working individually or in self-organized groups.
Each student can approach the problem with his/her own strategy. Tina walks among students as they work and makes suggestions or asks questions if needed.
Finally, when ready, students share and discuss their own conclusions with the whole class.

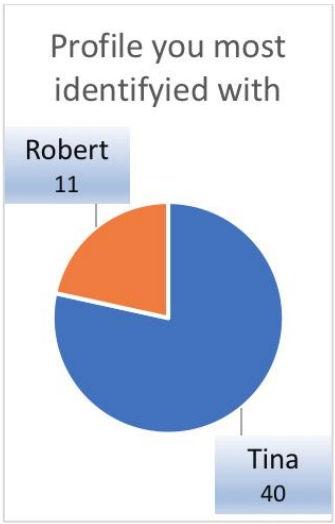


Figure 8. Vignette 2_results (N=51)

Robert

Among Robert's strategies, ***making explicit at the beginning of the lesson the content*** that will be addressed, seems to be the most important thing considered by the respondents (4). Others considered that ***proposing a step-by-step activity*** (3) was most relevant, and, to a lesser extent, ***guiding the class to conclusions*** (2). Finally, only one respondent indicated dividing the class into groups of similar ability as most important and another respondent did not answer the question.

Looking at what respondents would have done differently from Robert, we note that, except for one case, there is no tendency to mitigate the strong instructional lead of Robert's strategy, but to reinforce it.

Tina

Among the strategies that Tina proposed, respondents think it is particularly important to introduce the problem and ***let students deal with it with their own strategy*** (11) and ***to walk between desks to provide support to students*** (10). Fewer considered important to allow time for students to become familiar with the materials introduced (6). Only two respondents indicated that the most important trait is to allow time for students to discuss and share their conclusions at the end of the lesson. Finally, 11 respondents who chose this profile did not answer this question.

4.2 Follow-up interviews

Although the online questionnaire enabled us to reach a certain sample of teachers, the information we collected deserved to be further investigated with follow-up interviews, especially because of the prevalent use of closed-ended items. For this reason, we sought to explore in depth some particularly significant issues with some of the teachers who completed the questionnaire, through a semi-structured online interview.

Selection, and involvement of participants

Upon completion of the questionnaire, 16 teachers provided their email indicating that they were willing to be contacted again by the researchers to conduct an individual follow-up interview. With nine of them it was possible to arrange a 30-minute interview between April 2022 and May 2022.

Interviews prompts

The semi-structured interviews followed a protocol (reported in Appendix 2) that was structured as shown below (Tab.14). After a brief introduction, we moved on to a second part asking them about their impressions and opinions regarding filling out the questionnaire and a third part focusing on the teacher's experience and key themes already presented in the experts' interviews.

Presentation	School description (where is it / school typology and context).
	Teaching experience.
	What is mathematics (in a word or in a sentence).
Feelings about the questionnaire	Confidence with the topic / degree of familiarity with it within the school context.
	Observations about the topics covered in the questionnaire (e.g., relevance of questions, inconsistencies, something unexpected, aspects not taken into consideration).
Personal experience and beliefs	**Examples** of implemented activities (physical/ virtual) (if implemented).
	Importance - Do you believe is important propose ABM activities in schools for learning mathematics? Why? - Expected outcomes.
	Limitation and difficulties - Difficulties experienced when carrying out these activities (of students / of the teacher) and strategies carried out to overcome them. - Limitation and downsides to bringing in classroom these activities. - Possible reasons for the failure when implementing them.
	Effectiveness - Teaching strategies and instructional guidance to ensure the effectiveness of the implementation of the ABM activities.
	Hinder/ Foster factors: - What convinced you to propose them?

	- Possible constrains that limited the proposal. - Collaboration or support (present or needed).

Table 14. Main prompts in the follow-up teachers' interviews

Data Analysis

The narrative materials, transcribed in Jeffersonian simplified style, were analysed according to the Thematic content analysis. However, the analysis was not done in a structural way as with the experts' interviews, instead, we proceeded to pin-point analysis of those issues that we wanted to deepen starting from the results of the questionnaire. The whole transcripts are reported in Appendix 3.

Results

Profiles of the teachers interviewed

All Teachers interviewed had a long teaching experience and currently work in secondary schools, although one participant had some experience in primary schools. Two of them came from Government schools, the others from non-government ones, mainly Catholic single sex schools. They came from different states of Australia, although there was a prevalence of interviewees from Queensland. Some of them work with students with a middle-high socio-economic background but others with students of low socio-economic situation and non-English speaking (e.g., O) (Tab. 15).

	Where is the school	Type of School	Year levels taught	Teaching experience
G	Canberra	Traditional, Government, Open entry, Secondary school	11-12	38 years
K	Gunnedah	Non-Government (Christian Catholic), Secondary school	7-10	30 years
R	Brisbane	Non-Government, Single sex (girls), Open entry, from Prep to 12 school	7-12	25 years
St	Sydney	Independent (Roman Catholic), Single sex (girls), Boarding and day Secondary school	7,8 10 (high achievers) 11,12 (specialists)	37 years
Su	Queensland	Non-government (Catholic school), Single sex (boys), Secondary school	7-12	40 years
T	Brisbane	Independent, Boarding and day Single sex (girls) school, from Kindergarten to Year 12	11-12	Long-time experience
X	Canberra	Traditional Government, Streamed classes, Secondary school	7-12	Over 20 years
O	Melbourne	Non-Government (Catholic School), Open entry, Secondary school	11-12	25 years
J	Near Brisbane	Non-Government, Traditional school, from Prep to 12	5, 10, 12	21 years

Table 15. Teachers' profiles description

The teachers relate mathematics mainly to the order/ patterns (5) and to the interpretation / description of the world (4). Fewer of them considered it in relation to other discipline (especially sciences) as the core / the language they are based on (2), some emphasized the beauty (2) and fun (1) of this discipline and described it as a way of thinking (1). (Tab. 16)

	Mathematics is...
G	.. a way of **explaining and describing the physical world**
K	**.. order, making meaning of our world** with numbers, geometry...
R	.. the **language of science and so more disciplines** including music and [..] visual arts as well. mathematics is the, the foundation, **the core of much of what we understand** as knowledge and understanding **in the world that we live in**
St	**.. patterns**
Su	**.. patterns** and **beauty**
T	**.. fun**. I find it enjoyable. I like to work things out. I guess there's things, like, you need to know procedures and that sort of stuff so you can apply it. But, it's about, you know, **applying** the mathematics to different

	situations, **interpreting** those situations using your mathematics. I like mathematical modelling, and I like being able to use the maths that I know to try and **build models** and try and **make some sense of things**. Maybe, sometimes I'm not very good at any of it, but I like doing it
X	**.. order**. It's **structure**, **patterns**, **efficient thinking**. It's the **fundamental basis of our society**, of throughout the world, because without mathematics, we wouldn't be having this communication, we wouldn't have trade, we wouldn't have engineering, or building, or, well, anything like that. [..] It's the language of science, and, of technology. It's vital
O	.. a **language** and a **way of thinking**, and I see a lot of **beauty** in mathematics. It's a language that we can all speak, and it's a way of thinking about things and finding **patterns** and things like that.
J	.. the **core of all the sciences** and it's a **beautiful** subject

Table 16. If you have to summarize in a word or in a sentence, what is mathematics for you?

Although some teachers said they found the topic of the questionnaire very engaging, allowing them to reflect on their teaching practices (Teachers G, K, R) others indicated that they do have wide expertise with ABM activities or that they were only familiar on a theoretical level (Teachers St, J, X):

> Far removed from my reality. In the ideal world, it would be wonderful to be able to offer that. There are lots of working parts, there are lots of activities going on that impact on the students. Umm, lots of little things that interrupt throughout. [..] it's not taking into consideration the reality of my experience of schooling. (Teacher X)

Teachers pointed out that in secondary school ABM activities are generally rarer and less suitable, for example, not necessarily applicable to much content: *"being honest, two lessons out of the 50 are hands-on and the rest is traditional"* (Teacher J). However, many of them claimed that they do not carry out ABM activities as often as they would like or give as much space for exploration as desired.

Briefly outlining the main theme that emerged from the interviews, one of the main limitations identified in the responses to the questionnaire was the time factor. In interviews with experts, this information was investigated, and it was found that, when teachers indicated a lack of time, they referred to:

- the activities preparation (i.e., designing the activities, searching for resources, structuring, and integrating the activity into the curricular program)
- class-time spent in performing the activity (i.e., the ABM activities are quite time-consuming)

Time considerations are almost always related to the difficulty of addressing all curricular contents:

> The theoretical limit is you still have a certain amount of curriculum to cover in the time. And some of these activities take more time than traditional teaching, so there's a limitation on how many of these activities you could fit into a term or a semester. (Teacher G)

Other constraints highlighted in the interviews confirmed the main themes identified in the questionnaire: classroom management (number of students, variability of students, behaviour of students, loudness), lack of resources, and physical constraints.

For classroom management issues, respondents considered it useful, for instance, to have someone else to assist during implementation, for example, having a couple of teachers together during the activity. Furthermore, this emphasized the importance of having a well-structured plan for the ABM activity implementation: fixing the criteria to assess the goals and being clear in directions and explanations of tasks, for example, providing "*instruction sheets that are nice and guiding*" (Teacher J). Also *"to find activities where there's an entry point for everybody"* (Teacher Su), is considered relevant to fighting students' fear of failure.

Even though it was highlighted that there is no preferred, one-size-fits-all strategy, *"strategies depend on classroom formation, on teacher style, on the argument and tools involved*" (Teacher R), one component considered relevant in producing good results is grouping students ensuring a good peers-interaction during the activity. Thus, group formation is crucial. Competition is seen as a good way to engage students too. Finally, it is considered necessary to integrate activities into the curricular program: *"it's important to make it part of a series of lessons, not just the one lesson where it's a surprise*" (Teacher G).

For overcoming the difficulties encountered, some teachers suggested investigating the reasons for possible failures and trying to make adjustments experimentally. Others, on the other hand, stated that they cannot propose activities if not previously structured, and without already having a degree of certainty as to the positivity of the result*: "we try and do what would be called in the business 'due diligence' before we include something like that"* (Teachers G).

The importance of implementation turns out to be mainly related to engagement, as well as linking mathematics to the real world: *"they can see the real world - you know, like why they're doing something. So, I think that's important for students to understand that, yeah, it's not just pen and paper"* (Teacher J). As revealed by Teacher T, *"setting problems is the way that I encourage the kids to try and transfer the stuff that they've learnt, into different situations"*. Furthermore, they are believed important to allow a students' deep and meaningful understanding of the content carried out and for *"a lasting imprint of their mind"* (Teacher St):

> I also just think that the more senses that are involved in your learning, umm, which, you know, moving […]involves your feelings and stepping out something. I just think you are involving more of your brain […] it's more memorable that we talked about. So […] it stays deeper in their consciousness, I think. (Teacher K)

Finally, according to the belief that varying teaching strategies provide deeper access to mathematical knowledge for all students: *"just using as many different approaches as possible is going to help them improve their understanding"* (Teacher Su). However, ABM activities have not been usually considered for assessment.

The teachers who implement ABM activities acknowledged that their schools support them to have good sharing with colleagues (e.g., facilities, a good staff room). This is especially emphasized by those who have fairly stable teachers in the school, even if, however, time for collaborative work is considered insufficient:

> I think it's mainly the time to talk about ideas and map them into the curriculum, into lessons. So, having time to share best practices [..] One of the biggest barriers is just communication with each other and time to be able to collaborate and come up with ideas" (Teacher J).

Other respondents, on the other hand, emphasize that they need more knowledge, wishing for specific PD courses: *"someone to come and show us, umm, some activities to do"* (Teacher O). Most teachers interviewed came to propose ABM activities, after being suggested to do so, through their relationship with the university, PD courses, or colleagues' observations and suggestions.

5 Discussion

In this section we will discuss the main findings that emerged from the research conducted in Australia. In addition, we will briefly present the research conducted in parallel in Italy, illustrating its results by highlighting points of contact or distance from what was observed in the two contexts studied. Finally, we will state main limitations of the research and possible future directions of investigation.

5.1 Main results of the project in Australia

What seems to emerge consistently across instruments and participants is the presence of a strong relationship between a socio-constructivist and student-centred educational model and the implementation of ABM activities. This seems to align with what corresponds to a characterization of ABM activities by academic experts and research. Exploratory and meaning-making aspects also seem to be the ones most sought after by teachers in conducting these activities.

Moreover, among the expected outcomes of ABM activities implementation, we find strong agreement between the positions of academics and teachers implementing the activities: such activities offer deeper conceptual learning and have a lasting imprint in students' minds, they enhance mathematical visualization, promote student interest and succeed in engaging students. In accordance with the research results, the main difficulties experienced by students are related to the so-called *transfer of learning*, that is, applying what has been learned to other contexts and in relation to formal learning.

The Australian results show consistency between teachers' responses and the main constraints indicated by the academic experts. In particular, the academics pointed out that time pressure and coverage of curricular topics is one of the main factors inhibiting teachers from proposing these activities, which are also considered quite time- and energy-consuming for teachers. Indeed, one of the main limitations for proposing ABM activities pointed out by teachers is precisely the lack of available time. This is also the main reason why some teachers do not include these activities in their practice. In the follow-up interviews, we were able to get a better understanding of what teachers meant: on the one hand, the activities require a lot of time both in the classroom and in research and planning; on the other hand, with the time available for face-to-face instruction it is difficult to implement such activities, more time-consuming than traditional transmissive approaches, aiming to cover curricular contents. These statements highlight many subtexts, which can also be deduced from the analysis of other issues. Indeed, teachers do not seem to be so convinced that these activities bring results that are then reflected in standardized tests. Instead, according to academics, good results in these tests are the main goal of schools, which tend to measure themselves against NAPLAN assessments. It is therefore clear that the proposal is perceived by many teachers as ancillary to the planning and goals they are called upon to achieve. The other main difficulties identified are problems with classroom management and resource availability, which are factors also pointed out by academics. This relates both to affordability and, again, to availability of materials and resources, without spending a lot of time looking for them. While the context may therefore limit the implementation of ABM activities, the beliefs of teachers in prioritizing more traditional teaching methods geared toward content transmission, in order to cover the curriculum, should not be underestimated. As highlighted by academic Expert 4, teachers often refer to the lack of time and available resources when new teaching strategies are proposed to them. Usually, these arguments actually hide the belief that what you are proposing is an extra activity from their programming:

> Another belief, I think, which is related to practice, and this is - this comes into play any time when you're proposing something to teachers that is different or new that you want them to try, they will tend to treat this as something "extra", something more, something additional, and in addition to what they're already doing. So, then, you're up against time: "I don't have time to do this, I have a curriculum to cover, there's exams" and so on. So, [could be relevant] helping teachers understand that no, what I'm proposing can actually replace some of the things you are doing, without losing anything. So, by doing things this way instead of some other things you are currently doing, you will still be able to achieve - or the students will still be able to achieve - the learning outcomes in the curriculum. Now, that is not something teachers might find easy to accept, right? - at the start. (Expert 4, p.34)

One dimension that was not initially given much consideration, but which seems to heavily impact the ABM activities implementation, is the school's teaching culture. Both the academics' and teachers' statements (e.g., in the questionnaire, through the brief indications expressed in the *Other* alternative within the items, but also in some of the follow-up answers), emphasized how this factor heavily inhibits implementation. This affects both fellow teachers and the entire school staff as well as the students themselves, but also their parents.

The results show a tendency for greater resistance to the proposal of ABM activities in secondary school teachers than in primary school teachers. Indeed, there is a general belief that these activities may be suitable only for children in the lower grades, as reflected in the teachers' responses in agreement with the expectations of academics. Although the latter are convinced that implementing ABM activities is especially relevant for the early grades, *"the younger the learner are, the more we need to encourage and help them to do that enacting physically"* (Expert 6, p.19), they nevertheless see them as valuable learning experiences for all students, e.g. *"I think it's for all students, all students"* (Expert 4, p.32). Teachers share this belief to a lesser extent, as stated by some of them in response to question Q_14 and in some follow-up interviews, e.g., "*In the high school setting, the active body idea really makes it tokenistic. […] I think it's more for early conceptualisation of, basic ideas, in the primary years"* (Teacher X). Indeed, this view of mathematics teaching seems to be deep-rooted in school systems:

> .. what we do in our standard school system is we say: "Right we start with concrete but we're going to come up the linear hierarchy of the curriculum and we're gonna.. You're not kids anymore so you don't need concrete, right? You know, you're going to be able to- Now you are grow up and you gonna do real maths, you know?". It's so frustrating. (Expert 3, p. 131)

About the contents that can be covered with an ABM activity, *Algebra and Numbers* were confirmed to be the most cited by both academics and teachers. On the contrary, while the academics in their examples have paid little attention to geometric aspects, compared to many others, it is instead quite usual within the contributions of teachers to find references to *Geometry*, even if mainly to measurements and trigonometry. For sure, however, the greatest number of examples provided by the teachers interviewed, who were all secondary school teachers, fell into the category *Real World Problems*, such as problems of estimation, or even in the area of mathematics *Modelling*. Finally, also Probability and Statistics were quite often mentioned both by academics and teachers.

5.2 The research carried out in Italy

In the meantime, while we conducted the Australian research, a parallel study was conducted in Italy, with the same research design, similar methodologies, and same instruments.

A desk audit, consisting of a literature review and study of National and International educational policies, was followed by an exploratory survey involving 9 experts in mathematics education (7 academics and 2 teacher-researchers) through one-hour semi-structured online interviews. The criteria for selecting the experts were the same as those adopted for the Australian research, and the interview protocol and Data-analysis was identical to that concerning Australia.

We then conducted a survey targeting Italian primary and secondary school teachers through the same web-based instrument used in Australia, in the Italian version, with minor adaptations due to school organization and teacher educational background. The dissemination strategy was quite different: in addition to posting on teachers' Facebook groups/pages and disseminating through teachers' association mailing lists, we directly contacted most Italian schools with a direct e-mail to principals, asking them to circulate the link among mathematics teachers. We thus reached a convenience sample of 1301 respondents: 1206 of them answered at least the first filter questions, but only 877 of them could be considered as having completed the questionnaire. Among them, 292 respondents were willing to take part in a one-hour follow-up focus group. We managed to organize 6 online focus-groups (about 9 teachers for each focus groups): 2 for primary school (grades 1-5), 2 for middle-school (grades 6-8), 2 for Secondary school (grades 9-13).

5.3 Some hypotheses from the combined investigation in Italy and Australia

Considering contexts that have a culture of mathematics teaching that is dissimilar on many fronts, as Italy and Australia, allows us to consider possible differences in the characterization of ABM activities depending on the context's culture, as well as to formulate hypotheses regarding factors that may distinguish their implementation (Huang et al., 2020).

A different conceptualization of the ABM activities

From the analysis of the academic experts' interviews, aside from some common traits, a significant cultural difference was particularly evident. While the Australian academics tended to consider the activities as a way of bringing mathematics closer to students, *"I think math could be taught in a very abstract way and if - particularly for younger children- if you want them to engage and enjoy maths I think it's gonna be practical and real, and using manipulatives just helps them to see this being something real"* (Expert 1, p.28), showing how it represents a tool for investigating and interpreting the world, e.g., *"to visualise, [..] envision mathematics in the world"* (Expert 2, p. 38-42), Italian ones related them with the possibility, for a greater number of students, to access a deeper and more *relational* understanding of mathematics (Skemp, 1976), through a meaningful construction of knowledge that also considers its history and evolution. For instance, the Italian expert Maria Mellone stressed to what extent in these activities there is "*the possibility of a more meaningful learning, where students are actually an active protagonist in the construction of them knowledge*", *"allowing for a multifaceted approach to a mathematical meaning"* and including also "*examples that relate to the history of mathematics, because the mathematics that we know today has been mainly developed from these examples. And thus, by the way, not always consciously*", as suggest by expert Maria Giuseppina Bartolini Bussi. Furthermore, the expert Ferdinando Arzarello emphasized that in these activities clearly emerge *"what*

role the body plays in the solution [of mathematics task] *and thus the multimodality with which we relate to mathematics, which is fundamental"* in particular for *"opening up the* [teaching-learning] *proposal on multiple channels and having the belief that this actually facilitates more students to follow the teacher in the construction of knowledge, that is crucial",* as suggested by Italian expert Anna Baccaglini-Frank.

The different characterization, evident throughout the interviews, clearly emerges when analysing the examples of the ABM activities proposed by the experts, both in terms of the content areas concerned and the typologies of materials and tools involved. The Italian researchers showed a greater interest in more traditional mathematical disciplines (e.g., activities from the geometrical tradition) with an emphasis mostly on the conceptual and theoretical construction of knowledge. On the other hand, the Australian academics cited many examples of mathematics modelling and real-world problems, or activities related to the area of probability and statistics, which are completely absent in the Italian context. In addition, the Australian academics quite commonly referred to examples in interdisciplinary areas, unlike Italian researchers. In the Italian context, ABM activities are instead much more often conceptualized as ends for the discipline itself. Evidence of this are the many references to the history and development of mathematical ideas that emerged repeatedly from their narratives, involving references to examples with classical tools that have characterized the evolution of mathematics (such as the abacus, the ruler and compass, or mathematical machines). Finally, the Australian academics gave much less space to examples that recalled the use of a specific material designed for instructional purposes for the conceptual learning of mathematics, preferring materials related to everyday life and contexts. Beyond the examples, this characteristic emerges cross-categorially in the researchers' contributions. For instance, as illustrated in the conceptual map below (Fig. 9), showing the indications regarding the knowledge a teacher should possess to implement ABM activities, although most of the indications are in common, the Italian researchers stressed the importance of knowing the history and development of mathematical ideas: e.g.,

> Teachers need to know the epistemology, the philosophy and, nonetheless, the history of mathematics: how humans first came to certain concepts can be a fairly natural way to present them to children. Thus, it is necessary to know mathematics and, furthermore, some ancient mathematics (Italian expert Benedetto Scoppola, p. 63).

Meanwhile, the Australian academics highlight the need of specific knowledge to link formal mathematics to the experience of reality, as emphasized in the following contribution:

> It requires more experience in the teacher to be able to envision the mathematics in the world […] They have to see the mathematical ideas that are at play. And I think for most teachers, both primary and secondary, they don't have that experience. So they don't yet know how to make the links. They might know the mathematics but they haven't linked it. (Australian Expert 2, p.42)

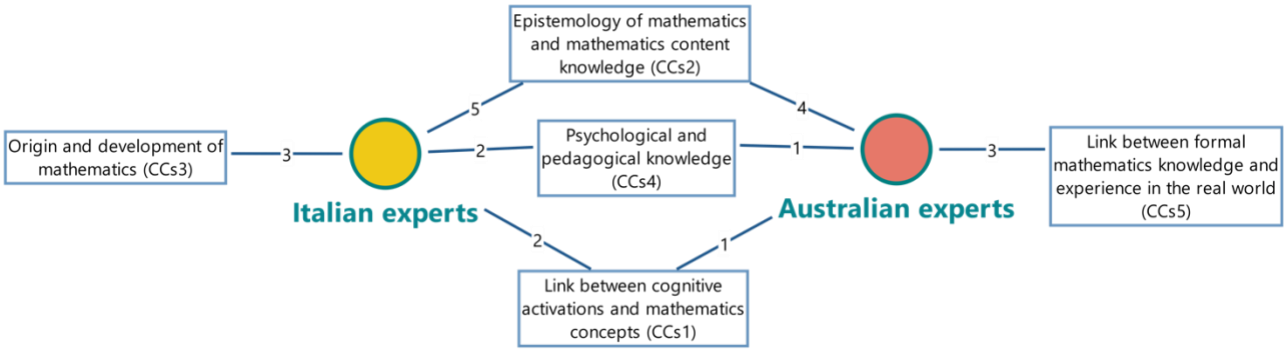


Figure 9. Concept Maps: Necessary teachers' knowledge for implementing ABM activities (XMap, MAXQDA Analytics Pro)

The teachers' survey confirmed this difference in the conceptualization of the ABM activities, although Australian teachers, especially in the follow-up interviews, called out much many geometrical examples.

Implementation of ABM activities

The statement of proposing ABM activities is virtually identical in both Italy (71.5% YES / 28.5% NO) and Australia (72% YES / 28% NO). However, the Australian sample consists almost entirely of secondary school teachers while the proportion in Italy is much more balanced (540 primary school teachers, 666 secondary school teachers). Therefore, judging from the teachers' statements, the data seems to indicate that ABM activities within secondary schools are implemented to a significantly greater extent in Australia.

In both Italy and Australia, it seems to be confirmed that the teaching strategy associated with the implementation of these practices is mostly exploratory, with a medium to low level of instructional guidance. This aspect emerges from the responses to the second vignette proposed in the questionnaire in which, with almost identical percentages in the two territories (In Italy: 24% Robert / 76% Tina; in Australia: 22% Robert / 78% Tina) respondents indicated that they felt aligned with Tina's teaching profile. What emerges appears to be aligned with the indications provided by the two groups of researchers, as well as the research.

While inclusion in the Italian context is among the top expected outcomes, this is not the case in the Australian context where there is a greater belief that these activities are only suitable for some students. This aspect misaligns Australian teachers' beliefs with those of academics. Especially among Italians, but also among Australian academics, these activities are in fact considered important to diversify varying teaching approaches, thus favouring all students. In fact, the belief that they are only suitable for certain students was one of the main hindering factors (among those related to teachers' beliefs) identified by the researchers.

Among those who do not propose the activities in their teaching practice, lack of adequate space and resources is confirmed to be the primary reason for excluding the classroom proposal in both territories. We find, however, a difference in the Italian and Australian case with respect to additional causes: while classroom management is one of the main concerns in the Australian context, in the Italian context it is the lack of confidence with these teaching approaches that is most cited.

The role played by colleagues in selecting activities and scheduling is also emphasised much more in the Australian context than in the Italian one, where the lack of paid work time for scheduling, including collaborative scheduling, is the most common complaint, both by researchers and teachers. Therefore, it seems that for Australian teachers there are more opportunities for sharing and collaboration. Despite the fact that there is a need for even more joint work with colleagues during class time, support and exchange of ideas was raised in the follow-up interviews.

More generally, within the Australian contributions, both from academics and teachers, the role played by the school culture present in the contexts in which teachers work is repeatedly emphasized, describing a great internal variability in the types of schools, the resources made available, and the internal organization within them. Probably for the greater uniformity of schools, this emerges to be a less present aspect within the Italian context.

Lack of time and pressure to cover contents is still the main inhibiting factor in both contexts. While this is more associated with the Australian context, with coverage of the topics of a very tight and rich curriculum, in the Italian context it is somewhat more so in relation to assessments. Indeed, in Italy, although there are no curricular programmatic directives, standardised tests and parallel assessment tests lead teachers to feel the burden of having to complete a rigidly established programme. We must also consider, as we have already pointed out, that the time teachers refer to is also to be considered preparation time, not just class-time.

5.4 Limitations and further developments

Limitation: the research design

First of all, in our survey looking at the implementation of ABM activities, and in particular at the perspective of teachers, there is a heavy *bias* within the sample of teachers. Despite our efforts to try and track down teachers from outside the circuits that are close to the world of research and universities, there is a limitation

in the research design that resulted in the selection of teachers who participated. Indeed, as participation in the research was voluntary, certainly the teachers who took part in the research tended to be interested in the subject matter. We therefore expect them to present a more general openness towards the proposal of these practices. Therefore, all results should be considered assuming that the research exhibits this imbalance.

Secondly, the number of participants reached in Australia are not remotely comparable to those contacted in Italy. Therefore, the possibility of making any comparison between the results is ruled out. Therefore, from the information gained we are merely able to draw hypotheses on the observed trends.

Furthermore, field research was precluded by the fact that the research project could be conducted only at distance, due to the pandemic emergency that broke out a few months after the start of the doctoral project. This contingency precluded the possibility of conducting case-studies observing teaching practices in both Italian and Australian classrooms. Therefore, the investigation could only be confined to teachers' statements, which are often far removed from daily teaching practice.

In addition, we attempted to briefly describe some features of Australian teaching culture possibly influencing the topic under investigation. However, further study would have been necessary to give voice to the complexity that takes into account historical, political and cultural roots.

Limitations: the questionnaire

Some items could have been better designed. For instance, for items related to expected outcomes and difficulties, it would have been more fruitful to ask open-ended questions. Conversely, items in which the social desirability may emerge more, such as those related to beliefs about teaching and learning mathematics, using instead rank order items might have helped to better understand teachers' priorities.

Further steps

Teachers' involvement in the research revealed the presence of a wide variety of proposals that are currently implemented in schools, even very different from each other in terms of tools/materials involved, the instructional orientation in teaching strategies, and the content knowledge concerned. It could be relevant to conduct some case-studies, observing in classroom the actual implementation of these activities and, in particular, to also analyse students' perspectives on the ABM activities. Indeed, students are the only key actors excluded from the research landscape we considered, while also being the "end users" of the research findings implementation.

Moreover, many teachers emphasized that participation was a precious opportunity to reflect on their own teaching practices and openness to other teaching methods. Furthermore, they strongly expressed interest in receiving support, collaboration, and resources to better implement ABM activities in their daily practice. Therefore, it would be an interesting prospect to deepen the dialogue among the interested teachers (both the ones that are already carrying out the implementation of ABM activities and the ones that willing to do it), offering formative courses to put in practice the suggestions provided by the researchers, trying to find answers to some of the needs expressed by teachers.

Finally, recurring and possibly relevant further data emerged from the survey, both in the follow-up interviews of teachers and from the analysis of the short indications provided in the alternative *Other* within the questionnaire items. These indications represent possible future research directions that have not yet been explored.

6 References

Abrahamson, D., Dutton, E., & Bakker, A (2022). Towards an enactivist mathematics pedagogy. In S. A. Stolz (Ed.), *The body, embodiment, and education: An interdisciplinary approach* (pp. 156–182). Routledge.

Alibali, M.W. & Nathan, M.J. (2012) Embodiment in Mathematics Teaching and Learning: Evidence From Learners' and Teachers' Gestures, Journal of the Learning Sciences, 21:2, 247286. https://doi.org/10.1080/10508406.2011.611446

Alibali, M. W., Nathan, M. J., Wolfgram, M. S., Church, R. B., Jacobs, S. A., Johnson Martinez, C., & Knuth, E. J. (2014). How teachers link ideas in mathematics instruction using speech and gesture: A corpus analysis. *Cognition and instruction*, *32*(1), 65-100.

Ambrose, R., Philipp, R., Chauvot, J., & Clement, L. (2003). A Web-Based Survey to Assess Prospective Elementary School Teachers' Beliefs about Mathematics and Mathematics Learning: An Alternative to Likert Scales. *International Group for the Psychology of Mathematics Education*, *2*, 33-40.

ACARA. Australian Curriculum, Assessment, and Reporting Authority. (2020). Australian Curriculum. https://www.australiancurriculum.edu.au/

ACARA. Australian Curriculum, Assessment, and Reporting Authority. (2022). Australian Curriculum. https://www.v9.australiancurriculum.edu.au/

Artigue, M., & Blomhøj, M. (2013). Conceptualizing inquiry-based education in mathematics. *Zdm*, *45*(6), 797-810.

Arzarello, F. & Robutti, O. (2009). Embodiment e multimodalità nell'apprendimento della matematica. *Insegnamento della matematica e delle scienze integrate,* vol.32, A-B n.3, pp. 243-268.

Baccaglini-Frank, A. (2015). Preventing low achievement in arithmetic through the didactical materials of the PerContare project. In *ICMI study 23 conference proceedings* (pp. 169-176).

Baccaglini-Frank, A., & Maracci, M. (2015). Multi-touch technology and preschoolers' development of number-sense. *Digital Experiences in Mathematics Education*, *1*(1), 7-27.

Baccaglini-Frank, A. Carotenuto, G. Sinclair, N. (2020). "Eliciting preschoolers' number abilities using open, multi-touch environments". *ZDM Mathematics Education* 52, 779–791.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617–645.

Bartolini Bussi, M. G., Taimina, D., & Isoda, M. (2010). Concrete models and dynamic instruments as early technology tools in classrooms at the dawn of ICMI: from Felix Klein to present applications in mathematics classrooms in different parts of the world. *ZDM Mathematics Education*, *42*(1), 19–31. https://doi.org/10.1007/s11858-009-0220-6

Bartolini Bussi, M. G., Maschietto, M., & Turrini, M. (2018). Mathematical laboratory in the Italian curriculum: the case of mathematical machines. *ICMI Study 24 School Mathematica Curriculum reforms: challenges, changes ad opportunities* (pp. 109-116).

Belenky, D. M., & Schalk, L. (2014). When to Use Manipulatives: A Review of Research on the Effects of Manuipulatives on Learning and Motivation. In *2014 Annual Meeting of the American Educational Research Association, AERA14*. 2014 Annual Meeting of the American Educational Research Association (AERA14).

Berthoz, A. (1997). *Le sens du mouvement*. Odile Jacob.

Beswick, K. (2012). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educational Studies in Mathematics*, *79*(1), 127-147. https://doi.org/10.1007/s10649-011-9333-2.

Bruner, J. S. (1966). *Toward a theory of instruction* (Vol. 59). Harvard University Press.

Bussi, M. G. B., & Maschietto, M. (2006). *Macchine matematiche: dalla storia alla scuola*. Springer.

Bussi, M. B., & Mariotti, M. A. (2008). Semiotic mediation in the mathematics classroom: Artifacts and signs after a Vygotskian perspective. *Handbook of international research in mathematics education*, *746*.

Callingham, R., Beswick, K., Carmichael, C., Goos, M., Hurrell, D., Hurst, C., & Muir, T. (2017). Nothing left to chance: characteristics of schools successful in mathematics. (Report of the building an evidence-base for best practice in mathematics education project).

Callingham, R., Watson, J., & Oates, G. (2021). Learning progressions and the Australian curriculum mathematics: The case of statistics and probability. *Australian Journal of Education*, *65*(3), 329-342.

Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of Educational Psychology*, *105*(2), 380.

Carbonneau, K. J., & Marley, S. C. (2015). Instructional guidance and realism of manipulatives influence preschool children's mathematics learning. *The Journal of Experimental Education*, *83*(4), 495–513. https://doi.org/10.1080/00220973.2014.989306

Carlson, R. A., Avraamides, M. N., Cary, M., & Strasberg, S. (2007). What do the hands externalize in simple arithmetic? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(4), 747–756. https://doi.org/10.1037/0278-7393.33.4.747

Carotenuto, G., Mellone, M., Sabena, C., & Lattaro, P. (2020). Un progetto di educazione matematica informale per prevenire la dispersione scolastica. *Matematica, Cultura e Società*-Rivista dell'Unione Matematica Italiana, Serie 1, Vol. 5, N. 2, pp.157-172.

Castelnuovo, E. (1963). Didattica della matematica. La Nuova Italia.

Clark, A. (2008). *Supersizing the mind: embodiment, action, and cognitive extension.* NewYork: Oxford University Press.

Century, J., & Cassata, A. (2014). Conceptual foundations for measuring the implementation of educational innovations. In L. M. Hagermoser Sanetti & T. R. Kratochwill (Eds.), *Treatment integrity: A foundation for evidence-based practice in applied psychology* (pp. 81–108). American Psychological Association. https://doi.org/10.1037/14275-006

Century, J., & Cassata., A. (2016). Implementation research: Finding common ground on what, how, why, where, and who. *Review of Research in Education*, *40*(1), 169–215. https://doi.org/10.3102/0091732X16665332

Châtelet, G. (2000). Figuring space: Philosophy, mathematics and physics. Springer.

Coburn, C. E., & Talbert, J. E. (2006). Conceptions of evidence use in school districts: Mapping the terrain. *American Journal of Education*, *112*, 469–495. https://doi.org/10.1086/505056

Cohen, L., Manion, L., & Morrison, K. (2017). Research methods in education (8th ed.). Routledge.

Cook, S. W., Mitchell, Z., & Goldin-Meadow, S. (2008). Gesturing makes learning last. *Cognition*, *106*(2), 1047-1058.

Cook, S.W., Yip. T.K. & Goldin-Meadow, S. (2012) Gestures, but not meaningless movements, lighten working memory load when explaining math, Language and Cognitive Processes, 27:4, 594-610, https://doi.org/10.1080/01690965.2011.567074

Cook, S. W. (2018). Enhancing learning with hand gestures: Potential mechanisms. In *Psychology of Learning and Motivation* (Vol. 69, pp. 107-133). Academic Press.

Common Core State Standards Initiative. (2020). *Common Core Standards for Mathematics.* Retrieved from http://www.corestandards.org/Math/

Congdon, E. L., Novack, M. A., Brooks, N., Hemani-Lopez, N., O'Keefe, L., & Goldin-Meadow, S. (2017). Better together: Simultaneous presentation of speech and gesture in math instruction supports generalization and retention. *Learning and instruction*, *50*, 65-74.

Corbin, J.M., & Strauss, A. (2008). Basics of Qualitative Research (3rd ed.): Techniques and Procedures for Developing Grounded Theory. Sage.

Daley, B. J. (2004). "Using concept maps in qualitative research". In A. J. Cañas, J. D. Novak, & F. M. Gonzales (Eds.), *Concept maps: Theory, methodology and technology* (Proceedings of the First International Conference on Concept Mapping, Vol. 1, pp. 191-197). Dirección de Publicaciones de la Universidad Pública de Navarra.

Dehaene, S. (2011). *The number sense: How the mind creates mathematics*. OUP USA.

Denbel, D. G. (2015). Functions in the secondary school mathematics curriculum. Journal of Education and Practice, 6(1), 77-81.

Denzin, N. K. (2009). The research act: A theoretical introduction to sociological methods (3rd ed.). Prentice Hall.

de Freitas, E., & Sinclair, N. (2012). Diagram, gesture, agency: Theorizing embodiment in the mathematics classroom. *Educational Studies in Mathematics*, *80*(1), 133-152.

de Freitas, E., & Sinclair, N. (2014). *Mathematics and the body*: *Material entanglement in the classroom.* Cambridge University Press. https://doi.org/10.1017/CBO9781139600378

de Freitas, E. & Ferrara, F. (2015). Movement, memory and mathematics: Henri Bergson and the ontology of learning. Studies in Philosophy and Education, 34(6), 565–585. https://doi.org/10.1007/s11217-014-9455-y

de Freitas, E. & Ferrara, F. (2016). Matter, movement and memory. In N. Snaza, D. Sonu, S.E. Truman & Z. Zaliwska (Eds.), Pedagogical matters: New materialisms and curriculum studies, 43–57. New York: Peter Lang. https://doi.org/10.1007/s10649-011-9364-8

Dewey, J. (1916). Democracy and education by John Dewey. *Project Gutenberg*.

Dewey, J. (1933). *How we think.* D.C. Heath.

Dewey, J. (1938). Experience and Education. Macmillan Company.

Dionne, J. (1993). Modifying elementary school teachers' conceptions of mathematics and mathematics teaching and learning: A strategy based on conceptual analysis. *The Proceedings of the Third International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*: Ithaca.

Domitrovich, C. E., Bradshaw, C. P., Poduska, J. M., Hoagwood, K., Buckley, J. A., Olin, S., Romanelli, L. H., Leaf, P. J., Greenberg, M. T., & Ialongo, N. S. (2008). Maximizing the implementation quality of evidence-based preventive interventions in schools: A conceptual framework. *Advances in School Mental Health Promotion*, *1*(3), 6–28. https://doi.org/10.1080/1754730x.2008.9715730

Drijvers, P. (2019). Embodied instrumentation: Combining different views on using digital technology in mathematics education. In U. T. Jankvist, M. Van den Heuvel-Panhuizen, & M. Veldhuis (Eds.), *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education* (pp. 8–28). Freudenthal Group & Freudenthal Institute; Utrecht University; ERME.

Edwards, L., Ferrara, F. & Moore-Russo, D. (Eds.) (2014). Emerging Perspectives on Gesture and Embodiment in Mathematics. Information Age Publishing.

Ernest, P. (1989). The impact of beliefs on the teaching of mathematics. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 249–253). Falmer.

Ezzy, D. (2013). *Qualitative analysis*. Routledge.

Ferrara, F. & Ferrari, G. (2020). "Reanimating tools in mathematical activity". *International Journal of Mathematical Education in Science and Technology*, *51*(2), 307-323.

Finch, J. (1987). The vignette technique in survey research. *Sociology*, *21*(1), 105-114.

Gallese, V., & Lakoff, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive neuropsychology*, *22*(3-4), 455-479.

Geisler, C., & Swarts, J. (2019). *Coding streams of language: Techniques for the systematic coding of text, talk, and other verbal data*. Ft. Collins, CO: WAC Clearinghouse. https://doi.org/10.37514/PRA-B.2019.0230.

Golafshani, N. (2013). Teachers' beliefs and teaching mathematics with manipulatives. *Canadian Journal of Education*, *36*(3), 137–159.

Goldin-Meadow, S., & Singer, M. A. (2003). From children's hands to adults' ears: gesture's role in the learning process. *Developmental psychology*, *39*(3), 509.

Goldin-Meadow, S. (2005). *Hearing gesture: How our hands help us think*. Harvard University Press.

Goldin-Meadow, S., Levine, S. C., Zinchenko, E., Yip, T. K., Hemani, N., & Factor, L. (2012). Doing gesture promotes learning a mental transformation task better than seeing gesture. *Developmental science*, *15*(6), 876-884.

Hourigan, M., Leavy, A. M., & Carroll, C. (2016). 'Come in with an open mind': Changing attitudes towards mathematics in primary teacher education. *Educational Research*, *58*(3), 319-346.

Huang, L., Doorman, M., & van Joolingen, W. (2020). Inquiry-Based Learning Practices in Lower-Secondary Mathematics Education Reported by Students from China and the Netherlands. *International Journal of Science and Mathematics Education*, *19*(7), 1505–1521. https://doi.org/10.1007/s10763-020-10122-5

Hughes, R., & Huby, M. (2004). The construction and interpretation of vignettes in social research. *Social Work and Social Sciences Review*, *11*(1), 36-51.

Jefferson, G. (2004). Glossary of transcript symbols. *Conversation analysis: Studies from the first generation*, 24-31.

Jeffries, C., & Maeder, D. W. (2005). Using vignettes to build and assess teacher understanding of instructional strategies. *Professional Educator*, *27*, 17-28.

Krippendorff, K. (2004). Content Analysis: An Introduction to Its Methodology, 2nd ed. Sage.

Lakoff, G. & Johnson, M. (1999). *Philosophy in the flesh: the embodied mind and its challenge to Western thought.* New York: Basic Books.

Lakoff, G., & Núñez, R. (2000). *Where mathematics comes from*. Basic Books.

Looi C.Y., Thompson J., Krause B., & Kadosh R.K. (2016). The Neuroscience of Mathematical Cognition and Learning. In *OECD Education Working Paper*, No. 136. OECD Publishing.

Longo, G. (2005). The Cognitive Foundations of Mathematics: human gestures in proofs and mathematical incompleteness of formalisms. *Images and reasoning*, 105-134.

Lowrie, T., Logan, T., & Scriven, B. (2012). Perspectives on geometry and measurement in the Australian Curriculum: Mathematics. *Engaging the Australian National Curriculum: Mathematics—Perspectives from the field (Online Publication)*, 71-88.

Mantovani, S., & Kanizsa, S. (1998). La ricerca sul campo in educazione. I metodi qualitativi. Mondadori.

Marley, S. C., & Carbonneau, K. J. (2014). Theoretical perspectives and empirical evidence relevant to classroom instruction with manipulatives. *Educational Psychology Review*, *26*(1), 1-7.

Mayring, P. (2015). Qualitative content analysis: Theoretical background and procedures. In *Approaches to qualitative research in mathematics education* (pp. 365-380). Springer, Dordrecht.

McNeill, D. (1992). *Hand and mind: What gestures reveal about thought.* University of Chicago Press.

Merleau-Ponty, M. (2013). *Phenomenology of perception*. Routledge.

Ministry of Education Singapore. (2012). *Mathematics syllabus: Primary one to six.* Curriculum Planning and Development Division https://www.moe.gov.sg/docs/default-source/document/education/syllabuses/sciences/files/mathematics_syllabus_primary_1_to_6.pdf

Montessori, M. (1934a). *Psicoaritmética*. Casa Editorial Araluce.

Montessori, M. (1934b). *Psicoaritmética*. Casa Editorial Araluce.

Montessori, M. (2011). *Maria Montessori Psicogeometria, Dattiloscritto inedito a cura di Benedetto Scoppola.* Edizioni Opera Nazionale Montessori.

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in mathematics*, *47*(2), 175-197.

Munson, A. (2010). Bourbaki at Seventy-Five: Its Influence in France and Beyond. *Journal of Mathematics Education at Teachers College*, *1*(2). https://doi.org/10.7916/jmetc.v1i2.686

Nemirovsky, R., & Borba, M. (2003). Perceptuo-motor activity and imagination in mathematics learning. In *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 1, pp. 103-135).

Nemirovsky, R. & Ferrara, F. (2009). Mathematical Imagination and Embodied Cognition. *Educational Studies in Mathematics,* 70(2), 159–174. https://doi.org/10.1007/s10649-008-9150-4

NSW Education Standards Authority (NESA). (2019). *NSW Syllabus for the Australian Curriculum: Mathematics K–10 Syllabus (2012).* https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/mathematics/mathematics-k-10

Núñez, R. (2006). Do real numbers really move? Language, thought, and gesture: The embodied cognitive foundations of mathematics. In *18 Unconventional essays on the nature of mathematics* (pp. 160-181). Springer, New York, NY.

Nunnally, JC.(1994). *Psychometric theory*. Third Edition. New: York: McGraw-Hill.

OECD (2009). *Creating effective teaching and learning environments. First Results from TALIS.* OECD Publications.

OECD (2016). *PISA 2015 Results (Volume II): Policies and Practices for Successful Schools*. OECD Publishing.

OECD (2019). *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*. OECD Publishing.

Peterson, S. M. (2013). Readiness to change: Effective implementation processes for meeting people where they are. *Applying implementation science in early childhood programs and systems*, 43-64.

Piaget, J. (1952). The child's concept of number. Humanities Press.

Piaget, J. (1953). *Origins of Intelligence in the Child.* Routledge & Kegan Paul.

Piaget, J. (1970). Science of education and the psychology of the child. (D. Coltman, Trans.). Orion Press.

Poincaré, H. (1908). *La science et l'hypothèse*. Flammarion.

Poulou, M. (2001). The role of vignettes in the research of emotional and behavioural difficulties. *Emotional and Behavioural Difficulties*, *6*(1), 50-62.

Pouw, W.T.J.L., van Gog, T., & Paas, F. (2014). An Embedded and Embodied Cognition Review of Instructional Manipulatives. *Educational Psychology Review,* 26, pp. 51–72

Puchner, L., Taylor, A., O'Donnell, B., & Fick, K. (2008). Teacher learning and mathematics manipulatives: A collective case study about teacher use of manipulatives in elementary and middle school mathematics lessons. *School Science and Mathematics*, *108*(7), 313-325.

Quigley, M. T. (2021). Concrete Materials in Primary Classrooms: Teachers' Beliefs and Practices about How and Why They Are Used. *Mathematics Teacher Education and Development*, *23*(2), 59-78.

Radford, L. (2013). Sensuous cognition. In *Visual mathematics and cyberlearning* (pp. 141-162). Springer, Dordrecht.

Radford, L. (2014). Towards an embodied, cultural, and material conception of mathematics cognition. *ZDM*, *46*(3), 349-361.

Radford, L., Arzarello, F., Edwards, L., & Sabena, C. (2017). The multimodal material mind: embodiment in mathematics education. In J. Cai (Ed.), *Compendium for research in mathematics education* (pp. 700–721). NCTM.

Rizzolatti, G., Fadiga, L., Fogassi, L. & Gallese, V. (1997). The space around us. Science, 277, 190–191.

Roth, W.M. (2016). Growing-making mathematics: a dynamic perspective on people, materials, and movement in classrooms. Educational Studies in Mathematics, 93(1), 87–103. https://doi.org/10.1007/s10649-016-9695-6

Rueckert, L., Church, R. B., Avila, A., & Trejo, T. (2017). Gesture enhances learning of a complex statistical concept. Cognitive Research: Principles and Implications, 2(1), 1-6.

Ruiz-Primo, M. A. (2006). *A multi-method and multi-source approach for studying fidelity of implementation*. The Regents of the University of California.

Sacks, H., Schegloff, E. A., & Jefferson, G. (1978). A simplest systematics for the organization of turn taking for conversation. In *Studies in the organization of conversational interaction* (pp. 7-55). Academic Press.

Seitz, J. A. (2000). The bodily basis of thought. New Ideas in Psychology, 18, 23–40.

Sheets-Johnstone, M. (2011). *The primacy of movement* (Vol. 82). John Benjamins Publishing.

Shvarts, A., & Abrahamson, D. (2019). Dual-eye-tracking Vygotsky: A microgenetic account of a teaching/learning collaboration in an embodied-interaction technological tutorial for mathematics. *Learning, Culture and Social Interaction*, 22, 100316.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics teaching*, *77*(1), 20-26.

Skilling, K., & Stylianides, G. J. (2020). Using vignettes in educational research: a framework for vignette construction. *International Journal of Research & Method in Education*, *43*(5), 541-556.

Skoumios, M., & Skoumpourdi, C. (2021). The use of outside educational materials in mathematics and science: Teachers' conceptions. *International Journal of Education in Mathematics, Science, and Technology*, *9*(2), 314-331.

Spencer, C.P., & Darvizeh, Z. (1981). The case for developing a cognitive environmental psychology that does not underestimate the abilities of young children. *Journal of Environmental Psychology, 1*, 21-31.

Stecher, B., Le, V. N., Hamilton, L., Ryan, G., Robyn, A., & Lockwood, J. R. (2006). Using structured classroom vignettes to measure instructional practices in mathematics. *Educational evaluation and policy analysis*, *28*(2), 101-130

Strauss, A. L. (1987). *Qualitative analysis for social scientists*. Cambridge university press.

Syed, M., & Nelson, S. C. (2015). Guidelines for establishing reliability when coding narrative data. Emerging Adulthood, 3(6), 375-387.

Trinchero, R. (2002). *Manuale di ricerca educativa* (pp. 1-432). Franco Angeli.

Vale, I., & Barbosa, A. (2017). The importance of seeing in mathematics communication. Journal of the European Teacher Education Network, 12, 49-63.

Valenzeno, L., Alibali, M. W., & Klatzky, R. (2003). Teachers' gestures facilitate students' learning: A lesson in symmetry. Contemporary Educational Psychology, 28(2), 187-204.

Van Zoest, L. R., Jones, G. A., & Thornton, C. A. (1994). Beliefs about mathematics teaching held by preservice teachers involved in a first grade mentorship program. *Mathematics Education Research Journal, 6*(1), 37–55. https://doi.org/10.1007/BF03217261

Varela, F., J. Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience.* MIT Press.

Vizzi, A. (2016). *Teachers' perceptions of manipulatives during middle school math instruction* [Doctoral dissertation, Walden University]. Proquest.

Wallace, I., Klahr, D., & Bluff, K. (1987). Self-modifying production system model of cognitive development. In *Production system models of learning and development* (pp. 359-435).

APPENDIX

Research Project

Body movement and active learning in mathematics:
Australian teachers' beliefs and practices

Alessandra Boscolo
International Ph.D. Contemporary Humanism, Curriculum: Education, XXXV° Cycle
Department of Human Studies (LUMSA) – Faculty of Education and Arts (ACU)

CONTENTS

APPENDIX 1: ETHICS COMMITTEE APPLICATION

In Appendix 1, the first document is the email certifying the ACU HREC APPROVAL of the Human Ethics Application. The application consisted of filling out a form on the ORION web platform, which follows the advertisement of approval in Appendix 1, and providing the documentation you will also find attached in Appendix 1, as well as the instruments (protocols and questionnaire) placed in the dedicated Appendix 2: *Instruments*.

A complete list of the Human Ethics Application attachments can be found below:

- RESEARCH PROPOSAL
- PROTOCOL FOR INTERVIEW WITH EXPERTS (IN APPENDIX 2: *INSTRUMENTS*)
- ADVERTISEMENT FOR EXPERTS
- PARTICIPANT INFORMATION LETTER: EXPERTS
- CONSENT FORM: EXPERTS
- PROTOCOL FOR TEACHERS' INDIVIDUAL INTERVIEW (IN APPENDIX 2: *INSTRUMENTS*)
- A COPY OF THE BMALM QUESTIONNAIRE (IN APPENDIX 2: *INSTRUMENTS*)
- NEWSLETTER ADVERTISEMENT FOR TEACHERS
- PARTICIPANT INFORMATION LETTER: TEACHERS
- CONSENT FORM – QUESTIONNAIRE: TEACHERS
- CONSENT FORM – INDIVIDUAL INTERVIEW: TEACHERS
- PEER REVIEW LETTER
- INVESTIGATOR SIGNATURES

[2021-199E] - Ethics application approved!

Leanne Stirling Leanne.Stirling@acu.edu.au on behalf of Res Ethics <Res.Ethics@acu.edu.au>
mar 19/10/2021 09:02

To: Vincent Geiger <Vincent.Geiger@acu.edu.au>
Cc: Alessandra Boscolo <alessandra.boscolo@myacu.edu.au>; g.agrusti@lumsa.it <g.agrusti@lumsa.it>;
Catherine Delzoppo <Catherine.Delzoppo@acu.edu.au>

Dear Applicant,

Chief Investigator: Professor Vince Geiger
Professor Gabriella Agrusti, Catherine Delzoppo
Student Researcher: Alessandra Boscolo
Ethics Register Number: 2021-199E
Project Title: Body Movement and Active Learning in Mathematics: Australian teachers' beliefs and practices
Date Approved: 19/10/2021
End Date: 30/10/2022

This is to certify that the above human ethics application has been reviewed by the Australian Catholic University Human Research Ethics Committee (ACU HREC). The application has been approved for the period given above.

Continued approval of this research project is contingent upon the submission of an annual progress report which is due on/before each anniversary of the project approval. A final report is due upon completion of the project. A report proforma can be downloaded from the ACU Research Ethics website.

Researchers are responsible for ensuring that all conditions of approval are adhered to and that any modifications to the protocol, including changes to personnel, are approved prior to implementation. In addition, the ACU HREC must be notified of any reportable matters including, but not limited to, incidents, complaints and unexpected issues.

Researchers are also responsible for ensuring that they adhere to the requirements of the National Statement on Ethical Conduct in Human Research, the Australian Code for the Responsible Conduct of Research and the University's Research Code of Conduct.

Any queries relating to this application should be directed to the Ethics Secretariat (res.ethics@acu.edu.au). Please quote your ethics approval number in all communications withus.

We wish you every success with your research.

Kind regards,

Leanne Stirling
on behalf of ACU HREC Chair, Assoc Prof. Michael Baker

Senior Research Ethics Officer | Research Services | Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
T: +61 2 9739 2646 E: res.ethics@acu.edu.au

ACU
AUSTRALIAN CATHOLIC UNIVERSITY

Human Ethics Application

Application ID :	2021-199E
Application Title :	Body Movement and Active Learning in Mathematics: Australian teachers' beliefs and practices
Date of Submission :	05/10/2021
Primary Investigator :	Professor Vince Geiger (Chief Investigator)
Other Personnel :	Alessandra Boscolo (Doctoral Student)
	Professor Gabriella Agrusti (Co-Investigator)
	Catherine Delzoppo (Research Assistant)
	Mr Benjamin Daniel Twining (Research Assistant)

Overview

Introduction

Introduction

The purpose of this form is to encourage you to think about the ethical dimensions of your research.
Questions are designed to determine that you have considered and addressed the risks associated with your research. The questions are derived from the National Statement on Ethical Conduct in Human Research which is the primary guiding document for ethical research in Australia.

The help icon () provides help / examples to relevant questions / page.

You may save your progress at any point by opening the Toolbar menu on the right side of the window and clicking the save button

Please click on the Next (Next page >>) below-right to continue

Contact

If you have any questions regarding your Ethics application, please contact the ETHICS TEAM on:
Phone: (02) 9739 **2646**
Email: res.ethics@acu.edu.au

If your questions relate to difficulties with the form itself or the system, please contact RESEARCH SYSTEMS:
Phone: (03) 9953 **3674**
Email: res.systems@acu.edu.au

References

- ACU Ethics website
- NHMRC ethics page
- National Statement on Ethical Conduct in Human Research
- Australian Code for the Responsible Conduct of Research
- ACU Code of Conduct for Research

Section A: Administrative Section

A.1: Title and Summary of Project

A.1.1 **Application ID**
The system will automatically generate a numerical ID code (eg: 000001234). Following submission, the Ethics Team will alter the numeric code to an alpha-numeric code. This code will include the year, a sequential number and a reference code denoting the type of application. Eg

- *C - Clinical Trial;*
- *E - Expedited Review;*
- *H - Full Committee Review;*
- *I - Indigenous Research Ethics Assessment Process (IREAP);*
- *N - Non-identifiable data;*
- *T - Transfer;*
- *R - Registration.*
- *W - Waiver.*

Please quote your new alpha-numeric code in all communications with the Ethics Secretariat (eg: 2017-1234HI).

2021-199E

A.1.2 Application Date (to be filled by Orion)

05/10/2021

A.1.3 Category *

ACU Human Ethics Project

A.1.4 What is the formal title of the research project?*

Body Movement and Active Learning in Mathematics: Australian teachers' beliefs and practices

A.1.5 Plain language title to be used on information letter and consent form (if different)

Body Movement and Active Learning in Mathematics

A.1.6 School*

Institute for Learning Sciences & Teacher Education

A.1.7 Description of the project in plain language (National Statement, 2007, s.1.2).
In addition, please attach a 2-4 page research proposal outlining the research design, objectives and methodology.*

In recent decades, the role of students' active, bodily experience in the exploration and construction of mathematical concepts has been seen as increasingly relevant in mathematics education research.
Everyday teaching practice is often inconsistent with these perspectives and still largely based on purely transmissive, teacher-directed approaches (OECD, 2009, 2016). These approaches tend to be focused on the implementation of clarity-of-instruction (e.g., procedural) rather than cognitive activation practices (e.g., problem-solving) (OECD, 2019).
The proposed research project is aimed at investigating primary and secondary mathematics teachers' perspectives on the implementation of active learning strategies that involve students' movement in the classroom and identifying possible hindering and facilitating factors, for example, teachers' beliefs.

The proposed research aims to:
• provide a state of the art review of research findings in the field and highlight the presence/absence of specific indications on how to carry out exploratory activities and active learning strategies including the use of artifacts, tools, or students' body movement in national/international curricular documents and educational policies.
• explore teachers' beliefs about active, bodily experiences of mathematics learning and how these can be linked to the implementation of this approach in school classrooms.
• document factors that foster or hinder the implementation of active, bodily experience activities in school mathematics classrooms.
• gain insight into the effective implementation of active, bodily experience activities in school mathematics teaching practices by documenting the influence of factors such as available resources and different approaches to instruction.

The research program will include:
- a review of the literature
- analysis of curricula and policies
- semi-structured interviews with experts in Mathematics Education
- an online questionnaire to teachers of primary and secondary schools
- individual interviews with teachers, grouped by school grade, aimed at validating the questionnaire produced and deepening the teachers' perspective on the main issues addressed with the survey

The proposed methodology is:
-to conduct a desk audit of relevant research literature, and relevant national and international curriculum documents and policies
-to identify a conceptual framework of the experts' views on active, bodily experience activities as outlined in the teachers' survey
-to reach a convenience sample of teachers working in diverse schools or localities (N=50-100 completed surveys) using a web-based instrument combining rating items (i.e., Likert-type scales) and multiple-choice items with few open-ended questions, and to complement the survey with individual interviews aimed at going deeper on some topics where the items in the questionnaire may not yield sufficient information.

A.1.8 Do you intend to publish this research in a peer reviewed publication?*
(●) Yes ( ) No

You have entered an project start date in the past / of today's date, are you sure this is correct?

A.1.9 Anticipated Start Date (project)*
30/09/2021

A.1.10 Anticipated Finish Date (project)*
30/10/2022

Data Collection must **NOT** commence until Ethics approval has been granted,
Please ensure your Anticipated Start Date for data collection is at least 28 days in the future to allow sufficient time for the Ethics approval process.

You have entered an data collection start date in the past / of today's date, are you sure this is correct?

A.1.11 Anticipated Start Date (data collection)*
30/10/2021

A.1.12 Anticipated Finish Date (data collection)*
30/10/2022

A.2: Types of Research

Tick as many of the following 'types of research' as applicable to this project Your answers will assist the HREC in considering this proposal. A tick in some of these boxes will generate additional questions relevant to your proposal (mainly because the National Statement requires additional ethical matters to be considered).

A.2.1 This project involves: (Please refer to details in help for items with an asterisk next to them)*

- ☐ Clinical Trial
- ☐ Research involving gametes or use or creation of embryos ART guidelines
- ☐ Research involving ionising radiation APRANSA guidelines
- ☐ Research involving participants and located / conducted overseas (NS 4.8)
- ☐ Research on workplace practices or possibly impacting on workplace relationships (NS 4.3)
- ☐ A cellular therapy (NS 3.6)
- ☐ Genetic testing/research (NS 3.5)
- ☐ Research involving collection and/or use of human samples, body tissues or fluid samples (NS 3.4)
- ☐ Research using quantitative methods, population level data or databanks (NS 3.2)*
- ☑ Research using qualitative measures (NS 3.1)
- ☐ None of the above

A.2.2 Will your research involve access to any of the following?

a. Research is conducted on Defense members, ex-serving personnel or other Defence personnel, their information or tissue.*
○ Yes ◉ No

b. Participants are to be recruited, either directly or indirectly, through a service provided by Defence or the Department of Veterans' Affairs (DVA)*
○ Yes ◉ No

c. Research is conducted by Defence or DVA personnel.*
○ Yes ◉ No

d. Research is conducted on/in a Defence establishment.*
○ Yes ◉ No

e. Research is sponsored, endorsed or funded in any part by Defence or DVA.*
○ Yes ◉ No

A.3: Risk of Social, Mental or Physical Harm

A.3.1 Please check the applicable boxes: (Please refer to details in help for items with an asterisk next to them)*

- ☐ Potentially unpleasant stimuli, tasks, investigations or procedures, during / following procedures**
- ☐ Use of non-treatment or placebo control conditions
- ☐ Performance of any acts which might diminish self-esteem or cause embarrassment or distress
- ☐ Access to confidential data* without the participant's written consent
- ☐ Intended contact with persons with infectious diseases (e.g. measles, hepatitis, TB, whooping cough)
- ☐ Use of injections which may result in the transmission of disease
- ☐ Contact with electrical supply (eg electrical stimulation)
- ☐ Treatments or techniques with unpleasant or harmful side effects
- ☐ Any possibility of cardio-pulmonary difficulties***
- ☐ Other
- ☑ None of the above

A.4: Vulnerable Groups

A.4.1 Does your research involve access to any of the following groups: (Please refer to details in help for items with an asterisk next to them)*

- ☐ Anyone who is a prisoner or ward of the state
- ☐ People in other countries*
- ☐ Elderly people who may be vulnerable or unable to give fully informed consent
- ☐ People who may be vulnerable or unable to give fully informed consent
- ☐ Welfare recipients who may be vulnerable
- ☐ Anyone at risk of criminal/civil liability, damage to financial/social standing or to employability
- ☐ Minors (anyone under the age of 18, eg students or children)
- ☐ Other
- ☑ None of the above

A.5: Level of Risk

A.5.1 Does the research involve any foreseeable harm to the participants?*
○ Yes ◉ No

A.5.2 Does the research involve only the inconvenience of completing a short, simple survey? (for example, no more than 30 minutes total time commitment)*
○ Yes ◉ No

A.5.3 Is there only one group of participants?*
○ Yes ◉ No

A.5.4 Is the data being collected non-identifiable?*

○ Yes ◉ No

This research cannot be negligible risk and you must select either the "Low Risk" or "More than Low Risk" category below

A.5.5 Please indicate the level of risk to the participant in this research:*

○ More than Low Risk
◉ Low Risk
○ Negligible Risk

Section B: Research Design

B.1: Description of Procedures

B.1.1 Provide a brief description of your project and the methodology involved
(e.g. method of data gathering, use of questionnaires, focus groups, interviews, and indicate any procedure/s that may have adverse effects)*

The project is an exploratory mixed-method study on the use of active, bodily experience activities in Australian mathematics classrooms, and associated teaching practices.

Participants will include:
- 6 experts in Mathematics Education (e.g. Australian university professors, principals, head teachers). They will be involved in semi-structured interviews. Participation is voluntary and consent will be required prior to starting the interviews. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Collected comments may be directly quoted (using a pseudonym, e.g. First expert), as expressly indicated in the consent form which participants have to complete prior to participating in the research project.
- approximately 50 primary and secondary mathematics teachers will be involved in an online survey. They will be recruited from around Australia via national and state mathematics teacher professional associations' Facebook pages/groups or association newsletters. In addition, we seek to advertise through educational networks, umbrella organisations, and broader teacher organisations aimed at Australian teachers. Furthermore, we will send the questionnaire to a list of mathematics educators who have indicated their interest in participating in ILSTE mathematics research projects.
After completing the questionnaire, teachers interested in participating in an individual interview will be asked to provide their email for further potential contact by the researchers (approximately 10).

Methods:

-The first component of the study involves conducting individual semi-structured interviews with a small number of experts in mathematics education (about 6) and will take place via Zoom. The interview questions are designed to gain insight into the experts' point of view about the theoretical framework on which the teacher questionnaire is based. We will collect transcriptions from these expert interviews and analyze them by constructing concept maps.
-The second component is an online questionnaire that will be administered via Qualtrics to gauge the practices and beliefs of primary and secondary mathematics teachers. The questionnaire will be anonymous. It will consist of a number of Likert-type, multiple-choice, and short open-ended response items regarding teaching practices and teacher beliefs. These include questions about the individual teacher's experience, the teacher's beliefs, and the implementation of active learning activities in which students are physically engaged.
-The third component of the study involves individual teacher interviews (approximately 10). These semi-structured interviews will involve a smaller teachers who have given consent to partake in follow up interviews during the Qualtrics survey. If teachers choose to take part in a follow-up interview, they will be lead to a new survey (to keep the first anonymous) which will ask them to provide their name and email address in order to arrange the individual interviews. These interviews will take place via Zoom and have been designed to gain insight into the original survey questions. The questions are qualitative in nature.

B.1.2 Will you be photographing or digitally recording participants?
ACU e research does not recommend using Zoom for recording of sensitive or identifiable information as it is not secure.
The recommendations for recordings are: Recording to your local computer, or Microsoft Teams (please note that Microsoft Teams can transcribe data)
If you use Zoom as your audio-recording medium, please ensure these recordings are saved to an alternative password protected location such as Cloudstor or OneDrive.
Zoom files are AUTOMATICALLY deleted by ACU IT Services at the end of each semester. *

◉ Yes ○ No

B.1.3 Please provide details and explain how confidentiality of the identifiable images will be maintained, or whether permission is being sought for use of images.*

Individual interviews with experts: The Zoom (minimum 30 minutes, maximum one hour) will be recorded for transcription purposes. Participation is voluntary and participants will be required to provide consent prior to starting the interviews. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Collected comments may be directly quoted (using a pseudonym, e.g. First expert), as expressly indicated in the informed consent form which participants have to complete prior to participating in the research project. Transcripts of the interview and comments made by the researchers on those data will be sent via email to each participant before publication. Once participants have reviewed the material, it will only be published if they have no objections.

Individual interviews with teachers: The Zoom meetings (about 40 minutes long) will be recorded for transcription purposes. Participation is voluntary and participants will be required to provide consent prior to starting the interviews. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Collected comments may be directly quoted (using a pseudonym, e.g. First teacher), as expressly indicated in the informed consent form which participants have to complete prior to participating in the research project. Transcripts of the interview and comments made by the researchers on those data will be sent via email to each participant before publication. Once participants have reviewed the material, it will only be published if they have no objections.

Both audio-recording of experts' interviews and of teachers' individual interviews will be deleted after the transcription of comments.

B.1.4 Does your research involve deception of participants?*

○ Yes ◉ No

B.2: Specific Risks

Does your research involve any of the following:
(if you answer yes to any of the questions in this section your research project must be reviewed by the **full HREC**)

Interventions and Therapies, including clinical and non-clinical trials and innovations (National Statement, 2007, s.3.3)

Does your research involve:

B.2.1 Administration of any substance or agent*
○ Yes ◉ No

B.2.2 A treatment or diagnostic procedure*
○ Yes ◉ No

B.2.3 A surgical procedure?*
○ Yes ◉ No

B.2.4 Any other therapeutic procedure or devices, preventative procedure or diagnostic device or procedure*
○ Yes ◉ No

Human Genetics (National Statement, 2007, s.3.4)

Does your research involve:

B.2.6 Study of single or multiple genes, gene-gene interaction or gene-environment interaction*
○ Yes ◉ No

B.2.7 Acquired somatic variation or inherited gene sequences*
○ Yes ◉ No

B.2.8 Gene expressions or genes of individuals, families or populations*
○ Yes ◉ No

B.2.9 Epigenetics or use of informatics and genetic information or clinical phenotypes*
○ Yes ◉ No

Stem Cell Research (National Statement, 2007, s.3.6)

Does your research involve:

B.2.11 Use of embryonic or somatic stem cells or those derived from primordial germ cells*
○ Yes ◉ No

Women who are pregnant and/or the human foetus (National Statement, 2007, s.4.1)

Does your research involve:

B.2.13 Research on a woman who is pregnant and the foetus in *utero**
○ Yes ◉ No

B.2.14 Research on the separated human foetus or on foetal tissue*
○ Yes ◉ No

People highly dependent on medical care who may be unable to give consent. (National Statement, 2007, s.4.4)

Does your research involve:

B.2.16 People who are highly dependent on medical care*
○ Yes ◉ No

B.2.17 People in terminal care, emergency care or intensive care*
○ Yes ◉ No

B.2.18 People who are unconscious or in a state of post-traumatic coma unresponsiveness *
○ Yes ◉ No

People with a cognitive impairment, an intellectual disability or a mental illness. (National Statement, 2007, s..4.5)

Does your research involve:

B.2.20 Anyone who is intellectually, mentally or physically impaired*
○ Yes ◉ No

People who may be involved in illegal activities (National Statement, 2007, s.4.6)

Does your research involve:

B.2.22 Study that intends to expose illegal activity*
○ Yes ◉ No

B.2.23 The likelihood of discovering illegal activity, even if not intended*
○ Yes ◉ No

B.2.24 The inadvertent and unexpected discovery of illegal activity*
○ Yes ◉ No

Aboriginal and Torres Strait Islander Peoples

Does your research involve:

B.2.26 Aboriginal and Torres Strait Islander Peoples*
○ Yes ◉ No

Section C: Researchers / Investigators

C.1: Researcher Details

C.1.1 Is this a student application?*
◉ Yes ○ No

C.1.2 This application is created by:*
◉ Student ○ Supervisor

C.1.3 Researchers / Investigators:
The ACU staff member is the Chief Investigator for the purposes of the application because all correspondence will be directed to the ACU staff member.
Please search by surname.
If you can't find an ACU student or sessional academic, please download and complete this form.

VOLUNTEERS – The addition of volunteers to ACU research projects is possible. The Chief Investigator must adhere to the ACU Work Experience and Volunteers policy and ensure that volunteers are covered by appropriate University insurance and their appointment must be approved by the relevant Executive Staff member.
https://policies.acu.edu.au/human-resources/recruitment_and_selection/work_experience_and_volunteers*

1	Order	1
	Person Type	HDR Student
	Title	Not Specified
	Given Name	Alessandra
	Surname	Boscolo
	Full Name	Alessandra Boscolo
	Gender	Female
	Work Number	
	Mobile Number	+393386425360
	Home Number	
	Email Address	alessandra.boscolo@myacu.edu.au
	AOU	Institute for Learning Sciences & Teacher Education
	Managing Unit	Faculty of Education and Arts
	Primary?	No
	Position	Doctoral Student
	Qualifications	Doctoral Student, International Ph.D. programme in Contemporary Humanism (LUMSA Italy-ACU Australia), curriculum Education, since November 2019; Master in Pure and Applied Mathematics, Università degli Studi di Roma Tor Vergata 2019; Bachelor degree in Mathematics, Università di Pisa 2016.
	Expertise relevant to this project	Areas of expertise: - Enactive and embodied learning - Manipulatives in mathematics teaching and learning - Montessori method materials and mathematics theoretical work
2	Order	2
	Person Type	Internal
	Title	Professor
	Given Name	Vince

	Surname	Geiger
	Full Name	Professor Vince Geiger
	Gender	Male
	Work Number	(07) 3623 7188
	Mobile Number	
	Home Number	
	Email Address	vincent.geiger@acu.edu.au
	AOU	Institute for Learning Sciences & Teacher Education
	Managing Unit	Faculty of Education and Arts
	Primary?	Yes
	Position	Chief Investigator
	Qualifications	Doctor of Philosophy, The University of Queensland 2009; Master of Educational Studies, The University of Queensland 1993; Bachelor of Educational Studies, The University of Queensland 1985; Diploma of Education, The University of Queensland 1982; Bachelor of Science, Griffith University 1979.
	Expertise relevant to this project	Areas of Expertise: - Inclusive teaching practices that promote numeracy capability - How students learn to use mathematics when solving real-world problems - The role of technology in learning/teaching - Stem learning, teaching, and leadership - Initial teacher education and teacher professional learning - Sociocultural theories of learning
3	Order	3
	Person Type	External
	Title	Prof.
	Given Name	Gabriella
	Surname	Agrusti
	Full Name	Professor Gabriella Agrusti
	Gender	Female
	Work Number	0039 668422282
	Mobile Number	0039 3471548963
	Home Number	
	Email Address	g.agrusti@lumsa.it
	AOU	
	Managing Unit	
	Organisation	
	Organisation Name	LUMSA
	Primary?	No
	Position	Co-Investigator
	Qualifications	Full professor in Educational Research, Department of Human Studies, LUMSA, from 2019; Member of the Council of the Doctorate Course in Contemporary Humanism (LUMSA), from 2016; Co-director of post-lauream courses in Assessing learning outcomes and Education system evaluation, 2012-2014; Council member for the Association for Educational Assessment-Europe, 2006-2014; Permanent researcher in Educational Research and Lecturer in Faculty of Education, Roma Tre University, 2005-2014; Post-doctoral Research Fellowship, April 2003-December 2004; Ph.D. (with scholarship) in Education, Roma Tre University, 2003.
	Expertise relevant to this project	Areas of expertise: - Education system evaluation - Assessing learning outcomes - Educational research methods - E-learning resources
4	Order	5
	Person Type	Internal
	Title	Not Specified
	Given Name	Catherine
	Surname	Delzoppo
	Full Name	Catherine Delzoppo
	Gender	Female
	Work Number	
	Mobile Number	
	Home Number	
	Email Address	catherine.delzoppo@acu.edu.au
	AOU	Institute for Learning Sciences & Teacher Education

	Managing Unit	Faculty of Education and Arts
	Primary?	
	Position	Research Assistant
	Qualifications	research
	Expertise relevant to this project	works for ILSTE
5	Order	6
	Person Type	Internal
	Title	Mr
	Given Name	Benjamin
	Surname	Holland-Twining
	Full Name	Mr Benjamin Daniel Twining
	Gender	Male
	Work Number	(07) 3861 617
	Mobile Number	0423911239
	Home Number	
	Email Address	Benjamin.Twining@acu.edu.au
	AOU	Institute for Learning Sciences & Teacher Education
	Managing Unit	Faculty of Education and Arts
	Primary?	
	Position	Research Assistant
	Qualifications	Research Assistant
	Expertise relevant to this project	Research Assistant

C.1.4 Primary Contact

Professor Vince Geiger

C.1.5 Student's enrolled degree level?*

Research Higher Degree

C.1.6 At which campus is the Principal Investigator based?*

Brisbane

C.2: Certification of Researchers

C.2.1 Are there any certification, accreditation or credentialling requirements relevant to the conduct of this research?*

○ Yes ◉ No

Section D: Resources

D.1: Project Funding / Support

D.1.1 Which of the following characterises the type(s) of funding being utilised *

- ☐ External Grant(s)-A PRoF (Project Registration online Form) should have already been completed
- ☐ Internal Grant(s)-Competitive
- ☐ Sponsor(s) - A PRoF (Project Registration online Form) should have already been completed
- ☐ Employer / organisation funding (external to ACU) - A PRoF (Project Registration online Form) should have already been completed
- ☐ ACU Department / school funding
- ☐ Other
- ☐ Still seeking funding
- ☑ No funding

Section E: Other Reviews

E.1: Ethical Reviews

E.1.1 Is ACU the primary HREC?*

◉ Yes ○ No

E.2: Permissions from External Organisations

E.2.1 Do you require any other non-HREC approvals/permissions? (National Statement, 2007, s.2.2.13)*

◉ Yes ○ No

E.2.2 Please provide details of other approvals*

Permissions from the page administrators for various National and State Mathematics Teacher Professional Associations'Facebook pages/groups or Association newsletters (e.g. Australian Association of Mathematics Teachers) will be needed in order to advertise for participants via these pages/groups.

Please note approvals / permissions not available at the time of submission must be forwarded to ACU HREC on receipt

E.3: Peer Review

E.3.1

The ACU Ethics Committee requires evidence of peer review to ensure that research design is appropriate. The Ethics Committee will only review research where evidence of peer review is attached. Please note that funded research that has undergone a recognised peer review process (e.g. ARC/NHMRC, ACURF etc) does not require additional evidence of peer review.
- HDR students should provide evidence of successful completion of Confirmation of Candidature. Where an HDR student has not yet undergone Confirmation of Candidature, justification from the Supervisor should be provided as to why they are seeking ethics approval at this stage, together with written support from their Head of School attesting to the research merit of the proposal
- non-HDR students should provide evidence of approval from the faculty/school (e.g. Honours Co-ordinator, Research Committee, Head of School, Course co-ordinator)
- where research does not fit into any of the above categories, an email from a colleague (who is not a member of the research team) along the following lines would be sufficient:

- Name of Researcher
- Title of Project
- Statement:
  - I have read the research proposal for the abovenamed project and I consider that:
    - the research methods are appropriate;
    - the sample size supports the research methods, or the sample size is sufficient for the study; and
    - the project has research merit.
  - The statement should also include any editorial comments made, comments about the aims and hypothesis, procedures and protocols and any other suggestions made to the researchers.
- Name of Reviewer
  - Title
  - Qualifications/experience
  - Relationship to researcher

Has the research proposal, including design, methodology and evaluation undergone a peer review process?
Written evidence of peer review must be attached.*

◉ Yes ○ No

E.3.2 Was the peer review process an ACU process or External process?*

External Process

E.3.6 What was the external peer-review process?*

External academic peer review process*

E.3.7 Please describe the external peer-review process*

Prof. Kim Beswick (BSc, Dip Ed, Ph.D.) has been asked to review the project proposal.
We sent her a file with the research proposal description to express her opinion on the project. In her first review, Prof. Beswick indicated that some parts of the project description should have been further developed, before assessing whether the study is worthwhile. In detail, she asked for further information regarding the theoretical framework behind the questionnaire design. Furthermore, a more detailed description of the data analysis methods was requested.
Following Prof. Kim Beswick's suggestions, we modified the file, and we sent her a second file with a better-detailed research proposal description. Prof. Beswick's appraisal concerning this second file is attached to this ethics committee application.
In this second review, she expressed her opinion on the worthiness of the study and suggested further minor edits directly in the file of the project description. We have therefore reviewed some of the factual details she has indicated before submitting this application.

E.3.8 Was the project deemed to have research merit?*

◉ Yes ○ No

Section F: Project

F.1: Benefits / Risks

F.1.1 What are the expected benefits (if any) of the project to participants? (National Statement, 2007, s.1.1)*

There is little direct benefit for participants. Taking part in the questionnaire may increase teachers' awareness of their own teaching practices by reflecting on them in answering the proposed questions.

F.1.2 What are the expected benefits (if any) of the project to the wider community or in general? (National Statement, 2007, s.1.1)*

The findings will inform advice for researchers in mathematics education, curriculum developers, and policymakers and thus there will be a benefit to the profession at large. Furthermore, the need for research that focuses on teachers' perspectives about research insights is relevant given the need to create communication between universities and schools in order to diminish the existing gap between the findings of scientific research and innovation in school.

F1.3 HREC is of the view that there are always some risks in research even if minor. These risks should be identified at F.1.4. The Committee wants to know that you have thought about the risks to participants.

F.1.4 Describe the possible/potential risks and burdens associated with your research and how they would be managed (outline the risks / burdens not only to the participants, but also to the researchers and any other non-participants.) For applications with higher risk profiles, a risk management plan may be required. Please attach this document at Section M.*

About teachers: There is a risk that participants may be identifiable via their survey data or interview responses. To mitigate this risk. all survey data is collected via an anonymous link, and any identifying details will be removed. In addition, only aggregated results will be presented in publications developed from this study. In terms of the interview, pseudonyms will be used and, again, any identify information will be removed. We are aware, however, that for some people it could be stressful to complete an online form answering questions for approximately 20 minutes. We have supplied the number for Lifeline for participants who find this process stressful.

About experts: There is a risk that participants may be identifiable via their interview responses. All participants will be de-identified using pseudonyms prior to sharing data with other project researchers. In addition, any identifying details will be removed from the transcripts prior to sharing. We are aware, however, that for some people it could be stressful to be interviewed online for a minimum of 30 minutes to a maximum of 1 hour. We have supplied the number for Lifeline for participants who find this process stressful.

F.1.5 Please identify an organisation / person to whom participants might be referred for counselling, medical or other appropriate support*

Lifeline - 13 11 14

F.1.6 Are there any other risks involved in this research? (e.g. to the research team, the organisation, others)*

○ Yes ◉ No

Section G: Conflicts of Interests

G.1: Conflicts of Interests

The following questions relates to National Statement, 2007, s.5.4, s.5.2.10 and s.5.2.11

G.1.1 Are any of the researchers intending to use their own students, patients, clients etc?*

○ Yes ◉ No

G.1.3 Are any of the researchers intending to undertake research in their place of work or in an area where they have a financial or commercial interest?*

○ Yes ◉ No

G.1.5 Will there be any proposed incentive/payment (eg movie tickets, food vouchers) or reimbursement (travel expenses) offered to participants? (National Statement, 2007 s.2.2.9, s.2.2.10)*

○ Yes ◉ No

Section H: Location of Study

H.1: Location, Overseas sites and permissions

H.1.1 Where will the research be conducted?*

ACU and External Sites

H.1.2 Please select the campus(es) at which the research will be conducted *

- ☐ Adelaide
- ☐ Ascot Vale, Mercy
- ☐ Ballarat
- ☐ Blacktown
- ☑ Brisbane
- ☐ Canberra
- ☐ Melbourne
- ☐ North Sydney
- ☐ Oakleigh, Christ
- ☑ Online
- ☐ Overseas
- ☐ Strathfield

H.1.3 Please provide names, addresses and contact details of all sites where research will be conducted*

Research will be conducted online using Qualtrics and online video tools. Data will be stored on computers at ACU Brisbane.

Section I: Participants

I.1: Informed Consent of Participants

I.1.1 Will participants aged 18 and over be asked to give consent? (National Statement, 2007, s.4.2)*

◉ Yes ○ No

I.1.2 How will consent be obtained?

Your response should indicate how consent is being obtained eg: verbal consent (can be used in special circumstances), a consent form, an online process. This response should outline what process is in place for the return or indication of how consent is being provided by participants.
It is consider a minimum standard that written consent be obtained and a copy of the consent form should be attached in the "Attachments" section.
Anonymous surveys may not require a consent form and the information letter would state that return of the non-identifiable survey is consent to participate and that responses cannot be withdrawn as they are not identifiable.

Consent form templates are available on the Human Research Ethics page.*

Experts need to read the Participant Information Letter and then give online consent (both via Qualtrics)
Teachers need to read the Participant Information Letter and then give online consent (both via Qualtrics) prior to starting the questionnaire completion.
Teachers who will be willing to take part in follow-up individual interviews will have to reread the Participant Information Letter and complete a further online consent form (via Qualtrics) prior to giving their email to be further contacted.

I.2: Participant Description

* Surveys involving ACU students must be registered and approved by the University in accordance with the ACU Survey Governance Framework.
The following questions relates to National Statement, 2007 s.1.4

I.2.1 Please provide a brief description of your participants - group 1: (e.g. year 11 students in public schools, childless couples who have been married for 10 or more years, nurses who have been working for at least 5 years, etc...)*

Participants will include two different groups (Group 1 and Group 2)

Group 1: about 6 experts in Mathematics Education (e.g. Australian university professors, principals, head teachers..). They will be involved in semi-structured interviews. The participation is voluntary and will be required to provide consent prior to starting the interviews.

I.2.2 Please provide a brief description of your participants - group 2 (if applicable):

Group 2: approximately 50 primary and secondary mathematics teachers, recruited from around Australia via national and state mathematics teacher professional associations' Facebook pages/groups or association newsletters (e.g., Australian Association of Mathematics Teachers), or contacted through educational networks (for example, through emailing school contacts and requesting wider dissemination), umbrella organisations, (for example, the Independent Schools Queensland; Catholic Education Offices), and broader teacher organisations aimed at Australian teachers (for example, through the Australian Teachers Association and Teachers supporting Teachers Facebook pages). Furthermore, we will send the questionnaire to a list of mathematics educators who have indicated their interest in participating in ILSTE mathematics research projects.

After completing the questionnaire, teachers interested in participating in an individual interview will be asked to provide their email for further potential contact by the researchers. We hope to interview approximately 10 teachers during this process.

I.2.3 Please provide a brief description of your participants - group 3 (if applicable):

This question is not answered.

I.2.4 Please provide a brief description of your participants - group 4 (if applicable):

This question is not answered.

I.2.6 Do you intend to include both males and females in this study?*

◉ Yes ○ No

I.2.8 How many **male** participants are involved in your study? (enter 0 if none)*

28

I.2.9 How many **female** participants are involved in your study? (enter 0 if none)*

28

I.2.11 Please provide the age range for **male** participants*

23-65

I.2.12 Please provide the age range for **female** participants*

23-65

I.2.13 Participants' state of health:*

◉ Normal ○ Other

I.3: Recruitment

The following questions relate to National Statement, 2007, s.1.4

I.3.1 What processes will be used to identify potential participants?*

About teachers:
A link to the Participant Information Letter and online questionnaire will be posted in national and state mathematics teacher professional associations' Facebook pages/groups or association newsletters (e.g. Australian Association of Mathematics Teachers) to recruit potential participants.
In addition to advertising via Australian mathematics associations' Facebook organisation newsletters, we seek to advertise through educational networks (for example, through emailing school contacts and requesting wider dissemination), umbrella organisations (for example, the Independent Schools Queensland; Catholic Education Offices), and broader teacher organisations aimed at Australian teachers (for example, through the Australian Teachers Association and Teachers supporting Teachers Facebook pages).
Furthermore, having hosted a free Zoom symposium for mathematics educators in Australia on 20 May 2021, Professor Geiger invited participants to complete an online feedback questionnaire. The filter question was: "Would you consent to being contacted about further research activities?". If they agreed, participants were asked to provide their email address. As a result, we have a list of mathematics educators who have indicated their interest in participating in further ILSTE mathematics research projects. We would like to invite them to participate in this research. As such, we would like to email them the information sheet for this project, together with the link to the online survey.

About experts:
Experts in mathematics education will be selected for their research interests and experience of working closely with teachers. Professor Geiger will use his substantial network of Mathematics experts to find and recruit 6 relevant Australian participants for this section.

I.3.2 Describe how initial contact will be made with potential participants*

About teachers:
Primary and secondary mathematics teachers will be recruited from around Australia via national and state mathematics teacher professional associations' Facebook pages/groups or association newsletters (e.g. Australian Association of Mathematics Teachers). This will involve posting an anonymous link to the survey on Facebook pages/groups with a request for primary and secondary Mathematics teachers to complete the survey. Clicking on the link will lead them to information about the project. Participants will then be required to provide consent prior to completing the survey. After completing the survey, teachers interested in participating in individual interviews would write their email in an addition (linked) survey in order to be contacted by the researchers.

In addition to advertising via Australian mathematics associations' Facebook organisation newsletters (e.g. Australian Association of Mathematics Teachers), we seek to advertise through educational networks (for example, through emailing school contacts and requesting wider dissemination), umbrella organisations (for example, the Independent Schools Queensland; Catholic Education Offices), and broader teacher organisations aimed at Australian teachers (for example, through the Australian Teachers Association and Teachers supporting Teachers Facebook pages).

Furthermore, we would like to invite to participate in this research mathematics educators who have indicated their interest in participating in further ILSTE mathematics research projects in the symposium mentioned in section I.3.1. As such, we would like to email them the information sheet for this project, together with the link to the online survey.

The advertisement to be sent by email can be found in section I.3.4. and as an attached document.
The advertisement contains the link to the online survey. Clicking on the link will lead potential participants to information about the project. They will then be required to provide consent prior to completing the survey. After completing the survey, teachers interested in participating in individual interviews would write their email in the form to be further contacted by the researchers.

About experts:
Professor Geiger will first identify a list of potential candidates. Alessandra will then send an email with the formal invitation to participate in the research, including a copy of the Participant Information Letter.

I.3.3 Is an advertisement, email, website, letter or telephone call proposed as the form of initial contact with potential participants?*
(●) Yes ( ) No

I.3.4 Please provide details of the initial contact. Please also attach a copy of the text/script in the "Attachments" section.*

Advertisement for teachers: (a copy in the Attachments)
Researchers from ACU's Institute for Learning Sciences and Teacher Education are currently taking part in an international study on the beliefs of primary and secondary teachers, and their teaching practices with regards to Mathematics. The focus of the study is the involvement of students' body and movement in mathematics active learning. You are invited to contribute to this study in order to provide a picture of Australian teachers' perspectives. As a teacher of mathematics, your views are critical to developing a clear picture of current practices. Accordingly, you are invited to participate in the study.
Participation involves the completion of an anonymous 40-minute online survey, available via the following link (https://docs.google.com/forms/d/19ar_8yuHG3NymtqEapJlCg7myYDhX8729uvE7uPGBNM/edit?usp=sharing).
At the completion of the survey, you will be offered the opportunity to register interest in an optional online individual interview to further elaborate on your views.

Recruiting question: (a copy in Attachments)
Having hosted a free Zoom symposium for mathematics educators in Australia on 20 May 2021, Professor Geiger invited participants to complete an online feedback questionnaire. The filter question was: "Would you consent to being contacted about further research activities?". If they agreed, participants were asked to provide their email address. To invite them to participate in this research, we would like to email them the aforementioned advertisement for teachers.

The email for experts contains: (a copy in the Attachments)
-Brief description of the research project
- A copy of the Participant Information Letter
-What will be asked to do for participating
-The framework and the semi-structured interview key-questions
-The link to the consent form
- A Contact for further information

I.3.5 How will potential participants indicate their agreement to participate in the research?*

Participants will indicate their agreement to participate in the research completing the online consent form.

I.5: Other Special Groups

I.5.1 Will participants be selected specifically based on cultural or community groups to which they belong (e.g. Refugees or Migrant Groups)?

Aboriginal and Torres Strait Islander Peoples are covered in a separate section*

○ Yes ◉ No

Section J: Overseas Research

J.1: Overview

J.1.1 Will your research be conducted overseas?*

○ Yes ◉ No

J.1.2 Will you be recruiting participants from other countries but conducting your research from Australia

Note: In relation to overseas travel please note the following:
a. STUDENTS: All student international travel must be approved by the DVCR;
b. STUDENTS and STAFF: The travel must comply with ACU travel policy and be booked through Campus Travel;
c. STUDENTS: Overseas travel will require a Variation to Candidature form be submitted requesting approval by the PVCR to do fieldwork overseas;
d. STUDENTS and STAFF: Subject to the above approvals you should ensure that all relevant entry requirements are met.
*

○ Yes ◉ No

Section K: Data Management

K.1: Data Recording and Storage

K.1.1 In what format will the data be stored during the research project? (e.g. paper copy, computer file, USB, audiotape, videotape? What types of computer files will be generated, .doc.xls,PDF?)
If you require further assistance regarding managing your data please contact eresearch@acu.edu.au, or visit ACU Research Data Management Toolkit - for assistance in completing the Data Management component of your application. *

Consent forms, survey data, and interview transcripts will be stored electronically, as .doc and PDF computer files, on separate password-protected shared drives at ILSTE, in line with ethical guidelines for safe use and storage of data.

K.1.2 In which room and at which campus of ACU will the primary data be stored during the study? (If electronic data, please specify how it will be stored)*

The project survey is being conducted using Qualtrics.
Participant interviews will be conducted via Zoom. These interviews will be recorded and stored digitally on the password-protected ACU network drive. They will be deleted once they have been transcribed.
Consent forms, survey data, and interview transcripts will be stored electronically on separate password-protected shared drives at ILSTE, in line with ethical guidelines for safe use and storage of data. ACU will also backup the data on a password-protected external hard drive, to be kept in a secure location. The data will be accessed only by the research team for this project. Between sites, files will be shared and securely transferred through AARNet Cloudstor, using ACU credentials.

K.1.3 In which room and at which campus of ACU will the primary data be stored following completion of the study? (If electronic data, please specify how it will be stored)*

Consent forms, survey data, and interview transcripts will be stored electronically on separate password-protected shared drives at ILSTE, in line with ethical guidelines for safe use and storage of data. The university will also backup the data on a password-protected external hard drive, to be kept in a secure location.

K.1.4 Specify the measures to be taken to ensure the security of information from misuse, loss, or unauthorised access while stored during and after the research project? (e.g. will identifiers be removed and at what stage? Will the information be physically stored in a locked cabinet?)*

The project survey is being conducted using Qualtrics. Information provided on this survey will be collected anonymously, with participants being automatically designated a randomly generated identifier.
Participant interviews will be conducted via Zoom. These interviews will be recorded and stored digitally on the password-protected ACU network drive. They will be deleted once they have been transcribed. The transcripts will be de-identified prior to any data analysis or data sharing between the universities. They will be assigned randomly generated pseudonyms matched for gender only. These pseudonyms will be stored separately to the data.
Consent forms, survey data, and interview transcripts will be stored electronically on separate password-protected shared drives at ILSTE, in line with ethical guidelines for safe use and storage of data. The university will also backup the data on a password-protected external hard drive, to be kept in a secure location. The data will be accessed only by the research team for this project. . Between sites, files will be shared and securely transferred through AARNet Cloudstor, using ACU credentials.
All data will be destroyed 5 years after the completion of the project.

K.2: Disposal of Data

K.2.1 How are the data to be disposed of after complying with the requirement to retain data for a minimum of fifteen (15) years?
Please refer to the ACU Records Retention and Disposal Schedule (part 13) for full details.

Please refer to the ACU Research Data Management Toolkit for a guide to retaining and archiving your data.*

All data will be destroyed 15 years after the completion of the project.

K.3: Dissemination of Results

K.3.1 Is it intended that the results of the study be published?*

◉ Yes ○ No

K.3.2 Please explain where the results are likely to be published*

In international peer reviewed journals in the field of Mathematics Education, in a monography.

K.3.3 Do you intend to use the results of your study in publications or in other communications with colleagues?*
◉ Yes ○ No

You have indicated 'Yes' to this question. Participants must be advised both in the *Information Letter to Participants* and on the *Consent Form*, if applicable, that the results from the study may be summarised and appear in publications or may be provided to other researchers in a form that does not identify the participants in any way.

K.3.5 Is it intended that the results of the research that relate to a specific participant be reported to that participant?*
◉ Yes ○ No

K.3.6 Is it intended that the general (non-specific) results of the research be reported to participants?*
◉ Yes ○ No

K.3.7 How will the results be communicated to participants?
(e.g. telephone call, individual letter, copy of publication, consultation with a medical practitioner or other)*

Given the nature of this research, each participant's personal data is not likely to be meaningful without comparison to the data collected for other participants. As such, except for experts, participant's individual data will not be provided, but interested individuals are encouraged to sign up to receive a summary of the results as soon as the project is completed.

Only the Data collected from the individual interview with experts will be reported to the participants as non-aggregated data: transcripts of the interview and comments made by the researchers on those data will be sent via email to each participant before publication.

K.3.9 Is it intended that results that relate to a specific participant be reported to anyone other than that participant?*
○ Yes ◉ No

K.3.13 Will the confidentiality of participants and their data be protected in the dissemination of research results?*
◉ Yes ○ No

K.3.15 Explain how confidentiality of participants and their data will be protected in the dissemination of research results*

The survey is anonymous. Data will be published as aggregated data.

Teachers' comments in the individual interview will be transcribed (as well as published) with pseudonyms.

We will report experts' comments with pseudonyms, giving only a broad description of the expert's profile associated with each pseudonym without providing information that could identify them.

Section L: Confidentiality / Privacy

L.1: Access to Personal Information

L.1.1 Will the project involve access to personal information, student files, computerised records or other data banks, human pathology or diagnostic specimens provided by one or more institutions or government departments?*
○ Yes ◉ No

L.2: Identifiability of Participants

The following questions relates to National Statement, 2007, s.3.2

L.2.1 In what format will the data be **collected**?*
☑ Individually identifiable data
☑ Re-identifiable data
☑ Non-identifiable data

L.2.2 Will the identity of any participant be disclosed to anyone other than the researcher/s?*
○ Yes ◉ No

L.3: Confidentiality of Participants' Responses

L.3.1 What measures will be taken to protect the confidentiality of the personal information gathered in this project? (e.g. removal of names and other identifiers either before, during or after analysis of data; reporting aggregated data only)*

The survey is anonymous. We will report aggregated data only.

Teachers' comments in the individual interviews will be transcribed with pseudonyms.

All the experts participating in interviews will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. We will report experts' comments with pseudonyms, giving only a non-identifiable broad description of the expert's profile associated with each pseudonym.

L.3.2 In this project are there any particular risks to the confidentiality of personal information (e.g. reporting non-aggregated data or descriptive data from small samples)? If so, how is it proposed to minimise them? *

We may report non-aggregated data or descriptive data from small samples about individual interviews with teachers and experts.

All the teachers and experts participating in individual interviews will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. We will report any expert or teacher comments with pseudonyms, giving only a non-identifiable broad description of the teacher's/expert's profile associated with each pseudonym.

L.4: Privacy

Researchers should be familiar with the existence of relevant Commonwealth, State and Territory legislation regarding privacy. Of special note are the Australian Privacy Principles and the Privacy Act 1988.

L.4.1 Are you aware of any privacy issues that may impact on participants?*

○ Yes ◉ No

Section M: Attachments

M.3: Other documents

M.3.1 Please attach the relevant documents listed below (please use ZIP file if there are more than 1 document per item).
If you are submitting a new version of a previously uploaded document, please use the "Add" button and leave the original file as-is to allow Res.Ethics team to track the changes.

Applications created by students will require the Supervisor sign off. Once submitted the Orion application will be forwarded to the Supervisor for completion of the "Supervisor Checklist".
Applications that involve Co-investigators should ensure that the **signature document** is completed by all researchers to acknowledge their participation in this project. *

1	Document type	Soft copy
	Reference (Document Title)	Research proposal - Final.docx
	Name	Research Proposal
	Description	A brief description of the Research Proposal
2	Document type	Soft copy
	Reference (Document Title)	Participant(Teachers)_Information_Letter II.pdf
	Name	Participant Information Letter (Revised letters must contain suitably highlighted changes)
	Description	Participant Information Letter for teachers - updated
3	Document type	Soft copy
	Reference (Document Title)	Investigator_Signatures_Document.pdf
	Name	Investigators' Signatures**
	Description	
4	Document type	Soft copy
	Reference (Document Title)	Informed Consent Form_ Experts.pdf
	Name	Consent Form (Revised forms must contain suitably highlighted changes)
	Description	Informed Consent Form for Experts via Qualtrics. The participant's first name, surname, and e-mail address will only be entered once they have chosen to take part in the research.
5	Document type	Soft copy
	Reference (Document Title)	Advertisement for experts II.docx
	Name	Advertisement text / script
	Description	Advertisement to recruit experts via email. The Links to the Participant Information Letter and to the Informed Consent Form will be provided in the e-mail.
6	Document type	Soft copy
	Reference (Document Title)	Peer Review Letter.docx
	Name	Peer Review
	Description	The letter of Professor Beswick's second review.
7	Document type	Soft copy
	Reference (Document Title)	Questionnaire BMALM.pdf
	Name	Questionnaires / Interview Questions
	Description	This is a pdf file of the new version of the questionnaire on Qualtrics.
8	Document type	Soft copy
	Reference (Document Title)	
	Name	Ethics approval from overseas research sites
	Description	

9	Document type	Soft copy
	Reference (Document Title)	
	Name	Non-HREC Review Approval letters
	Description	
10	Document type	Soft copy
	Reference (Document Title)	
	Name	External HREC Approval letters
	Description	
11	Document type	Soft copy
	Reference (Document Title)	
	Name	Other approvals / permissions from overseas research sites
	Description	
12	Document type	Soft copy
	Reference (Document Title)	
	Name	Proforma for gaining the consent of the person responsible*
	Description	
13	Document type	Soft copy
	Reference (Document Title)	Advertisement for teachers II.docx
	Name	Advertisement text / script for teachers
	Description	Advertisement text to recruit teachers - updated
14	Document type	Soft copy
	Reference (Document Title)	Informed Consent Form_Teachers interview.pdf
	Name	Consent Form (teachers): Individual interview
	Description	The Informed Consent Form for teachers' follow-up individual interview. Teachers will find it at the end of the questionnaire via Qualtrics. Contact details will not be requested if teachers select the option: I've decided to not participate further in this research.
15	Document type	Soft copy
	Reference (Document Title)	Informed Consent Form_Teacher_ Questionnaire.pdf
	Name	Consent Form (teachers): Questionnaire
	Description	Informed Consent Form for teachers, at the beginning of the Qualtrics survey, prior to starting the questionnaire completion.
16	Document type	Soft copy
	Reference (Document Title)	Recruiting Question.PNG
	Name	Recruiting question
	Description	Filter question to have a list of mathematics educators who have indicated their interest in participating in further ILSTE mathematics research projects.
17	Document type	Soft copy
	Reference (Document Title)	Teacher Interview Questions - updated.docx
	Name	Teacher interview questions
	Description	
18	Document type	Soft copy
	Reference (Document Title)	Protocol for Interview with Experts.docx
	Name	Protocol for interviews (experts)
	Description	Protocol for the individual interviews with experts
19	Document type	Soft copy
	Reference (Document Title)	Participant(Experts)_Information_Letter II.pdf
	Name	Participant Information Letter - Experts
	Description	Participant Information Letter for Experts - updated

Please ensure you have attached the advertisement text / script, as you have indicated advertising is used in the Participants: Recruitment section

Further information on how to respond to comments and upload documents is available from the Researcher Amendment Guidelines document available under the heading Introduction / Overview.

For ethics team: Show Documents Uploaded with Date

Section N: Office Use Only

N.1: Ethics Officer Review

N.1.1 Risk Assessment Outcome

Show Documents Uploaded with Date *

Low Risk

N.1.2 Workflow Branch*

Low Risk Branch

Date Approved

19/10/2021

Status

Approved

Section O: Checklist

O.2: Checklist - For Supervisor

Approvals

O.2.1 I/we declare that until written approval has been received from HREC and any external approvals:*

- ☑ Data collection will not commence
- ☑ Participants will not be approached
- ☑ Participants' records/files/specimens will not be accessed

Research Project

O.2.2 I attest that:*

- ☑ I have provided a step by step description of participant recruitment
- ☑ I have read and adhered to ACU Guidelines for Applicants to Human Research Ethics Committee (HREC)
- ☑ The Principal Investigator is accountable for the conduct of the research
- ☑ The project has been articulated in clear, concise, lay language
- ☑ I have checked the application and its attachments
- ☑ This research has been peer-reviewed and has been deemed to be methodologically sound

O.2.3 I accept responsibility for:*

- ☑ The conduct of this research in accordance with any other conditions specified by the HREC of ACU
- ☑ The conduct of this research in accordance with NHMRC principles

O.2.4 Please acknowledge you have a statement from a medical practitioner/psychologist/counselor to provide professional assistance, if you have specified your project as:
- More than low risk (in "Administrative Section : Level of Risk") *and*
- Have procedures which might have an adverse effect on a participant's wellbeing

(Select "(N/A)" if not applicable)*

◉ (N/A) ○ I have such a statement

Documents

O.2.5 I have attached all supporting documents (where appropriate):

- ☐ Ethics approval from external institutions (e.g. hospitals, schools) if available/applicable
- ☐ Approval letter(s) from any external organisation(s) involved in your research (if applicable)
- ☐ Letter of support from the Centre of Indigenous Education and Research (CIER) (if applicable)
- ☑ Copies of all questionnaires and interview schedules**
- ☑ Letter and consent forms follow the recommended format and wording on the ACU website*
- ☑ Information letter and consent forms are free from spelling, typographical and grammatical errors
- ☑ Information letter and consent forms are on current ACU letterhead
- ☑ The Information Letter to Participants and Consent Form(s)
- ☑ Research Proposal (as requested at the "Attachments : Other documents" section)

You must notify the Human Research Ethics Committee immediately of any variation to this project e.g. Changes to the number or mix of participants, to research procedures, to the survey instruments or questionnaires.

Continue

Next

Please click the Submit Application button below to submit your application to the Office of Research Services.

Submit Application

ATTACHMENTS

Research proposal

Formal Title

Body Movement and Active Learning in Mathematics: Australian teachers' beliefs and practices

Plain language Title (to be used on information letter and consent form)

Body Movement and Active Learning in Mathematics

Background

In recent decades, the role of students' active, bodily experience in the exploration and construction of mathematical concepts has been seen as increasingly relevant in mathematics education research. The roots of this tradition can be found as far back as the early 1900s, in the work of Maria Montessori's (Montessori, 1934a, 1934b; Lillard, 2016). More recently, cognitive psychology and neuroscience studies have demonstrated the interrelationship of perception-action and conceptualization in learning processes. This research has been key to the development of the embodied cognition theory (Wilson, 2002; Lakoff & Nunez, 2000; Varela et al., 1991). Several theoretical perspectives, based on perceptual-motor involvement in the teaching-learning processes of mathematics, also provide advice on the development of artefacts and how they are used to promote student learning at different levels of schooling (e.g., Carotenuto et al., 2021; Abrahamson et al., 2020; Baccaglini-Frank et al., 2020; Flood et al., 2020; Sinclair & Pimm, 2015; Nemirovsky et al, 2012; Sarama & Clements 2009; Ferrara, 2006; White & Mitchelmore, 2003). These include *enactivist pedagogy* (Abrahamnson et al., in press), *inclusive materialism* (de Freitas & Sinclair, 2014), and *multimodal approaches* (Radford et al., 2017; Ferrara & Ferrari, 2020).

Everyday teaching practice is often inconsistent with these perspectives and still largely based on purely transmissive, teacher-directed approaches (OECD, 2009, 2016). These approaches tend to be focused on the implementation of clarity-of-instruction (e.g., procedural) rather than cognitive activation practices (e.g., problem solving) (OECD, 2019).

The proposed research project is aimed at investigating primary and secondary mathematics teachers' perspectives on the implementation of active learning strategies that involve students' movement in the classroom and identifying possible hindering and facilitating factors, for example, teachers' beliefs.

Project Aims

The proposed research aims to:

- provide a state of the art review of research findings in the field and highlight the presence/absence of specific indications on how to carry out exploratory activities and active learning strategies including the use of artifacts, tools, or students' body movement in national/international curricular documents and educational policies.

- explore teachers' beliefs about active, bodily experiences of mathematics learning and how these can be linked to the implementation of this approach in school classrooms.
- document factors that foster or hinder the implementation of active, bodily experience activities in school mathematics classrooms.
- gain insight into the effective implementation of active, bodily experience activities in school mathematics teaching practices by documenting the influence of factors such as available resources and different approaches to instruction.

Approach

The project is an exploratory mixed-method study on the use of active, bodily experience activities in Australian mathematics classrooms, and associated teaching practices. This includes practice in which students are physically engaged and may include the use of manipulatives, tools, and artefacts.

Research activities will include:

- conducting a desk audit of relevant research literature, and relevant national and international curriculum documents and policies
- documenting experts' views on active, bodily experience activities as outlined in the teachers' survey (N~6)
- administering of an online questionnaire of primary and secondary teachers related to active, bodily experience activities (N~50)
- conducting individual/focus group semi-structured interviews aimed at providing greater insight into issues raised in the participants' survey responses (N~10)

Participants

Participants and protocols will include:

- six experts in mathematics education (e.g., Australian university Professors, principals, head teachers). They will be involved in semi-structured interviews. Participation is voluntary and consent will be required prior to starting the interviews. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Collected comments may be directly quoted (using a pseudonym, e.g., first expert), as indicated in the informed consent form which participants must complete prior to participating in the research project. Transcripts of the interview and comments made by the researchers on those data will be sent, via email, to each participant before publication. Participants must endorse the content of transcripts before this material can be used in developing manuscripts intended for publication.
- approximately 50 primary and secondary mathematics teachers will be recruited from around Australia via national and state mathematics teacher professional associations' Facebook pages/groups or association newsletters (e.g., Australian Association of Mathematics Teachers). This will involve posting an anonymous link to the questionnaire on Facebook pages/groups/newsletters with a request for it to be completed by participants. Clicking on the link will lead potential participants to information about the project. Participants will then be required to provide consent prior to completing the questionnaire. In addition to advertising via Australian mathematics associations' Facebook organisation newsletters, we seek to advertise through educational networks (for example, through emailing school contacts and requesting wider dissemination), umbrella organisations (for example, the Independent Schools

Queensland; Catholic Education Offices), and broader teacher organisations aimed at Australian teachers (for example, through the Australian Teachers Association and Teachers supporting Teachers Facebook pages). Furthermore, we will send the questionnaire to a list of mathematics educators who have indicated their interest in participating in ILSTE mathematics research projects. We will invite them to participate in this research by sending them the information sheet for this project, together with the link to the online questionnaire by email.

- After completing the questionnaire, teachers interested in participating in an individual interview will be asked to provide their email (in the form) for further potential contact by the researchers. The aim is to interview around 10 teachers.

Instrumentation, Methods and Data-analysis

The following outlines methods for data collection and analysis:

Interviews with experts

The first component of the study involves conducting individual semi-structured interviews via Zoom with a small number of experts in mathematics education (6). The interview prompts are designed to gain insight into the experts' points of view about the key aspects of teachers' instructional practice, especially in relation to active, bodily experience activities. Interviews will be transcribed and analysed according to the thematic content analysis method, using open, inductive coding in the first instance (Palys et Atchinson, 2014, p. 305) and then refining the results with a focused, axial coding that will lead to the construction of concept maps (Daley, 2004). MOVIE (Gonzalez Canche, 2021) will be used to analyse these qualitative data and to compare and contrast individual responses to each question.

Teacher Survey

The second component is an online questionnaire that will be administered via Qualtrics. This questionnaire is being designed to document the practices and beliefs of primary and secondary mathematics teachers in relation to mathematics instruction in general and active, bodily experience activities in particular. This questionnaire will be anonymous. It will consist of Likert-type, multiple-choice, short open-response and vignette-items (Skilling & Stylianides, 2020).

The questionnaire items cover dimensions derived from the literature concerning teachers' beliefs on mathematics teaching and learning (Beswick, 2012; Van Zoest et al., 1994; Dionne, 1993; Ernest, 1989), conceptions of educational material usage (e.g., Skoumios & Skoumpourdi, 2021) and beliefs and instructional practices with manipulatives (Carbonneau & Marley, 2015; Golafshani, 2013; Vizzi, 2016). Other items were adapted from items on existing surveys such as OECD TALIS (2018) and IEA TIMSS (2019). There will be additional items concerning new explorative dimensions.

There are two parallel versions of the questionnaire, one for primary school and one for secondary school teachers, with minor adaptations to accommodate teaching context. Both questionnaires consist of five sections.

1. *The School* – concerning general information about the current school (e.g., government/ non-government school; traditional/school based on specific educational method such as Montessori) and school level/s that the respondent is currently teaching.
2. *General* – designed to provide information about the teacher's educational background and teaching experience.
3. *Beliefs* – including broad beliefs about teaching and learning mathematics (e.g., the role of the teacher or peers in the learning process).
4. *Beliefs* – specific beliefs about active, bodily experience activities (e.g., which school levels these

activities considered appropriate, what kind of educational impact is expected to be achieved, what factors can possibly limit their use, what kind of evaluation/assessment strategy may be appropriate).

5. At the end of the fourth section, a **filter question** concerning the actual use of these activities in daily teaching practices splits the questionnaire into two alternative parts on the basis of the teacher's use these activities in their teaching practice (Yes/No). This next section asks teachers for additional information such as the reasons for this choice, what other teaching strategies they deem to be effective, and comment about their implementation in classrooms (if used).

Descriptive statistics (e.g., frequencies, percentages, cross-tabulations with Chi-squared test) and correlations resulting from recording the similarities and the differences among the basic variables of the sample will be used to analyse the Likert type and multiple-choice item responses. Open-ended questions will be initially coded following an analytic induction from the content (Cohen et al., 2000; e.g., in Hourigan et al., 2016). Then the initial codes will be grouped into categories or themes, which will be examined for patterns across school levels. The number of comments from teachers at each school level in each of the broad categories will be counted to provide an indication of the relative emphasis on each category/theme across school levels, to identify the main trends and recurring themes (e.g., in Beswick et al., 2019). The vignette items include Likert type, multiple-choice and short open-ended questions. The answers will be analysed accordingly as previously stated. Cronbach alpha coefficient will be used for getting indication about the reliability and internal consistency of the questionnaire.

Individual interviews with teachers

The third component of the study involves individual semi-structured interviews. These semi-structured interviews will involve a smaller number of participants and will take place via Zoom. The interview questions are designed to gain insight into the original survey questions and are qualitative in nature. These responses will be audio-recorded, transcribed, and analysed via thematic content analysis in a similar fashion to the expert interviews (Anderson, 2007).

References

Abrahamson, D., Dutton, E., & Bakker, A (in press). Towards an enactivist mathematics pedagogy. In S. A. Stolz (Ed.), *The body, embodiment, and education: An interdisciplinary approach*. Routledge.

Abrahamson, D., Nathan, M. J., Williams-Pierce, C., Walkington, C., Ottmar, E. R., Soto, H., & Alibali, M. W. (2020). The future of embodied design for mathematics teaching and learning. In *Frontiers in Education* (Vol. 5, p. 147). Frontiers.

Anderson, R. (2007). Thematic content analysis (TCA). *Descriptive presentation of qualitative data*, 1-4.

Baccaglini-Frank, A., Carotenuto, G., & Sinclair, N. (2020). Eliciting preschoolers' number abilities using open, multi-touch environments. *ZDM Mathematics Education, 52*, 779–791. https://doi.org/10.1007/s11858-020-01144-y

Beswick, K. (2012). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educational Studies in Mathematics*, *79*(1), 127-147. https://doi.org/10.1007/s10649-011-9333-2

Carbonneau, K. J., & Marley, S. C. (2015). Instructional guidance and realism of manipulatives influence preschool children's mathematics learning. *The Journal of Experimental Education*, *83*(4), 495-513. https://doi.org/10.1080/00220973.2014.989306

Carotenuto, G., Mellone, M., & Spadea, M. (2021). Moving in early geometry education. *For the Learning of Mathematics*, *41*(1), 30-36.

Cohen, L., Monion, L., & Morris, K. (2000). Research methods in education 5th ed. London UK and New York.

Daley, B. (2004). *Using concept maps in qualitative research* [Paper presentation]. First International Conference on Concept Mapping, Spain.

Dionne, J. (1993). Modifying elementary school teachers' conceptions of mathematics and mathematics teaching and learning: A strategy based on conceptual analysis. *The Proceedings of the Third International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*: Ithaca.

de Freitas, & E. Sinclair, N. (2014). *Mathematics and the body*: *Material entanglement in the classroom.* Cambridge University Press.

Ernest, P. (1989). The impact of beliefs on the teaching of mathematics. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 249–253). Falmer.

Ferrara, F. (2006, July). Remembering and imagining: moving back and forth between motion and its representation. In *Proceeding 30th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 65-72).

Ferrara, F., & Ferrari, G. (2020) Reanimating tools in mathematical activity. *International Journal of Mathematical Education in Science and Technology*, *51*(2), 307-323. https://doi.org/10.1080/0020739X.2019.1648889

Flood, V. J., Shvarts, A., & Abrahamson, D. (2020). Teaching with embodied learning technologies for mathematics: responsive teaching for embodied learning. *ZDM*, *52*(7), 1307-1331.

Gallese, V., & Lakoff, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive neuropsychology*, *22*(3-4), 455-479. https://doi.org/10.1080/02643290442000310

Golafshani, N. (2013). Teachers' beliefs and teaching mathematics with manipulatives. *Canadian Journal of Education/Revue canadienne de l'éducation*, *36*(3), 137-159. https://www.jstor.org/stable/canajeducrevucan.36.3.137

Gonzalez Canche, M. S. (under review). Mapping, organizing, and visualizing interdependent events (MOVIE): A rigorous and cost-free approach to observe the evolution of processes taking place in qualitative research settings. *Methodological Innovations.*

Hourigan, M., Leavy, A. M., & Carroll, C. (2016). 'Come in with an open mind': Changing attitudes towards mathematics in primary teacher education. *Educational Research*, *58*(3), 319-346.

Lakoff, G., & Núñez, R. (2000). *Where mathematics comes from* (Vol. 6). Basic Books.

Lillard, A. S. (2016). *Montessori: The science behind the genius*. Oxford University Press.

Montessori, M. (1934a). *Psicogeometria*. Talleres Gràficos Garroff.

Montessori, M. (1934b). *Psicoaritmética*. Casa Editorial Araluce.

Nemirovsky, R., Rasmussen, C., Sweeney, G., & Wawro, M. (2012). When the classroom floor becomes the complex plane: Addition and multiplication as ways of bodily navigation. *Journal of the Learning Sciences*, *21*(2), 287-323.

OECD (2009). *Creating effective teaching and learning environments*. www.oecd.org/edu/school/43023606.pdf
OECD (2016). *PISA 2015 Results (Volume II): Policies and Practices for Successful Schools*. OECD Publishing.

OECD (2019). *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*. OECD Publishing.

Palys, T. S., & Atchison, C. (2014). *Research decisions: Quantitative, qualitative, and mixed method approaches*. Nelson Education.

Radford, L., Edwards, L., & Arzarello, F. (2009). Introduction: Beyond words. *Educational studies in mathematics*, *70*(2), 91-95. https://doi.org/10.1007/s10649-008-9172-y

Radford, L., Arzarello F., Edwards, L., & Sabena, C. (2017).The multimodal material mind: Embodiment in mathematics education.. In J.Cai (Ed.), *Compendium for Research in Mathematics Education* (pp. 700-721). NCTM.

Sarama, J., & Clements, D. H. (2009). "Concrete" computer manipulatives in mathematics education. *Child Development Perspectives*, *3*(3), 145-150.

Sinclair, N., & Pimm, D. (2015). Mathematics using multiple senses: Developing finger gnosis with three-and four-year-olds in an era of multi-touch technologies. *Asia-Pacific Journal of Research in Early Childhood Education*, *9*(3), 99-109.

Skilling, K., & Stylianides, G. (2020). Using vignettes in educational research: A framework for vignette construction, *International Journal of Research & Method in Education, 43*(5), 541-556. https://doi.org/10.1080/1743727X.2019.1704243

Skoumios, M., & Skoumpourdi, C. (2021). The use of outside educational materials in mathematics and science: Teachers' conceptions. *International Journal of Education in Mathematics, Science, and Technology*, *9*(2), 314-331.

Van Zoest, L. R., Jones, G. A., & Thornton, C. A. (1994). Beliefs about mathematics teaching held by preservice teachers involved in a first grade mentorship program. *Mathematics Education Research Journal, 6*(1), 37–55. https://doi.org/10.1007/BF03217261

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience.* MIT Press.

Vizzi, A. (2016). *Teachers' perceptions of manipulatives during middle school math instruction* [Doctoral dissertation, Walden University]. Proquest.

White, P. & Mitchelmore, M. (2003). Teaching Angles by Abstraction from Physical Activities with Concrete Materials. *International Group for the Psychology of Mathematics Education*, *4*, 403-410.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic bulletin & review*, *9*(4), 625-636. https://doi.org/10.3758/BF03196322

Email text for experts recruitment

Dear _ _ _ ,

With this email we would like to invite you to participate in an international research project carried out by researchers from ACU's Institute for Learning Sciences and Teacher Education.

We are currently conducting a research study in Italy and Australia that focuses on the beliefs of primary and secondary teachers, and their teaching practices with regards to mathematics. We are particularly interested in the instructional practice of activities that involve the active participation of students, in a laboratorial mode, involving their body and movement, to explore mathematical concepts. These include, for example, activities designed from the perspective of enactive-embodied learning, inquiry activities using manipulative materials and artifacts, hands-on activities using tools (virtual or physical) in an exploratory mode, activities where the whole body is engaged to explore mathematical concepts.

We are collecting the opinions of experts in the field on some key questions as part of this explorative study. Participation involves an interview (minimum 30 minutes, maximum one hour) via Zoom (on a day and time to be agreed upon), according to the framework briefly outlined below.

The interview will be recorded with your permission. Afterward, the audio will be transcribed and your comments will be collected, with those of other experts interviewed, to create a conceptual framework in which the main themes that emerge and their relationships will be reported. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Your comments may be directly quoted (using a pseudonym, e.g. First expert), as expressly indicated in the informed consent form which I will ask you to complete before agreeing to participate. Transcripts of the interview and comments made by the researchers on those data will be sent to you via email before publication. Once you have reviewed the material, it will only be published if you will have no objections.

Below you will find the key questions of the interview.

Experts' opinions on an internal research issue:

In our research, we will administer an online questionnaire to primary and secondary school teachers.

1) In the Australian version of the questionnaire, what terminology would you use to define the activities being surveyed in a clear and easily accessible way for teachers?

2) Do you think it would be useful to provide examples? Which examples do you think are commonly known and recognized by teachers? (Also consider the different school grades)

Experts' opinions about the central questions of the survey:

3) Do you think it is important to use these activities in school? Why?

4) What are the beliefs that should guide teachers in proposing these activities in the classroom?
What are the considerations, awareness, knowledge that should accompany teaching when implementing these activities? E.g. In terms of the choice of teaching strategies to be adopted, in terms of assessment, ...

5) What characteristics concerning the implementation of these activities in school determine their teaching effectiveness?

6) What are the main limitations of the use of these activities in teaching practice?
What are factors that hinder / favour the implementation of these activities in school?

In order to participate to the research study, please complete the Informed Consent Form via the following link:

https://acu.qualtrics.com/jfe/form/SV_8AeFvL07RkCP686

Please, you can find the Participant Information Letter at the following link: Participant Information Letter

We would be grateful if you could confirm your participation within 10 days of receiving this email. Afterward, you will be contacted by Doctoral Researcher Alessandra Boscolo to receive further information. The individual interview will take place via Zoom within a month of informed consent form completion, at a time convenient for participants.

If you are not interested in participating, we would be grateful if you could provide us with the contact details of any of your colleagues who might be interested in this topic.

For further details, you could contact Alessandra Boscolo a.boscolo@lumsa.it

We thank you for your time.

Best regards,

Professor Vince Geiger
Faculty of Education and Arts
Australian Catholic University
vincent.geiger@acu.edu.au

Professor Gabriella Agrusti
Department of Humanities
LUMSA (Italy)
g.agrusti@lumsa.it

Ph.D. Student Alessandra Boscolo
Faculty of Education and Arts
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s00313963@myacu.edu.au
Department of Humanities
LUMSA (Italy)
a.boscolo@lumsa.it

PARTICIPANT INFORMATION LETTER

Body Movement and Active Learning in Mathematics

Investigators:
Professor Vincent Geiger (Australian Catholic University)
Professor Gabriella Agrusti (LUMSA (Italy))
Doctoral Researcher Alessandra Boscolo (LUMSA (Italy)-Australian Catholic University)

Dear Participant,
It is our pleasure to invite you, as a primary or secondary school Mathematics teacher, to participate in a study on *Body Movement and Active Learning in Mathematics*. This study has received approval from Australian Catholic University's ethics committee (2021-199E).

What is the project about?
We are conducting a research study in Italy and Australia that focuses on the beliefs of primary and secondary teachers, and their teaching practices with regards to mathematics. We are particularly interested in the proposal and implementation in instructional practice of activities that involve the active participation of students, in a laboratorial mode, involving their body and movement, to explore mathematical concepts. These include, for example, activities designed from the perspective of enactive-embodied learning, inquiry activities using manipulative materials and artifacts, hands-on activities using tools (virtual or physical) in an exploratory mode, activities where the whole body is engaged to explore mathematical concepts.

Who is undertaking the project?
The project is being led by Professor Vincent Geiger (Australian Catholic University), who is the Chief investigator, Professor Gabriella Agrusti (LUMSA (Italy)) who is Co-investigator and the Student Researcher Alessandra Boscolo (LUMSA (Italy)-ACU). The project investigators are experienced researchers with expertise in mathematics education both nationally and internationally.

Are there any risks associated with participating in this project?

There are no foreseeable risks involved with participation in this project. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. We are aware, however, that for some people it could be stressful to be interviewed online for a minimum of 30 minutes to a maximum of 1 hour. If, for any reason, this project causes you undue distress, please call Lifeline on 13 11 14.

What will I be asked to do?
The project will involve you in a semi-structured interview via Zoom, at a time convenient for participants. This interview should not take more than an hour and will provide project researchers an opportunity to ask you questions which provide deeper insight into specific aspects of the survey. The Zoom meeting will be recorded for transcription purposes. Participants' comments will be collected, with those of other experts interviewed, to create a conceptual framework in which the main themes that emerged and their relationships will be reported. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Your comments may be directly quoted (using a pseudonym, e.g. First expert), as expressly indicated in the informed consent form which I will ask you to sign before agreeing to participate. Transcripts of the interview and comments made by the researchers on those data will be sent to you via email before publication. Once you have reviewed the material, it will only be published if you will have no objections.

What are the benefits of the research project?
Although there is no direct benefit to individual participants, the findings will inform advice for mathematics education researchers, curriculum developers and policymakers and thus there will be a benefit to the wide education community. Furthermore, the need for research that focuses on the teachers' perspective is relevant given the need to create communication between universities and schools in order to diminish the existing gap between the findings of scientific research and innovation in school.

Can I withdraw from the study?
Participation in this project is completely voluntary. You are not under any obligation to participate. If you agree to participate, you can withdraw from the study at any time, without adverse consequences, prior to publication of the findings, after which time it is no longer possible for us to do so.

Will anyone else know the results of the project?
The results of this project will be published, however the information collected via interview will be de-identified and reported in a collated manner. Participant interviews will be conducted via Zoom. These interviews will be recorded and stored digitally on the password protected ACU network drive. They will be deleted once they have been transcribed. The transcripts will be de-identified prior to any data analysis or data sharing between the universities and stored on password protected network drives. Only research team members will have access to these securely stored and de- identified transcripts.

Will I be able to find out the results of the project?
Transcripts of the individual interview and comments made by the researchers on those data will be sent to you before publication. Furthermore, interested individuals are encouraged to sign up to receive a summary of the results as soon as the project is completed.

Who do I contact if I have questions about the project?
Any questions regarding this project should be directed to the Principal Researcher:
Professor Vincent Geiger
Australian Catholic University Brisbane
Campus Brisbane, QLD, 4000
Ph.: 07 3623 7188
Email: vincent.geiger@acu.edu.au;

What if I have a complaint or any concerns?
The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (2021-199E). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice Chancellor (Research).

Manager, Ethics
c/o Office of the Deputy Vice Chancellor
(Research) Australian Catholic University North
Sydney CampusNorth Sydney, NSW 2059
Ph.: 02 9739 2519
Email: resethics.manager@acu.edu.au

Any concern will be treated in confidence and fully investigated. You will be informed of the outcome.

I want to participate! How do I sign up?
If you are willing to help us with this project, please return to the Qualtrics and complete the informed consent form. Please make sure you keep this letter as a record of the project description and for the contact details of the chief investigators in case you have any questions.

Yours sincerely,

Professor Vince Geiger
Faculty of Education and Arts
Australian Catholic University
vincent.geiger@acu.edu.au

Professor Gabriella Agrusti
Department of Human Studies
LUMSA (Italy)
g.agrusti@lumsa.it

Ph.D. Student Alessandra Boscolo
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ACU
INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

LUMSA UNIVERSITÀ
1939 OTTANTESIMO 2019

Informed Consent Form

Thank you for choosing to participate in the research project: Body Movement andActive Learning in Mathematics.

The purpose of the study is to investigate, both in Italy and Australia, whether teachers, from across school grades, propose, and how they select and implement, active learning in their mathematics teaching practice. In particular, we focus on learning activities in which students are actively involved with manipulations of artifacts (both physical and virtual) or body movements, to experience mathematical concepts through sensorimotor perceptions. Furthermore, we investigate what teachers' beliefs are about the expected outcomes, limitations, and constraints in implementing these activities and about teaching and learning mathematics.

For your participation in the research project, the following collaboration is required: one interview via ZOOM lasting a minimum of 30 minutes, a maximum of 1 hour. Your involvement aims to clarify some critical points in the drafting of the questionnaire, as well as to gather the views of experts in the field on the subject of the study.

Participation in the study is voluntary and free of charge. If you agree to participate, you can withdraw from the study at any time, even without prior notice or specific reason, without adverse consequences.

The interview will be video-recorded for transcriptions purposes. All participants will bede-identified prior to sharing data with other project researchers or dissemination of findings via publication. The information obtained from the studies will be used in scientific publications or conferences. Your comments may be directly quoted (using a pseudonym, e.g. First expert) only if you agreed explicitly, giving the consent in the form below. Transcripts of the interview and comments made by the researchers on those data will be sent via email to you before publication. Once you have reviewed the material, it will only be published if you will have no objections. Ph.D. student Alessandra Boscolo will be responsible for data processing and

storage.Thank you.

Professor Vince Geiger
Faculty of Education and Arts
Australian Catholic University
vincent.geiger@acu.edu.au

Professor Gabriella Agrusti
Department of Human Studies
LUMSA (Italy)
g.agrusti@lumsa.it

Ph.D. Student Alessandra Boscolo
Faculty of Education and Arts
Australian Catholic University
s00313963@myacu.edu.au
Department of Human Studies
LUMSA (Italy)

For further information please contact: a.boscolo@lumsa.it

Before proceeding to complete the consent form below,please read the Participant Information Letter at the following link: Participant(Experts) Information Letter.pdf

- I have read and understood the information providedin the Participants Information Letter. Any questions Ihave asked have been answered to my satisfaction.
- I agree to participate in a 30 minutes video conference call, realising that I can withdraw my consent at any time without adverse consequences.
- I agree that research data collected for the study maybe published or may be provided to other researchers.

- ○ I understand and give consent
- ○ I've decided not to participate further in this research

Name and Surname

E-mail

I agree that the information provided during the interviewmay be expressly quoted, using a pseudonym, in research reports

- ○ Yes
- ○ No

ACU
INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

LUMSA UNIVERSITÀ
1939 OTTANTESIMO 2019

Researchers from ACU's Institute for Learning Sciences and Teacher Education are currently taking part in an international study on the beliefs of primary and secondary teachers, and their teaching practices with regards to Mathematics. The focus of the study is the involvement of students' body and movement in mathematics active learning. You are invited to contribute to this study in order to provide a picture of Australian teachers' perspective. As a teacher of mathematics, your views are critical to developing a clear picture of current practices. Accordingly, you are invited to participate in the study.

Participation involves the completion of an anonymous 20-minute online survey, available via the following link: https://acu.qualtrics.com/jfe/form/SV_9ZEGAphu9STIi9g.

At the completion of the survey, you will be offered the opportunity to register interest in an optional online individual interview to further elaborate on your views.

Please, you can find further information in the Participant Information Letter at the following link: Participant Information Letter.

PARTICIPANT INFORMATION LETTER
Body Movement and Active Learning in Mathematics

Investigators:
Professor Vincent Geiger (Australian Catholic University)
Professor Gabriella Agrusti (LUMSA (Italy))
Doctoral Researcher Alessandra Boscolo (LUMSA (Italy)-Australian Catholic University)

Dear Participant,

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Who is undertaking the project?
The project is being led by Professor Vincent Geiger (Australian Catholic University), who is the chief investigator, Professor Gabriella Agrusti (LUMSA (Italy)) who is co-investigator and the Ph.D. Student Alessandra Boscolo (LUMSA (Italy)-ACU). The project investigators are experienced researchers with expertise in mathematics education both nationally and internationally.

Are there any risks associated with participating in this project?
There are no foreseeable risks involved with participation in this project. All survey data is collected via an anonymous link, negating the risk of being identified. In addition, only aggregated results will be presented in publications developed from this study. We are aware, however, that for some people it could be stressful to complete an online form answering questions for approximately 20 minutes. If, for any reason, this project causes you undue distress, please call Lifeline on 13 11 14.

What will I be asked to do?
The project will involve you completing an online survey via Qualtrics related to your experience as a Mathematics teacher. This will take approximately 20 minutes. The survey data will be anonymously collected.

OPTIONAL: As part of the survey, you will be asked whether you are willing to take part in a follow-up individual interview. If you agree, you will need to provide your contact email. This data will be collected separately from your survey responses to ensure anonymity of survey responses. The individual interview will take place via Zoom within a month of survey completion at a time convenient for participants. These interviews will provide project researchers an opportunity to ask you questions which provide deeper insight into specific aspects of the survey. The Zoom meeting will be recorded for transcription purposes. All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication.

What are the benefits of the research project?

Taking part in the questionnaire can increase teachers' awareness of their own teaching practices by reflecting on them in answering the proposed questions.
The findings will inform advice for researchers in mathematics education, curriculum developers and policymakers and thus there will be a benefit to the profession at large. Furthermore, the need for research that focuses on the teachers' perspective is relevant given the need to create communication between universities and schools in order to diminish the existing gap between the findings of scientific research and innovation in school.

Can I withdraw from the study?

Participation in this project is completely voluntary. You are not under any obligation to participate. If you agree to participate, you can withdraw from the study at any time without adverse consequences. As survey responses are anonymous, however, we cannot identify individual entries and it is therefore not possible for us to remove responses after submission. For individual interviews, participants may choose to withdraw their responses at any stage prior to publication of the findings, after which time it is no longer possible for us to do so.

Will anyone else know the results of the project?

The results of this project will be published, however the information collected via survey will be anonymous. We ask that you do not include any potentially identifiable information in any open-ended question responses. For instance, the name of your school. Should you accidentally do so, such information will be removed or replaced with a pseudonym prior to data analysis. Only de-identified data from this project will be shared between LUMSA University and ACU for further analysis and reporting.
The survey is being conducted via Qualtrics. Information you provide on this survey will be transferred to a secure ACU University server in line with ethical guidelines for the secure use and storage of data. Only research team members will have access to this securely stored data.
With regards to the information collected via individual interview, the results of this project will be published, however the information collected will be de-identified and reported in a collated manner. Participant interviews will be conducted via Zoom. These interviews will be recorded and stored digitally on the password protected ACU network drive. They will be deleted once they have been transcribed. The transcripts will be de-identified prior to any data analysis or data sharing between the universities and stored on password protected network drives. Only research team members will have access to these securely stored and de-identified transcripts.

Will I be able to find out the results of the project?

Given the nature of this research, each participant's personal data is not likely to be meaningful without comparison to the data collected for other participants. As such, participant's individual data will not be provided, but interested individuals are encouraged to sign up to receive a summary of the results as soon as the project is completed.

Who do I contact if I have questions about the project?

Any questions regarding this project should be directed to the Principal Researcher:
Professor Vincent Geiger
Australian Catholic University Brisbane Campus

Brisbane, QLD, 4000
Ph.: 07 3623 7188
Email: vincent.geiger@acu.edu.au;

What if I have a complaint or any concerns?
The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (2021-199E). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice Chancellor (Research).

Manager, Ethics
c/o Office of the Deputy Vice Chancellor (Research)
Australian Catholic University North Sydney Campus
North Sydney, NSW 2059
Ph.: 02 9739 2519
Email: resethics.manager@acu.edu.au

Any concern will be treated in confidence and fully investigated. You will be informed of the outcome.

I want to participate! How do I sign up?
If you are willing to help us with this project, return to the Qualtrics link and read through the informed consent page before ticking that you give consent to participate. This will allow you to access the survey questions.

Please make sure you keep this letter as a record of the project description and for the contact details of the chief investigators in case you have any questions.

Yours sincerely,

Professor Vince Geiger
Faculty of Education and Arts
Australian Catholic University
vincent.geiger@acu.edu.au

Professor Gabriella Agrusti
Department of Human Studies
LUMSA (Italy)
g.agrusti@lumsa.it

Ph.D. Student Alessandra Boscolo
Faculty of Education and Arts
Australian Catholic University
s00313963@myacu.edu.au
Department of Human Studies
LUMSA (Italy)
a.boscolo@lumsa.it

Questionnaire on Body Movement and Active Learning in Mathematics

Thank you for choosing to participate in the research project: Body Movement and Active Learning in Mathematics.

The purpose of the study is to investigate, both in Italy and Australia, whether teachers, from across school grades, propose, and how they select and implement, active learning in their mathematics teaching practice. In particular, we focus on learning activities in which students are actively involved with manipulations of artifacts (both physical and virtual) or body movements, to experience mathematical concepts through sensorimotor perceptions. Furthermore, we investigate teachers' beliefs about the expected outcomes, limitations, and constraints in implementingthese activities, and about teaching and learning mathematics.

This study takes the form of an online questionnaire which takes approximately 20minutes to complete.

Please answer every question. We want to find out about your experiences, there areno right or wrong answers. Please answer the questions with reference to your own teaching practices in the school where you are working in.

As part of this survey, you will be asked whether you are willing to take part in afollow-up individual interview. If you agree, we will ask for your email address. Thisinformation will be collected separately from your survey responses to ensure the anonymity of survey responses.

Responses to this survey are anonymous. You will not be identifiable in any publication based on this research. If you agree to participate, you can withdraw fromthe study at any time without adverse consequences. As survey responses are anonymous, however, we cannot identify individual entries and it is therefore not possible for us to remove responses after submission.

Thank you.

Professor Vince Geiger
Faculty of Education and Arts
Australian Catholic University
vincent.geiger@acu.edu.au

Professor Gabriella Agrusti
Department of Human Studies

LUMSA (Italy)
g.agrusti@lumsa.it

Ph.D. Student Alessandra Boscolo
Faculty of Education and Arts
Australian Catholic University
s00313963@myacu.edu.au
Department of Human Studies
LUMSA (Italy)
a.boscolo@lumsa.it

For further information please contact: a.boscolo@lumsa.it

Before proceeding with the survey, please read the Participant Information Letter,clicking on the following link: Participant Information Letter for Teachers and complete the Informed Consent Form below.

- I have read and understood the information provided in the Participant Information Letter. Any questions I hadhave been answered to my satisfaction.
- I agree to participate in this 20-minute online survey, realising that I can withdraw my consent at any time (without adverse consequences). The only exception is for data that has already been submitted as surveyresponses are anonymous and therefore cannot be removed for a select individual.
- I agree that research data collected for the study may be published or provided to other researchers in a formthat does not identify me in any way.

- ○ I understand and give consent
- ○ I've decided not to participate further in this research

Default Question Block

CONTACT DETAILS and INFORMED CONSENT FORM

Thank you for choosing to continue your participation in the research project: Body Movement and Active Learningin Mathematics.

This survey is to collect your contact details for the purpose of organising a follow-up Zoom interview. Your participation in this interview will enable us to ask you questions that provide deeper insight into specific aspects ofthe survey.

Thank you.

Professor Vince Geiger
Faculty of Education and Arts
Australian Catholic University
vincent.geiger@acu.edu.au

Professor Gabriella Agrusti
Department of Human Studies
LUMSA (Italy)
g.agrusti@lumsa.it

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a.boscolo@lumsa.it

For further information please contact:
a.boscolo@lumsa.it

Before proceeding the completion of the Informed Consent Form below, please read the Participant Information Letter, clicking on the following link: Participant Information Letter for Teachers

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- I have read and understood the information provided in the Participant Information Letter. Any questions I hadhave been answered to my satisfaction.
- I agree to participate in a 30 minute video conference call, realising that I can withdraw my consent at any time(without adverse consequences). I recognise that this conference call will be audio recorded for transcription purposes.
- I agree that research data collected for the study may be published or provided to other researchers in a formthat does not identify me in any way.

- ○ I understand and give consent
- ○ I've decided not to participate further in this research

Name

Surname

E-mail

E-mail Confirmation

Year levels taught

Title: Body Movement and Active Learning in Mathematics: Australian teachers' beliefs and practices

Researchers: student and Vince Geiger

Reviewer

Name: Professor Kim Beswick, BSc, Dip Ed, PhD

I have read the research proposal mentioned above and make the following comments and suggestions for the research team.

The proposal has been significantly improved and now outlines a worthwhile study. Please see minor edits and a small number of comments on the attached copy.

INVESTIGATOR SIGNATURES

The linked image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the link points to the correct file and location.

APPENDIX 2: INSTRUMENTS

PROTOCOL FOR EXPERTS'INTERVIEWS

WEB-BASED SURVEY

PROTOCOL FOR TEACHERS' FOLLOW-UP INDIVIDUAL INTERVIEWS

PROTOCOL FOR EXPERTS'INTERVIEWS

Protocol for Interview with Experts

A. Introduction

Thank you for your participation in this research project. We are currently conducting a research study in Italy and Australia that focuses on the beliefs of primary and secondary teachers, and their teaching practices with regards to mathematics. We are particularly interested in the proposal and implementation in instructional practice of activities that involve the active participation of students, in a laboratorial mode, involving their body and movement, to explore mathematical concepts. These include, for example, activities designed from the perspective of enactive-embodied learning, inquiry activities using manipulative materials and artifacts, hands-on activities using tools (virtual or physical) in an exploratory mode, activities where the whole body is engaged to explore mathematical concepts.
The interview will be recorded with your permission. Afterward, the audio will be transcribed and your comments will be collected, with those of other experts interviewed, to create a conceptual framework in which the main themes that emerged and their relationships will be reported.
All participants will be de-identified prior to sharing data with other project researchers or dissemination of findings via publication. Your comments may be directly quoted (using a pseudonym, e.g. First expert), as expressly indicated in the informed consent which we asked you to sign before agreeing to participate. Transcripts of the interview and comments made by the researchers on those data will be sent to you before publication. Once you have reviewed the material, it will only be published if you will have no objections.

B. Experts' opinions on an internal research issue

In our research, we will administer an online questionnaire to primary and secondary school teachers.
I. In the Australian version of the questionnaire, what terminology would you use to define the activities being surveyed in a clear and easily accessible way for teachers?
II. Do you think it would be useful to provide examples? Which examples do you think are commonly known and recognized by teachers? (Also consider the different school grades)

C. Experts' opinions about the central questions of the survey

III. Do you think it is important to use this type of activity in school? Why?
IV. What are the beliefs that should guide teachers in proposing these activities in the classroom?
What are the considerations, awareness, knowledge that should accompany teaching when implementing these activities? E.g. In terms of the choice of teaching strategies to be adopted, in terms of assessment, ...
V. What characteristics concerning the implementation of these activities in school determine their teaching effectiveness?
VI. What are the main limitations of the use of these activities in teaching practice?
What are factors that hinder / favour the implementation of these activities in school?

D. Greetings and thanks

Thank you for participating. Your collaboration is really precious for our research.

English

Body Movement and Active Learning in Mathematics

Questionnaire Body Movement and Active Learning in Mathematics

ACU
INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

LUMSA UNIVERSITÀ
1939 OTTANTESIMO 2019

Thank you for choosing to participate in the research project: Body Movement and Active Learning in Mathematics.

The purpose of the study is to investigate, both in Italy and Australia, whether teachers, from across school grades, propose, and how they select and implement, active learning in their mathematics teaching practice. In particular, we focus on learning activities in which students are actively involved with manipulations of artifacts (both physical and virtual) or body movements, to experience mathematical concepts through sensorimotor perceptions. Furthermore, we investigate teachers' beliefs about the expected outcomes, limitations, and constraints in implementing these activities, and about teaching and learning mathematics.

This study takes the form of an online questionnaire which takes approximately 20 minutes to complete. Please answer every question. We want to find out about your experiences, there are no right or wrong answers. Please answer the questions with reference to your own teaching practices in the school where you are working in. As part of this survey, you will be asked whether you are willing to take part in a follow-up individual interview. If you agree, we

will ask for your email address. This information will be collected separately from your survey responses to ensure the anonymity of survey responses.

Responses to this survey are anonymous. You will not be identifiable in any publication based on this research. If you agree to participate, you can withdraw from the study at any time without adverse consequences. As survey responses are anonymous, however, we cannot identify individual entries and it is therefore not possible for us to remove responses after submission.

Thank you.

Ph.D. Student Alessandra Boscolo	Professor Vincent Geiger	Professor Gabriella Agrusti
Australian Catholic University	Institute for Learning Sciences and Teacher Education,	Department of Humanities
LUMSA University	Australian Catholic University	LUMSA University (Italy)

For further information please contact: a.boscolo@lumsa.it, +39 3386425360

Before proceeding with the survey, please read the Participant Information Letter, clicking on the following link: Participant Information Letter for Teachers and complete the Informed Consent Form below.

- I have read and understood the information provided in the Participant Information Letter. Any questions I had have been answered to my satisfaction.
- I agree to participate in this 20-minute online survey, realising that I can withdraw my consent at any time (without adverse consequences). The only exception is for data that has already been submitted as survey responses are anonymous and therefore cannot be removed for a select individual.
- I agree that research data collected for the study may be published or provided to other researchers in a form that does not identify me in any way.

○ I understand and give consent

○ I've decided not to participate further in this research

1) Please, select one of the following:

○ I'm a **Primary** school teacher
○ I'm a **Secondary** school teacher

The School

2) In the current school year, which year level(s) are you teaching?

Select one or more alternatives from the following ones.

☐ **Preschool**
☐ **Pre-Year 1** (Foundation year)
☐ **Year 1** (Primary-school)
☐ **Year 2** (Primary-school)
☐ **Year 3** (Primary-school)
☐ **Year 4** (Primary-school)
☐ **Year 5** (Primary-school)
☐ **Year 6** (Primary-school)

2) In the current school year, which year level(s) are you teaching?

Select one or more alternatives from the following ones.

☐ **Year 7** (Secondary (High)-school)
☐ **Year 8** (Secondary (High)-school)
☐ **Year 9** (Secondary (High)-school)
☐ **Year 10** (Secondary (High)-school)
☐ **Year 11** (Senior (Upper) Secondary (High)-school)

☐ **Year 12** (Senior (Upper) Secondary (High)-school)

3) Which best describe your current school?

Select one alternative from the following ones.

4) Referring to class formation, which best describes your current school?

Select one alternative from the following ones.

5) Referring to inspiring principles, which best describes your current school?

Select one alternative from the following ones.

- ○ Traditional School
- ○ School based on a specific educational method
  (e.g., Montessori method school, Steiner school)

Which typology?

Write down your answer.

6) What subject(s) are you teaching for the majority of hours per week in this school during the current school year?

If you teach more than one subject for the same hours, please select up to two alternatives.

- ☐ Mathematics
- ☐ Sciences
- ☐ Physics

- [ ] Technology
- [ ] Economy
- [ ] Biology
- [ ] Other (Please Specify)

General

7) What is the highest level of formal education you have completed?

Select one alternative from the following ones.

- ○ Bachelor's Degree
- ○ Master's Degree or professional degree (MD, DDS, lawyer, minister)
- ○ Doctorate (Ph.D. / Ed.D.)
- ○ Other (Please Specify)

7) What is the highest level of formal education you have completed?

Select one alternative from the following ones.

- ○ Graduate Diploma (Diploma of Education / Diploma of Teaching)
- ○ Bachelor's Degree
- ○ Master's Degree or professional degree (MD, DDS, lawyer, minister)
- ○ Doctorate (Ph.D. / Ed.D.)
- ○ Other (Please Specify)

8) During your college or university education, what was the major discipline knowledge?

Select one alternative from the following ones.

○ **Mathematics**
(e.g. Geometry, Algebra, Probability and Statistics, Numerical Analysis)

○ **Mathematics Education**
(You took specific Mathematics Education courses)

○ [ ] **Other** (Please Specify)

9) At the end of this school year, how many years have you been working as a mathematics teacher?

Select one alternative from the following ones.

○ from 1 to 3 years
○ from 4 to 10 years
○ more than 10 years

Beliefs

10) In your opinion, to what extent do the following factors play a significant role in students' mathematical development?

For each row, select one alternative.

	To a large extent	To a moderat extent	To a small extent	Not at all	I don't know
a) **Teacher's** role	○	○	○	○	○
b) **Peer's** role	○	○	○	○	○
c) **Student's** role (in supporting their own development)	○	○	○	○	○

11) What is the teacher's role in supporting mathematical development?

Select one alternative from the following ones.

- ○ **Instructor**: preparing students to use and apply mathematics results and procedures correctly and efficiently
- ○ **Explainer**: allowing students to comprehend and deeply understand mathematical concepts
- ○ **Facilitator**: providing students with the necessary scaffolding and teaching skills to think mathematically
- ○ **None of the previous**

12) To what extent do you agree or disagree with the following statements?

For each sentence, select one alternative.

	To a large extent	To a moderate extent	To a small extent	Not at all	I don't know
a) Mathematics is a collection of rules, facts and methods to be used as a tools to solve problems	○	○	○	○	○
b) Mathematics is a beautiful, creative and useful human endeavour that is both a way of knowing and a way of thinking	○	○	○	○	○
c) Mathematics is the science of formal structure and rigorous logic	○	○	○	○	○
d) It is teacher's responsibility to provide children with clear and concise solution methods for mathematical problems	○	○	○	○	○
e) Mathematical material is best presented in an expository style: demonstrating, explaining and describing concepts and skills	○	○	○	○	○
f) Mathematics knowledge can't be transmitted, but it should be constructed by the learner	○	○	○	○	○

Body and Movement in Mathematics Active Learning:

Beliefs

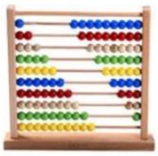
ACTIVE, BODILY EXPERIENCE MATHEMATICS LEARNING ACTIVITIES

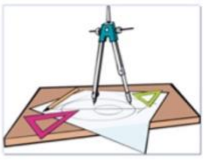
We refer to learning activities in which students are actively involved with their body and movement, in a laboratorial mode, engaging their sensorimotor perceptions through manipulations with virtual or physical artifacts, tools, or simply body movements, to explore and understand mathematical concepts.

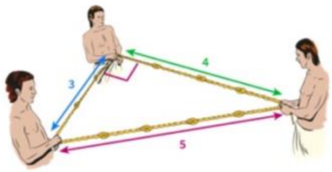
These activities include, for example, hands-on learning activities with manipulatives (virtual or digital) designed from an "active" learning perspective, including inquiry or exploratory activities in which students are physically engaged.

Examples:

Hands-on activities with manipulatives, artifacts and tools







Exploring mathematics (e.g. computational thinking, Pythagorean Triples) with students' whole body movement

Activities carried out with digital apps (e.g. TouchCounts or Geogebra) on multi-touch devices (e.g. ipads)

13) To what extent do you believe it is important to propose active learning activities involving student' body and movement in mathematics teaching practice?

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know
Select an alternative.	○	○	○	○	○

14) For which schools levels do you believe active, bodily experience mathematics learning activities are appropriate?

Write down your answer.

15) Which topic(s)/content(s) do you believe should be taught with this type of learning activity?

Write down 1-3 examples.

Example 1

Example 2

Example 3

15) Which topic(s)/content(s) do you believe should be taught with this type of learning activity?

Write down 1-3 examples.

Example 1

Example 2

Example 3

16) Do you believe this type of learning activities could have a positive influence on students' ...

For each row, select an alternative.

	To a large extent	To a moderate extent	To a small extent	Not at all	I don't know
1. deep understanding	○	○	○	○	○
2. achievement in standard tests	○	○	○	○	○
3. reasoning skills	○	○	○	○	○
4. mathematics visualization capabilities	○	○	○	○	○
5. problem solving skills, critical thinking and creativity	○	○	○	○	○
6. interest and motivation	○	○	○	○	○
7. attitudes toward mathematics (affect/ self-efficacy)	○	○	○	○	○

17) Do you believe this type of learning activities could impact on ...

For each row, select an alternative.

	To a large extent	To a moderate extent	To a small extent	Not at all	I don't know
1. supportive classroom environment	○	○	○	○	○
2. environment conducive to the expression of opinions	○	○	○	○	○
3. the inclusion of special educational needs students	○	○	○	○	○
4. the inclusion of students with different cultural/economic backgrounds	○	○	○	○	○
5. teacher's knowledge of students' learning processes	○	○	○	○	○

18) In your experience, what are the most relevant limitations for this type of learning activities' implementation?

Select up to three alternatives.

- ☐ Classroom management (e.g. Difficulty of classroom control and noise level)
- ☐ Students' assessment
- ☐ Suit only low achievers
- ☐ Suit only high achievers
- ☐ Not inclusive for students with a different cultural background
- ☐ Not inclusive for special needs students
- ☐ Time factors

- [ ] Availability of space and resources
- [ ] Not effective as an instructional strategy
- [ ] Only few topics can be taught with these
- [ ] Appropriate only for childhood primary
- [ ] Other (Please Specify)

19) What kind of assessment strategy or instrument do you believe is most appropriate for this type of learning activities?

Select up to two alternatives.

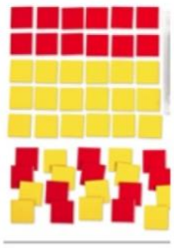
- [ ] Written test
- [ ] Oral examinations
- [ ] Observation
- [ ] Peer assessment
- [ ] Project work
- [ ] Portfolio
- [ ] Student self-assessment
- [ ] I don't think these activities should have assess at all
- [ ] Other (Please Specify)

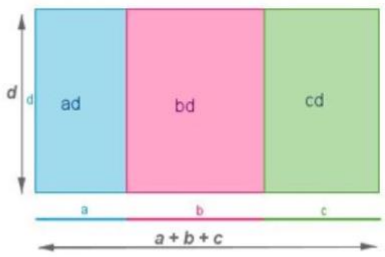
20) Please read the brief story before answering the following questions.

Monica is a young teacher who decided to propose an active learning activity using manipulative materials in her classroom for the first time.

The activity requires the use of wooden shapes to explore geometric representations of the distributive properties of multiplication.

Distributive properties of multiplication





Monica shows the whole class the wooden shapes and explains how students can use them to solve arithmetical problems. Then, she asks the students to carry out a series of pre-defined tasks in scheduled timing, suggesting using the wooden shapes. She observes the students while they are carrying out the tasks independently.

Even though, at first, many students show interest and become engaged with the new way to represent arithmetical properties, the majority of students do not use wooden shapes to solve the tasks. Instead, they use traditional strategies (i.e., paper and pencil calculations) they are already familiar with.

Thus, Monica believes the activity is not effective, as most of the students did not use the wooden shapes and geometric interpretations to carry out the tasks.

20) Think about Monica's story, please express to what extent do you agree or disagree with the following statements:

For each of the following 4 sentences, select one alternative.

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know
a) The activity was in fact effective, as students got to know an alternative way of representing distributive properties. It doesn't matter if they solved the tasks with the already known solving strategies.	○	○	○	○	○
b) This type of activity takes a long time before students become familiar with a new way of working and become aware of how experience with wooden shapes can help them solve arithmetic problems.	○	○	○	○	○
c) Proposing exploratory tasks and open-ended problems make this type of learning activity more effective than solving predefined tasks in scheduled timing.	○	○	○	○	○

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know
d) A high level of student interaction with the teacher and peers during the activity would have stimulated the use of wooden shapes to solve arithmetical problems.	○	○	○	○	○
e) The reason for Monica's failure is that she failed to convey to the students the goal of the activity: to explore and become familiar with geometric interpretations of distributive properties.	○	○	○	○	○

20) Please read the brief story before answering the following questions.

Monica is a young teacher who has decided to implement an active learning activity using manipulative materials, in her classroom, for the first time.

The activity requires the use of wooden shapes to solve algebraic problems through geometric representations.

E.g. Cube of a binomial

Monica shows the whole class the wooden shapes and explains how students can use them to solve algebraic problems.

Then, she asks the students to carry out a series of predefined tasks in scheduled timing, suggesting using the wooden shapes. She observes the students while they are carrying out the tasks independently.

Even though, at first, many students show interest and become engaged with the new way of representing algebraic problems, the majority of students do not use wooden shapes to solve the tasks. Instead, they use the traditional strategies (i.e., paper and pencil calculation) they are already familiar with.

Thus, Monica believes the activity is not effective, as most students have not used the wooden shapes and the geometrical interpretation to deal with the tasks.

20) Think about Monica's story, please express to what extent do you agree or disagree with the following statements:

For each of the following 4 sentences, select one alternative.

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know
a) The activity was in fact effective, as students got to know an alternative way of representing algebraic problems. It doesn't matter if they solved the tasks with the already known solving strategies.	○	○	○	○	○

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know
b) This type of activity takes a long time before students become familiar with a new way of working and become aware of how experience with wooden shapes can help them solve algebraic problems.	○	○	○	○	○
c) Proposing exploratory tasks and open-ended problems make this type of learning activity more effective than solving predefined tasks at scheduled timing.	○	○	○	○	○
d) A high level of student interaction with the teacher and peers during the activity would have stimulated the use of wooden shapes to solve algebraic problems.	○	○	○	○	○

	To a large extent	To a moderate extent	To a small extent	Not at all	I dont' know
e) The reason for Monica's failure is that she failed to convey to the students the goal of the activity: to explore and become familiar with geometric interpretations of algebraic problems.	○	○	○	○	○

Body and Movement in Mathematics Active Learning: Implementation

21) Do you include active, bodily experience mathematics learning activities in your instructional practice?

Select one alternative from the following ones.

- ○ Yes
- ○ No

22) How often do you implement an active, bodily experience mathematics learning activity in your instructional practice?

Select one alternative from the following ones.

- ○ Once a week or more
- ○ 1-3 times a month
- ○ 5-10 times every year
- ○ Less than 4 times every year
- ○ [ ] Other (Please specify)

23) On average, how much time do you spend implementing a learning activity of this type?

Select one alternative from the following ones.

- ○ Less than a lesson
- ○ From 1 to 3 lesson
- ○ More than 3 lessons

24) During your classes, you mainly implement this type of learning activities:

Select one or more alternatives from the following ones.

- ☐ to introduce new topics
- ☐ as consolidation activities (to exercise)
- ☐ to revise topics
- ☐ as remedial activities
- ☐ as advanced (enrichment) activities
- ☐ to enhance students' motivation
- ☐ [ ] Other (Please Specify)

25) What types of materials/ tools are involved in your instructional practice when you implement a learning activity of this type?

Select one or more alternatives from the following ones.

- ☐ **mechanical tools**
  (e.g. drawing tools like compass, etch-a-sketch, perspective tools)
- ☐ **computational devices**
  (e.g., Position Detector, Calculator Based Laboratory)
- ☐ **physical manipulatives**
  (e.g., origami, wooden geometrical shapes)

☐ **daily life objects**
(e.g. straws, cardboard boxes)

☐ **gym equipment**
(e.g. ropes, hula-hoop, rods, psychomotor blocks)

☐ **interactive digital tools**
(e.g. interactive apps like Geogebra applets on multitouch devices - iPads)

☐ only **students' body** (or also usual stuff such as pencil and paper)

☐ Other (Please Specify)

25) What types of materials/ tools are involved in your instructional practice when you implement a learning activity of this type?

Select one or more alternatives from the following ones.

☐ **mechanical tools**
(e.g., drawing tools like compass, etch-a-sketch, perspective tools)

☐ **computational devices**
(e.g., abacus, pascaline)

☐ **physical manipulatives**
(e.g., tangram, Montessori's materials, origami, wooden geometrical shapes, base-ten Dienes blocks)

☐ **daily life objects**
(e.g., straws, cardboard boxes)

☐ **gym equipment**
(e.g., ropes, hula-hoop, rods, psychomotor blocks)

☐ **interactive digital tools**
(e.g., interactive apps like Geogebra applets, Fingu, TouchCounts, on multitouch devices - iPads)

☐ only **students' body** (or also usual stuff such as pencil and paper)

☐ Other (Please Specify)

26) When you implement activities of this type in your classroom, do you usually...

Select one or more alternatives from the following ones.

- ☐ use commercially developed materials, tools
- ☐ adapt commercially developed materials, tools
- ☐ design and construct materials, tools from scratch

27) Which of the following ones is/are the major/main criteria that determine your choices in selecting and designing active, bodily experience mathematics learning activities?

Select up to two alternatives from the following ones.

- ☐ **Experts' evaluation** (Information from professional development courses, official professional texts, and books, newsletters or periodical reviews articles)
- ☐ **Colleagues suggestions** and information about their own experiences
- ☐ Your own **personal experience** (as a teacher or as a student)
- ☐ Specific contextual **student's needs**
- ☐ Specific **instructional goals** you would like to achieve
- ☐ **Availability / accessibility/ affordability** of resources
- ☐ [ ] Other (Please Specify)

28) In your opinion, what are the main difficulties experienced by students (in learning effectively) during a learning activity of this type?

Select up to two alternatives from the following ones.

- ☐ Understand the task
- ☐ Explain their own ideas in class
- ☐ Maintain interest during the activity
- ☐ Physically handling objects and tools
- ☐ Take part in a discussion among peers
- ☐ Apply their mathematical knowledge in the activity
- ☐ Transfer in new contexts what they have learned

☐ Formalize what they have learned using mathematical language

☐ Simultaneously handling different representations of mathematical concepts (e.g. concrete, figurative, symbolic))

☐ Other (Please Specify)

29) Please read the brief story before answering the following question.

Robert and Tina are Maths teachers in grade 8. They decided to propose an active, bodily experience learning activity in their own class, but following different instructional strategies.

Robert makes explicit the content knowledge of the activity at the beginning of the class period.
After he introduces the manipulatives (i.e., tools, objects, artifacts...) that students have to use.
He follows a high structured instructional activity (step-by-step procedures) with scheduled timing. Robert divides students into mixed ability groups of 3-4 members.
Standing in front of the board, he interacts with the whole class to get them to draw conclusions from the activity.

Tina shows students the manipulatives (i.e. tools, objects, artifacts..) and gives them to students, so they can become familiar with their use. Then, she introduces a problem to solve.
She allows students to co-design and self-direct the activity, working individually or in self-organized groups.
Each student can approach the problem with his/her own strategy. Tina walks among students as they work and makes suggestions or asks questions if needed.
Finally, when ready, students share and discuss their own conclusions with the whole class.

29) Overall, which of the two teachers do you most identify with?

○ Robert

○ Tina

30) Select from the following list one thing, that Robert did, that you believe is the most important for supporting an effective learning activity:

Select one alternative from the following ones.

- ○ Make explicit the content knowledge at the beginning of the activity
- ○ Design the activity as a step-by-step procedures with scheduled timing
- ○ Divide the class into mixed ability groups
- ○ Guide the whole class when drawing conclusions from the activity

31) Is there anything you would have done differently than Robert to support more effective learning?

Write down your answer.

30) Select from the following list one thing, that Tina did, that you believe is the most important for supporting an effective learning activity:

Select one alternative from the following ones.

- ○ Introduce manipulatives and left students time to be confident with them at the beginning
- ○ Introduce a problem and allow students to self-direct the activity, approaching it with their own strategy
- ○ Walk among students to scaffold their understanding and problem solving strategies
- ○ Allow time for students to discuss and share conclusions with the whole class at the end

31) Is there anything you would have done differently than Tina to support more effective learning?

Write down your answer.

Further questions

22) Why do you not include these types of activities in your daily practice?

Select up to two alternatives from the following ones.

- ☐ Insufficient confidence with these approaches / lack of guidance
- ☐ Difficulty with classroom management
- ☐ These activites are not appropriate for my student's school level
- ☐ Unsuccessful previous experiences
- ☐ These activities are not effective
- ☐ Lack of time
- ☐ Lack of availability of resources, tools, materials
- ☐ Lack of adequate spaces/ Too many students in classrooms
- ☐ [ ] Other (Please Specify)

23) What other kind of instructional strategy of your daily practice do you believe is particularly effective?

Select up to three alternatives from the following ones.

- ☐ Relate the lesson to students' daily lives
- ☐ Apply what students have learned to new problem situations on their own
- ☐ Link new content to student's prior knowledge
- ☐ Ask students to explain their ideas in class
- ☐ Listen to me explain how to solve problems
- ☐ Encourage classroom discussions among students
- ☐ Ask students to select their own problem solving strategies
- ☐ Work problems together in the whole class with direct guidance from teacher
- ☐ Work in mixed ability group
- ☐ Work in same ability group
- ☐ [ ] Other (Please Specify)

Are you willing to take part in a follow-up interview?

Select one alternative from the followings.

- ○ Yes
- ○ No

FOLLOW-UP INTERVIEW

Thank you for choosing to continue your participation in the research project: Body Movement and Active Learning in Mathematics.

Your participation in a follow-up interview will enable us to ask you questions that provide deeper insight into specific aspects of the survey.

To participate in a follow-up Zoom interview, please complete the Informed Consent Form and enter your contact details (First and last name, Email, Years level taught) at the link provided below.

To ensure the anonymity of the questionnaire, we ask you to provide your contact details by completing the survey at the following link:

https://acu.qualtrics.com/jfe/form/SV_bwGimcZJ6Jf9Ima

PROTOCOL FOR TEACHERS'FOLLOW-UP INDIVIDUAL INTERVIEWS

Protocol for Online Individual Interview

A. Introduction

Thank attendees for coming etc. We are currently conducting a research study in Italy and Australia that focuses on the beliefs of primary and secondary teachers, and their teaching practices with regards to mathematics. We are particularly interested in the proposal and implementation in instructional practice of activities that involve the active participation of students, in a laboratorial mode, involving their body and movement, to explore mathematical concepts.
As a mathematics teacher, your views are critical to developing a clear picture of current practices and beliefs. We would like to ask you some questions about your beliefs and experiences in teaching mathematics, deepening some of the issues you have already addressed in the questionnaire.There are no right or wrong answers. We are interested in the thoughts that come out of the interview.
The interview will be audio recorded. Later, we will transcribe the audio and apply pseudonyms to all participants to ensure your comments are reported anonymously.
[Any questions or concerns?] [Seek approval for recording].

B. Guiding questions

I. GENERAL QUESTIONS ABOUT THE QUESTIONNAIRE

1) **WARM-UP** – [After submitting the questionnaire to review the items in five minutes]- Thinking back to the moment of completing the questionnaire. How did you find it?

Prompt questions [A couple of these possible question will be used to stimulate the discussion]

- 1A. Generally, were in the questionnaire unclear vocabulary or ambiguous sentences?
- 1B. What did you think of the topic? Did it seem familiar, something you had heard about sporadically, or something very far from your school reality?
- 1C. Did you find the questions relevant or did you find something you didn't expect? For example, did you feel that some aspects were not taken into account?

II. BELIEFS ABOUT MATHEMATICS, MATHEMATICS TEACHING AND LEARNING

1) **[Beliefs about teaching and learning mathematics]**- What do you think are the main goals of school math instruction?

Prompt questions [A couple of these possible question will be used to stimulate the discussion]

- 2A. What do students need to learn about mathematics at school?
- 2B. What do you think is the best way to develop mathematical learning? Which teaching strategies do you think are the most effective?
- 2C. How do you evaluate mathematics achievement?
- 2D. What do you believe are students' main difficulties in mathematics?
- 2E. (Do you think that mathematics is accessible to everyone?) Do you think there are particular students' characteristics that promote math learning?

III. MATHEMATICS ACTIVE LEARNING WITH THE INVOLVEMENT OF STUDENTS' BODIES AND MOVEMENT

1) **[Beliefs on mathematics active learning with the involvement of students' bodies and movement]-** After showing a short video (e.g. a part of the TIMSS VIDEO (3D Pythagorean Theorem) https://www.youtube.com/watch?v=ymY74MZ2QY0)

   Do you think that carrying out activities involving students' bodies and movement is important for learning mathematics? Why?

   Prompt questions [A couple of these possible question will be used to stimulate the discussion]

   - 1A. What kind of results would you expect to obtain from such an activity?
   - 1B. What do you think are the most important features to ensure the effectiveness of this type of activity?
   - 1C. What do you think is important to observe and to do, as a teacher, during this kind of activity? What do you think the teacher in the video does to achieve this?
   - 1D. Do you think these activities require an assessment? If so, what kind?
   - 1E. What could be the main reasons for the failure of these activities in classroom practice?
   - 1F. Do you think this kind of activity is suitable for all students? (E.g. Age, level of achievement, cultural background,..) Do you believe these activities are inclusive?

2) **[About your experience]** Can you give some examples from your own experience?

   Prompt questions [A couple of these possible question will be used to stimulate the discussion]

   - 2A. How often do you propose this kind of activity in your teaching practice?
   - 2B. What is the role of these activities in your instructional practice? (E.g. to introduce new topics, to exercise, to revise topics, as remedial activities, as enrichment activities..)
   - 2C. What kind of teaching strategies/ instructional guidance do you implement to ensure the effectiveness of these activities?
   - 2D. What difficulties did you experience when carrying out these activities? What are the main difficulties experienced by students during those activities?

3) [About the selection and proposal of these activities at school] How did you decide to propose, or not to propose, these activities?

   Prompt questions [A couple of these possible question will be used to stimulate the discussion]

   - 3A. What are the main criteria that determine your choices in selecting and designing the activity?

     E.g. Did you encounter similar activities in your own experience as a student? Did you receive information from other teachers? Did you get information from professional development courses? Did you find information by searching online on your own?

     You try to answer specific contextual students' needs, or to achieve specific instructional goals you would like to achieve

   - 3B. Are you supported in proposing and implementing these activities (school leadership /collaboration with other teachers/ collaboration with university professionals)? What kind of collaboration or support would you need?

   - 3C. Are there any constraints that limited you in the proposal or implementation of those activities in school practices? e.g. time, issues related to classroom management (number of students, school spaces), availability of school resources, curriculum constraints etc.

C. Greetings and thanks

Thank you for participating in this focus group. Your collaboration is really precious for our research.

APPENDIX 3: TRANSCRIPTS

TRANSCRIPTS OF EXPERTS' INTERVIEWS

TRANSCRIPTS OF TEACHERS'INTERCCIEWS

TRANSCRIPTS OF EXPERTS' INTERVIEWS

Expert 1

16/11/2021 (8:30 a.m. Brisbane | 11:30 p.m. Rome)

1	I: Good morning Professor
2	E1: Hello, call Me A.
3	I: A., perfect. Thank you. Are you there? And could you listen to me? I can see you.. Oh, all right!
4	E1: All right, I think is because you were recording and it wouldn't let me turn my camera on until I quit the ok
5	I: Ah, ok ok. Is it a problem.. is it a problem for you if I'll record the meeting?
6	E1: No, no. It's just that I tried to turn the microphone and the video on before I clicked ok, and it wouldn't let me do it. So I think it is what happen when I dropped down.
7	I: Oh ok, so thank you.
8	E1: And how are you?
9	I: Find, it'a a strange time and I will reather prefer to meet you in person but this is the world we are living in, so..
10	E1: It is, and it looks like it's going to be a little bit up and down to the next 12-months still
11	I: Of course, also we have in Europe the CERME conference, that is as the MERGA in Australia and we can't met in February ,they communicated that we are at distance also this year.
12	E1: Yes, I saw the email. I disappointing because it's so much nice to meet in person.
13	I: Of course
14	E1: At this stage MERGA is going ahead, but who knows what will happen. So, at this stage, they are planning on mainly, or hopefully mainly meet in person in summer.
15	I: In July is the..
16	E1: In july
17	I: I'm now a member of the MERGA, since a week
18	E1: Oh ok.
19	I: So, I would really like to thank you for your help and your time, for your contribution in my research. It's really really important, so thank you.
20	E1: Oh, that's a pleasure.
21	I: Secondly I want to briefly present to you my project, so you can have the scenario in which your contribution is added. So, (0.6) the main focus in the research project are the activities in which students are physically engaged, (0.5) both using manipulatives, like virtual manipulatives, or objects, tools, physical and concrete, and also whole body movement, like in a gym, with the aim to learn Mathematics, in the perspectives of <embodied cognition, or enactive learning..> Many theoretical perspectives. (0.9) So, those are the objects, but the investigation is on teachers' perspective on this kind of activities. And to have a glimpse on what are (0.7) the differences between teacher point of

	view and researcher point of view, (0.6) interviewing experts is really precious because experts are, and particularly experts we have selected, are in the middle, between the (0.5) school world and the world of the research. (0.8)This is the scenario of my research project (1.2) and, in particular, I've designed a survey for teachers, with questionnaire and follow-up interviews. So, (1.4) the first question I would like to ask you is about an internal issues in my research, that is to search a terminology that could be familiar and easy accessible for teachers (0.4) to refer to this kind of activity, something that could sound familiar for them, in your opinion.
22	E1: I think the ones that you had in your sheet where you talked about <hands-on activities and manipulatives>, they're the sort of terminology that we would use (0.8) and you also mentioned <enactive, embodied learning>. Now, I'm not really familiar with a lot of that, but that sort of sounds.. (0.5) I think if you gave an example of that, it would probably help the teachers to understand what, what you are meaning.
23	I: And could you indicate to me some examples that you believe could be familiar for teachers in Australia, also considering that teachers I'm referring to are both secondary school teachers and primary school teachers?
24	E1: Ok, so.. (0.3) Although I am secondary trained, I am actually teaching into the primary program, so I take the final cost of the primary pre-service- the performal maths education courses that the primary pre-service teachers take. And I just started to write down a few sorts of activities that I get my students to do, which may serve as examples. (0.4) So, using different models other than length, area- a length or an area model for fractions, (0.4) using a balance to talk- when you talking about solving equations- using a physical balance, (0.4) using both the solid form, the schedule form and a net when you looking at 3D models (0.4) to help students to be able to make, to really understand what the faces and the edges and vertices are, (0.7) using spinners and dice for probability. So they are probably, (0.4) they are probably some of the examples (0.7) I tried to pick some across different branch of the maths. The only really embodied- (0.3) Or, exact, the MIB blocks for..(0.3) ehm.. (0.5) place value. (0.4) The only really embodied example I could think of is (0.5) we do an activity where you look at side transport (0.5) and get the students to actually be <the data points in a graph>. (0.4) So they are probably some examples that certainly I'm familiar with in the primary context, the sort that are probably general enough, and what one of the things that we did with- that happened with Covid, (0.8) was that I ended up looking then a lot of virtual manipulatives, (0.4) because when I was doing tutorials and couldn't actually see the students, I wanted them to do, (0.8) To get the sense of what, what I wanted them to do. And so(0.9) we ended up supplementing the virtual manipulatives which are (unclear: Kepdin? *09:23), (0.6) so the students now do, they actually use the physical manipulatives but they now start to use the virtual manipulatives as well. So they get a sense of both.
25	I: Are the virtual manipulatives the transposition of the physical one?
26	E1: Yeah, yes. (0.4) So, there is a web site called <Illuminations>, it is a NCTM website and it's got some free resources that we've used and I've just speak the few of them. Few are of that, (0.5) there is a virtual spinner (0.4) and a couple of other things where the students can play around with, with the manipulatives on the screen. And..(0.9) because, like, (0.4) some of the students don't have access and are very well off, so may...(0.8) and the resources it means, these are free activities, so.. (0.5) We don't have a lot of time with the, (0.3) the way are courses structured is we have only 10 weeks and I only have one 2-hour tutorial per week. So, this is not a lot of time with them, so (0.5) what up tend to do is have physical the manipulatives in the tutorials, and then got them to go and play with the virtual manipulatives <outside the class time>, and so having access to the free ones, mains this is not costing position on them.
27	I: Of course, great. And now I will go on to the more conceptual question of the interview, and the first is (0.5) about, what is your opinion about the importance of implementing this kind of activities in classrooms? If you think they are important and, also, (0.4) if you think Yes or No, why? What are the main reasons?
28	E1: I think they are really important because they help students to make the connections. (0.4) I think math could be taught in a very abstract way and if, >particularly for younger children<, if you want

	them to engage and enjoy maths I think it's gonna be practical and real, (0.4) and using manipulatives just helps them to..(0.8) to see this being something real. (0.5) And also to make..(0.6) the example that I used with the nets, (0.4) it just helps them <form a mental image> that they can then come back to when they are talking about those sorts of things and they can say "Oh yeah, I felt that and I know what that it is". So, it helps a conceptual understanding by having something real to hang on to.
29	I: Of course. And, about teachers, who are the individuals who implement in school, what do you believe should be their <beliefs, that should accompany them when they are implementing those activities at schools>? Beliefs, but also the knowledge, the awareness.. (0.7) What are the main features of teachers' conceptions that should guide them when they implement those kinds of activities at schools?
30	E1: I think they have to (0.8) believe in the value of the activities, (0.5) and I think to have that belief they have to have a solid <mathematical knowledge> and, (1.4) again, I'm talking about my preservice teachers is that I am..(0.4) I've come across a lot of them who don't have a solid mathematical knowledge, because they've learnt it in a very abstract way, so they don't-(0.4)They know how to follow the procedures but they don't really know, they don't really understand why they are doing things, well, and how it all fits together. (0.6) So I think a solid mathematical knowledge is important, (0.8) and I think they need to have beliefs that (1.2) are constructivist (0.6) and support an enquiry-based approach, and now, I mean..(0.3) And it's getting a balance. (0.4) I think the reality in school is very hard sometimes, depending on what the school context is, it's very hard to implement those, because of the pressure on their own teachers, unless they have those strong beliefs. (0.9) The <culture within the school> may.. (0.7) may make it really difficult for them to do that sort of thing.
31	I: Of course, yes. And, about (0.7) not only the individuals, the teachers, but also (0.5) characteristics that could determine the effectiveness of those activities, what do you believe could be some characteristics that should impact on the effectiveness of these activities?
32	E1: I think, in some school work-(0.5) Do you know much about the Australian context?
33	I: So and so
34	E1: So, you know, we have National testing for literacy and numeracy, at grade 3, grade 5, grade 7 and grade 9, [I:Yes] So, (0.9) and what they do is that: publish the results on a website that's available to anybody to.. to view. (0.5) So there's a lot of pressure on schools to improve performance on Naplan. So, sometimes depending on the school there can be..(1.2) there can be an emphasis on the preparation for Naplan, rather than spending time developing students' conceptual understanding. (0.4) So, I think that, that can be a big impact. (0.5) In some schools here, there are difficulties with.. (0.5) There are challenges with resourcing, in some of the schools in low social-economic areas, (0.8) so that can have an impact. And I think time for teachers: (0.5) there are so many pressures on teachers' time to actually learn how to use and find out about the activities. Ehm.. (0.6) just, just their access to professional learning, I think.
35	I: And characteristics that are of the activities, (0.8) that characterise the activities itself?
36	E1: What did may impact on whether or not the activities are actually used? [I: Yes] Ehm..
37	I: …both used and also effective for students learning, in a certain sense. I don't want to specify what (0.6) what I want to say with "effective", but (0.9) in your opinion…
38	E1: Ok ok. I think all these activities require time in the classroom, and (0.7) I think sometimes- (0.4) and less teachers are willing to devote an adequate amount of time to them, they can be rushed and they don't give time, (0.4) time to the children or the students to think about what they are doing. (0.4) And perhaps that might have impact. (0.6) It's really time pressure, just not having the time to spend doing the activities, like, it might be just a little bit of this, rather than giving them enough time to think through, and to do the problem-solving themselves.
39	I: Of course. And (0.7)about the main limitation of these activities that you see in the context, what could they be?

40	E1:I probably.. I will be guessing on that because I haven't spent a lot of time in schools recently
41	I: of course
42	E1: So, my teaching load at the moment, I have- (0.9) I don't actually visit the pre-service teachers (0.6) when they are in their own placements, so I'm really not, I don't think I could really answer that with any certainty.
43	I: Yeah, but referring to what could you guess could be, not what are the real ones, but, (0.8) in your opinion, like (0.7) about what teachers say, or pre-service say in professional development courses, or something like this, what could you think could be the..?
44	E1: ..a limitation? Some limitations?
45	I: Yes, or factors that could hinder or foster. Something that could influence, or have link..
46	E1: I think the view, (0.5) and this is going back to my research (1.2) "looking at numeracy across the curriculum": what are the things that influence the teaching?(0.5) The school context and the colleagues, and if the colleagues are taking that sort of approach. Then sometimes, >particularly for beginning teachers<, can be difficult, because the norm within the school is "You teach in a particular way". And as a pre-service teacher, or as a beginning teacher- well, as a preservice teacher you have to teach in that way, because you're under the supervision of the teacher, but even as a, as a beginning teacher it's very hard if everybody else is teaching in a certain way, if you come into a school and you've got all those wonderful ideas eh.. (0.9) Particularly in the primary schools, the program is also set up, so you have to teach in that way. So I think the norms in the school and the influence of colleagues play a big part. And I think.. <that's sort of coming from other research<, but probably applies similarly to the use of manipulatives.
47	I: Of course. And, are there some references to this kind of activities, (1.4) the movement, but also the use of concrete representations, or of virtual manipulatives or so on, (0.9) in curricular documents or national policies, or official guidelines in general, in Australia?
48	E1: Ehm, there are..(0.8) Probably some- (0.7) in our curricular document there are links to a resource bank called Scootle, (0.8) and that has a whole, (0.7) has a collection of a range of different resources, (0.4) and there probably are some links to manipulatives activities- (0.7) to activities that use manipulatives in math. (0.9) Ehm.. (0.7) certainly in the teaching journals, in the Australian Primary Maths Classroom, there are some activities (0.8) but it's hard to know how many teachers actually read that, (0.5)and less that they have an interest in mathematics.(0.8) They may not. (0.79 I will they may not read that particular journal.
49	I: Mmm. (0.9) And in PD courses, they are presented, in a certain sense, these materials, these resources that are available for teachers?
50	E1: Ah (4.3) Again, it would be through <professional associations>, ehm.. (0.8) So the Queensland Association of maths teachers has a conference and there's PD, obviously, through the conference, and I do run some PD activities throughout the year, (0.6) but it really depends on what the focus of the presentations are, >as to whether or not there is anything on manipulatives<
51	I: Of course. Than, the final thing is: what..(1.3) what do you believe could be (0.7) the outcomes of an effective activities of this type in schools?
52	E1: I think it's it. (0.5) If I used effectively, I think it would improve students' mathematical learning, (0.4) and probably also their enjoinment of maths.
53	I: Perfect. But (0.5) you work especially with pre-service teachers that both (0.5) will go into primary school and preschool, (0.9) is it correct?
54	E1: Just it. Yeah, some of them are in preschool, yes. (0.4) So, the course..(1.5) Oh I do that.. (2.2) because I don't think is part of the bachelor really childhood, so the ones that I do are mainly Primary

	School. (0.6)One that I taught, a while ago, who is in both program but I think the final ones are only in the..(2.3) in the primary program.
55	I: I only want to ask you if you have an idea if these kind of activities are also used in preschool, (0.9) in informal mathematical learning..
56	E1: as in acting in a play-based learning?
57	I: Yes
58	E1: Yes. Look, I think they probably are in some places, (0.7) and certainly (1.4) the maths in the early years course, >which is not the one that I take<, it has more a focus in that area. (0.8) So, (0.5) I mean, hopefully those pre-service teachers who are doing the bachelor primary- have a early-childhood, do employ those activities, (0.5) but that's certainly is the aim of the.. (1.7) the childcare pre-school- the preschool sort of age group.
59	I: Yes, of course. And the very last question is if you think there are some possible factors that can foster this kind of implementation in schools.
60	E1: (5.6) So, from the teacher's perspective or from the school perspective?
61	I: Both of them
62	E1: Oh both..ehm.. (2.4) I think from the teacher's perspective, it comes back.. -(0.9) If we are talking about beginning, a whole, yeah. (1.2) I think it comes back to a <strong mathematical knowledge and a valuing of these types of activities>, (0.5) so it comes back to the teachers' beliefs. (0.8) And I think from (0.6) the school perspective, it's having.. (1.2) the teachers having time to be able to focus on those, (0.7) to implement those types of activities.. (0.5) Ehm.. (1.7) because it's getting a balance (0.7) about.. (0.9) There is a lot of pressure on schools to improve Naplan results, and so I think it's..(0.9) the teachers feeling is a..(0.5) they can't implement those kinds of activities, (0.4) and that comes back to the culture of the school (0.5) and the culture of their colleagues.
63	I: Of course. And the time is (1.4) the time for implementing or the time to design, to select..?
64	E1: I think it is both. (1.2) I think there is a lot of pressure on teachers at the moment, so (0.6) the time they've got to, to do professional learning be that (0.7) self-directed or from outside, to be able to see activities, (0.7) to find, to workout where I fit into the curriculum (1.8). That type of things, (0.6) the time to do that is limited, (0.9) but I think also the time to (0.7) implement that in the classroom is (0.5) limited, (0.7) just because of all the other things they are doing.
65	I: Yes, of course. You are right. So, I would really like to thank for this interview and (0.9), again, for your time and kind consideration
66	E1: I hope it's been helpful
67	I: Yeah, of course, it's of great help, and I will inform you about the results and also about the data of the interview that I have with experts and also with teachers, hopefully
68	E1: So, with your research you're going to do a survey initially?
69	I: Yeah
70	E1: And then interviews, what happened, doesn't or..?
71	I: Follow up interviews with teachers who give their availability to be contacted after doing the questionnaire. And the idea is that with the questionnaire I take some general variable that could be important, in a certain sense, that could be relevant for the implementation of these activities at school, and after, with the follow-up interviews, I want to deepen this kind of information. Because a questionnaire is superficial, obviously, and I want to go further in the direction that the questionnaire gives me as relevant. This is the idea.
72	E1: So, is all the research being conducted in Australia? Or you also..?

73	I: Both in Italy and in Australia, because I believe that.. that could be some characteristics that are of both the contexts and someone that could be cultural, and I think that also this cultural constraints, limits or fostering factors, for instance, could also be interesting if we want to go deep in this investigation, because they are something that could be.. Could follow not written rules, in a certain sense. So, I believe, for this reason, could be good to compare to context that are so distant, so different, with different tradition in mathematics also, and I hope this could give me some insights that are relevant and I'm curious about it.
74	E1: That's good, that sounds like a really interesting study
75	I: Thank you
76	E1: So, look forward to hearing what the findings are
77	I: Of course I will email you with results at the time I've got something. So thank you again, good evening
78	E1: And good morning to you
79	I: Thanks, see you soon, if possible.
80	E1: Yeh, hopefully, not this year probably but next year to be able to present it in MERGA
81	I: Eh yes, fantastic, it will be fantastic! Thank you again
82	E1: Ok, thank you. Bye
83	I: Bye

Expert 2

30/11/2021 (4 p.m. Brisbane | 7 a.m. Rome)

1	I: Good morning professor
2	E2: I'm so sorry, I haven't seen the note, doing a lot of things, and I lost track of time
3	I: It's not a problem, I want only to be sure that everything goes right and then we can start.
4	E2: Ok
5	I: Nice to meet you professor
6	E2: Nice to meet you
7	I: I really want to thank you for your precious contribution in my research project, and in particular for your time and your kind consideration during this time. Thank you
8	E2: You are welcome.
9	I: I also want to briefly (0.5) present to you my project. (0.8) In this way you can have the idea of the scenario in which your contribution could.. (0.9) enforce my project. And.. (0.6) the first thing is that I'm now at the third year of my Ph.D.
10	E2: Ok
11	I: ..at the very beginning of my third year but my project was affected by the pandemic emergency. So, I restarted during the second year, in the design. The main focus of the project is on the enactive embodied activities, in particular, activities in which students are physically engaged, using manipulatives or other physical tools or instruments, but also virtual instruments when interaction with the students is great, with some devices or.. (0.8) Also with the mouse, but a great interaction. So these are the main objects under study and..
12	E2: So, I'm interested in asking you quickly, Alessandra, does it mean that have to be a <physical object>? So.. (0.8) it's not just engagement in activities but.. (0.8) -in the physical world, but it needs to be.. (0.7) to have some world representation, maybe, that there were also..
13	I: Not only, not only. Also activities in the world where the body and the movement and the perception of students have importance to construct mathematical concepts. [E2: Ok, ok] >Sorry, I don't mention these<, but also activities in which the whole body is involved, such as in a gym, where students could..(0.5) I don't know, something like experience the triangle with some path, or something like this, so.. (0.5) also this kind of activities
14	E2: Ok, ok. Thank you.
15	I: And (1.8) my point is to investigate what are teachers' point of view on this kind of activities. (1.2) And, for this reason, I'm also interested in experts' interview - experts' point of view, because I want to disclose the gap between the research, >literature and theoretical background but also some empirical research<, and the teachers; and experts in education are in the middle of these two opposite sides. So I'm, I'm really interested in experts' point of view, this is the point. And I conduct this project, (0.5) this survey, both in Italy and in Australia. In Italy I'm in presence, (0.4) but I interviewed online also in Italy, and in Australia, (0.4) for the moment I'm at distance totally.
16	E2: Yes, yes. So what do you know about education system in Australia?

17	I: I studied something about the, (0.3) the curriculum and the school system, different kind of schools and something like this, but I don't know- (0.4) I didn't have already done the study of policies that are related with this kind of activities or... (0.5) I read something about enquiry learning, that is your object of study, that could have some link with this kind of activities but not something in particular. And, I don't know, if you have some suggestion, where I can find something interesting (0.4) in this way could be of great help for me, thank you.
18	E2: Ok. That is why I ask you the question about.. (0.8) where you were describing the embodiment, manipulatives and, you know, mouse and things like that because for me, (0.7) my..(0.4) the work that I do involve much more, I guess, being in physical space and less about manipulatives and ICT.
19	I: Of course but I also includes this kind of things because the point, for me, is the involvement of body and movement to..
20	E2: Yes, of course, I'm just saying that I cannot contribute to the discussion about those two things because they're not in my expertise.
21	I: Of course, of course
22	E2: Go ahead
23	I: The point is that: (0.5) when I started the project I encountered a problem that is to use the correct terminology to speak with teachers. Because, from a theoretical point of view there are many perspectives, (0.4) such as the <manipulatives, the embodiment, the enactive learning>, but when I have to speak with teachers I have to overcome these differences and use simple language that are easy accessible for them.
24	E2: yes
25	I: So, I want to ask you: what do you think would be a good terminology to speak to, with teachers of these kind of activities, in general? If you have any suggestions.
26	E2: So, embodiment is not an area that I know a lot of the theory in, I admit, (0.6) but I think if you talk about the use of, of the body and <more why it is that kind of engagement for children>, as opposed to just sitting and working abstractly, is helpful. And, of course, using an example. (0.5) So, you described, for example, you know, working around with a triangle, (0.8) that gives an example of why is that helpful for students, what is it, the triggers for them to deepen their learning.
27	I: Of course
28	E2: So, I often have been thinking about also being able to visualise, so, and envision, something, someone they physically engaging it. I think that it's easier for them to (0.5) think and envision manipulatives in math space, >even if they didn't physically manipulate it when they were in the space, but they can imagine doing those things<. Where I think..(0.7) if they haven't had that physical experience of some sort, it's <just a word to them>. They don't have a picture in their minds that they can.. then, you know, work with, to try and prove the understanding.
29	I: Of course. So, give example could be something really important for communicate
30	E2: Absolutely, yeah. Not an example but more than an example
31	I: More than one

32	E2: No, no more than one. (0.4) Something that illustrates the principles that you're trying to discuss, so why is that physical activity something that will help students, not just that they do a physical activity, it's not the activity itself, right? It's what's behind the activity that is important. (0.5) So, sort of specific example that they can really do and maybe have experienced before. So, again, they can envision, what are you talking about. And.. (0.5) You know, it's like if you give directions to somebody to go some place, if they've been there before then they can imagine the pathway, so when you say to turn right, you know, at the gas station, they know what you're talking about, but if you said this otherwise, to somebody who's never been to a place, (0.6) it's sort of a <list of words> but they can't really imagine it themselves. (0.7) So, it doesn't have the same kind of depth understanding of that place. (0.5) When you read directions you actually can imagine, you know, going through this to a place you've been before.
33	I: Yeah, of course. And could you suggest me some examples that you believe are commonly known by teachers in primary school, or in secondary school,sa or in both of them, for instance?
34	E2: Ehm.. well.. (0.6) In one of the problems, for example, that is in our States, the resources that our..(0.5) that our teachers using in Queensland, they're required to address the problem about trying to figure out, in the school hall, like an Auditorium in the flat floor of gymnasium, that's a place where there are also, it's a multi-purpose place, so they might play games there but they also might hold them music concerts there, or assemblies there, things like that. (0.4) So, the students were ask to.. (0.9) In this problem, they're asked to determine how many people could fit in a hall for a music concert, how many people could fit in the audience. And..(0.5) when they are only working on paper, they weren't thinking about things like: "how close together the chairs need to be?" Or, "how to make use of a space to ensure somebody with a pram, or a stroller can get through the aisles?" So they weren't thinking about those practicalities, (0.7) but when they go down to this base, then they could start it with the chairs, the physical chairs, and manipulate the chairs, they could start to envision how that would work and to think more deeply about <the mathematics that they need to make sense of it>. (0.8) And it's not just, it's not the same kind of mathematics if you just gave him a piece of paper and asked them to draw it. (0.3) Because they wouldn't have that sense of proportion, for example, in the space, or how it relates to their body, or how close to the, you know, are they to the.. to the row in front of them. (0.5) Or imagine in different scenarios like somebody's, you know, coming with a lot of things with them and having space for those things. So, ehm..(0.7) Being in a space, even for one lesson, they can come back to the classroom and they can still discuss things that happened in that space, they don't have to continuely go down there, but they can imagine what's going on (0.4) when they talk about the chairs, and and how long a row might be. (0.5) Ehm.. (0.4) or they can reconstruct that if they are having an argument about whether, you know, 10 chairs in a row is reasonable, they can.. they can reconstruct, <they have an i:dea of what to reconstruct>. I think it's..(0.6) otherwise, it's just an instruction. So that might be an example, I guess.
35	I: Oh yes.
36	E2: Are you seeing, actually, teachers talk about (0.9) when their students don't have this experience, going down to the hall, (1.2) they keep asking the teacher to tell them: "How close could I put the chairs? What should I do for these?" They are much more passive, (0.9) they don't have the confidence to follow up on (0.8) their own curiosity,(0.6) if that makes sense.
37	I: Of course. This is the point. I want to ask you if you-(0.6) Whether you believe these kinds of activities are important or not and why? What are the main reasons why is important to have in schools these kinds of experiences?

38	E2: So, I think some of them I have already answered ready, but, part of it is being able to <visualize the space>, (0.7) and even when they're not in the space later on, they can still manipulate the space in their mind, and they can.. (0.6) They have a shared understanding of that space, (0.4) so (1.2) they can act out pieces of it, so it might be that they..they do some pieces in a classroom, to kind of indicate how long something is, or they take two or three chairs and put them together and then try to imagine, you know, sets of those going forward. (1.1) So, it allows them, I think, mostly to <manipulate in their mind the mathematical ideas, and connect those mathematic ideas to the context>, so they are not just mathematical ideas <in the air>, or on a piece of paper, but they actually have meaning attached to a context (0.5) that is familiar to them and that they have experienced. So, I think if a peer, talks about something they can- I don't' know if the right word is like curiously, can have imagine what's going on, (0.4) but, even if they haven't directly experience did, I think they can..(0.8) If they have some experience, for some physical experience of it, they can still imagine the scenario that's in the context.
39	I: Of course. They have an experience of the mathematical concepts in reality.
40	E2: yeah.
41	I: These kinds of things. And (0.7) what do you believe could be <the awareness, the knowledge, the beliefs> that a teacher have to accompany to this kind of activities in classroom?
42	E2: Yeah, this is the difficulty (0.5) because, I think, it requires more experience in the teacher to be able to envision the mathematics in the world. So..(0.9) I teach a group of.. (1.5) The example I gave you before it is from a <primary school>, but I also teach pre-service teachers who are studying to become secondary mathematics teachers (1.1.) And we.. (0.4) in our classroom, this semester, we did a problem where I had them fold an origami frog, (0.8) and it jumps. So, (0.7) when you can flick it, it jumps. (0.4) And the question ask them: "how far do those frogs jump?" And of course, when they actually did- when they tried to imagine it, they only imagine a single jump, really, and might think about, you know, what's it reasonable the frog will jump. But then when they actually engage in the activity, whether having to collect data on the jumps, <sometimes the frog jumps backwards, sometimes it goes far, sometimes it doesn't go far>. And when we look at that data altogether, it was a mess, it was very hard to make any sense of it. (0.7) So, when I would ask them "ok, so, look at the data and from this evidence, how far does the origami frog jump?". (0.4) They want to calculate the mean, and they - (0.5) So, they said "Ok the frog jump, let's say, you know, 19.26 centimeters", (0.6) and so I said, you know, "Ok, so, if you jump a frog now, will it go exactly that far?", "Oh, no no. Of course not" but, again, (1.2) they hadn't really considered the <physical link between calculating a mean>, which is what they have had a habit of doing when they got a list of data, <and the context that they are working in>. So, it enables to start to have a discussion about "what, what's the reasonable prediction for this context?". (0.8) You know, "is it to have 2 decimal place, you know, precision? Is it to have a single number even, or is it about a range?" You know, if you were talking to somebody about what's a way that you would be describing this. So, they didn't have yet an experience of taking <the formal knowledge they have done> in the mathematics degree, that was finished now, and <hands-on experience>, because they never actually put those two together. (0.5) So, I was trying to show them, I guess, the importance of having <that physical engagements in a context where they could have tried to apply> the statistical principles, the statistical rules they have learned. And.. because they didn't have that experience before, they didn't know how to make the connections. (0.5) So this is what I see, I guess for teachers is that they,(0.4) in order to make the physical- (0.4)the physical activity that they are doing links to the mathematics, (1.2) <they have to have those experiences themselves>. (0.5) They have <to see the mathematical ideas that are at play>. And I think for most teachers, both primary and secondary, <they don't have that experience>. So they don't yet

	know how to make the links. (1.0) <They might know the mathematics but they haven't linked it>. (0.6) For many teachers, especially in the primary or teachers out of service, who are, sorry, out of field, so not in their expertise, (0.9) they might not have the content knowledge, the horizon knowledge (0.7) to be able to make those links. (0.3) So, that makes it even more difficult,(0.5) because their knowledge is quite fragile (0.4) and, so, it might be..(0.5) it might be limited to procedural knowledge, and so they can't - (0.5) they can't know what they don't know. (0.4) So, they can't.. (0.5) their knowledge is not connected enough, <any relational>, so it makes hard for them to see the potential mathematics <in a student's idea or in an activity to them>, (0.5) they see the activity but they don't.. (0.4) They don't how students make the connections. So, so surely having, you know, a weak content knowledge is a problem, but it's not instrumental, (0.8) and I find.. (1.3) >what do you think?< First of all, <having the content knowledge isn't enough>, because I know that my students have very strong mathematical content knowledge, (0.6) but they don't have- the pre-service teachers don't have <the experience of connecting the content to the world>. And, on the other hand, the primary school teachers that I work with, (0.5) they are in the schools, (0.6) they don't have a strong content knowledge but actually they can- (0.5) they've learnt quite a bit of content knowledge through engaging in these activities themselves, (0.4) and starting to make those connections. (0.7) And they end up with quite deep content knowledge because of that. So, they can still.. (0.6) it's not that we send them away to <go learn more content>, it's that they can, by engaging in these activities and engaging with their students in these activities, <especially if they have a support system>, where they can have somebody to talk to you about what's going on, or periods to work with, then, they can still learn that mathematical depth. So, it's not that they have to do <content knowledge first>.
43	I: Ok. Thank you. And about the main characteristics that could have this kind of activity to be effective? And I don't want to specify what I mean with effective
44	E2: [((Laugh))] Of course.
45	I: [((Laugh))] ..What do you believe could be ..(0.7) About teaching strategies, or also characteristics of the activity itself, (0.8) or characteristics of the environment, all the kind of things- (08) or assessment, all kind of things you can put on the centre of the "effective way" to conduct this kind of activities.
46	E2: Oh, I think, the most important thing that comes down to, is <making connections. And making connections explicit, and helping students make those connections>. (0.4) It's often through questioning, and.. (0.6) Or through, you know, allowing students to engage in struggle with the, (0.9) what they're doing, >in a supported way, of course, not just to get them frustrated<, but to <help them see the benefit of struggling so that they are willing to persist>. Because, I think, that the mathematics is not lying on the surface, is often a bit below the surface. So..(0.6) and so they need to have, I think, sustained, engagements with these activities that involve embodied experiences, so that they start to see the benefit of it and start to trust their..(0.6) their body and their own insights that they get through those experiences. But, that doesn't happen in a vacuum, <I think it needs the guidance of a teacher>, it needs experience, you know, <making connections and discussing and elaborating with peers>, and those elements. (0.7) You know, there is a challenge, in (0.6) you know, we don't.. (0.9) I think we don't know very well <how to assess this kind of insight>, and so until we learn how to assess it it's hard to ask schools to value it, because they're held quite accountable to, you know, <very proce:dural knowledge>, that doesn't… (0.7) that these kind of activity doesn't necessarily improve. (1.2) It doesn't mean that they're gonna do better on their national exam.
47	I: Yes, the awareness of this kind of thing.

48	E2: Yes, yes. So.. so.. (0.6) And that's what schools are being held the accountable for, so, (0.7) the pressure teachers are under
49	I: Of course
50	E2: So, I think the teacher in herself or himself has to be..(0.9) has to be convinced, I guess, of the value of these. So, they ensure that they provide the experiences for their students.
51	I: For sure. Without the belief that they could be of great improvement for their students (0.8) is impossible that they spend time on these particular activities, because these activities required many time, obviously
52	E2: Yeah, I admit though that when I work with teachers I don't discuss embodiment with them, I mean. (0.8)There is so much theory, I guess, that is at play when you're talking about teaching and learning and.. (1.5) and I think.. (2.3) I don't, I don't think it's <not valuable> but it can be overwhelming for us in academia, we think theoretically, about things we've been trained to think theoretically and I think we've, (0.4) after many years of hard work, have come to value why theoretical perspectives are so powerful, (0.5) but to tell the teacher that, (0.5) you know, it's like anything that they have to experience that themselves. (0.9) And I think it's very difficult <then to try to express that>, because otherwise it just becomes a telling .. (0.7) And, anymore than, if you're telling kids how to, you know, how to multiply rather than have them go out and experience multiplication, so..
53	I: something that is far removed from their perspective on the daily practice
54	E2: Yes, their daily practice, right. (0.4) So, how many theories can we tell them about, you know, that is valuable and.. They would have heard about, you know, ZPD, for example, (0.4) >probably in their teacher training program<, and for some of them they can see the way that they enact it itself as a scaffolding, but, you know, we keep adding to the number of theories that we.. (0.4) that we talk to teachers about. So I think it's.. (0.5) it's maybe about one, you know, <engaging teachers that have particular interests, perhaps, in the physical aspect> or maybe they've had their own insight into how, you know, when are students engaged in physical activity they see <a change in the way to understand material>. So, almost that they have to have (1.2) some reasons to want to know more, in order to have that..(0.6) the theoretical side of it come to life or to be useful to them, otherwise is it just becomes.. (0.6) To telling
55	I: Of course, chat chat chat
56	E2: Chat chat chat, yeah.
57	I: And, do you believe that there are many limitations to the use of these kinds of activities? Something that could be a limit (0.7) of those activities in school?
58	E2: Of course, (1.3) there's many. (0.8) Time is a big one, (0.5) because generally embodied activities take more time. (0.8) And the curriculum is very packed, there's also (0.7) the number of students that a teacher is looking after and the command they have around managing their classroom or their students, because there's more opportunities for students (0.5) to get in trouble, I guess, you could say, (1.4) in these activities, (0.5) and having the space to do so, because generally it's.. (0.9) I suppose, you know, manipulatives in the classroom are possible, and ICT activities, but I guess the more physical, (0.5) physical space that I've been talking about. (0.8) Usually required leaving the classroom, >not all but usually required that<. (0.7)We do work with (0.7) a teacher that was in grade 3, teaching her students about maps. (0.8) She had the students each bringing a map that they had worked with, may be a map of the shopping mall or a map of a park that they have done a walk in or a map of the zoo, (0.9) and so they had that <physical experience with the map>, so it didn't come this is a piece of paper, but it came

	with an experience, and so, (0.7) I think, that was an opportunity, I guess, to build on (0.7) <children's experience in the world>, and then to bring it together to the abstraction of what makes a good map, and that is what she was tring to get them to learn and to think about the use of <alphanumeric grades>, for example. (0.6) So, the fact that the maps of the children brain came out of their experience (1.2) <was really essential>, >'cause she could have just bought a bunch of maps to the students to looking at but they maybe just been pieces of paper with no meaning to them<. So, (0.9) <the classroom management is a huge one, (0.6) the time limitations is a huge one, (0.6) the resources>, >when you're talking about the physical manipulatives, is a huge limitation,< the teachers' own experience and understanding of how.. (0.8) Whatever the physical manipulatives, >experiences, computer, whatever is there working on<, how that links to mathematics, so that they can help students <experience the mathematics> through those.. (0.7) the physicality that, they're taking part in. (1.3) Thus many, many, many limitations in that sense. And there's, you know, teachers are under enormous pressure, as it is, so, with so many dimensions to improve
59	I: Yeah, of course. And do you believe that could be any factor that could <foster or hinder the use of these activities at school>? Obviously, the limitations that you have already mentioned, but factors that could foster or hinder, also external factors or internal factors. I don't know
60	E2: I think a big factor is <the culture of the working environment there in> (0.9) and whether there is <a collective, I guess, desire to try to make mathematics more real to students>, (0.7) and to make it a more powerful part of their lives and for..(0.5) So, the will I guess is there, and I think for a teacher doing it by themselves it can be very difficult, (0.7) especially if the leadership in the school is not encouraging this. So, you know, wherever we can be building, (0.9) when we.. (1.2) when we have the.. (0.4) whatever national curriculum we are working with, and teachers are often given examples of activities that connect, to make sure that we have tried to add as many experiences that they can..(0.5) that have embodiment as a part of them, so they can see that is a potential avenue for them to engage with that particular learning, and they have to, you no, work with. So, a lot of.. (0.4) sometimes they just lack- not lack the imagination but lack the possibilities, and I think for teachers, (0.5) if they can experience something whether it's in them.. (1.2) experiencing it with their own students, (0.3) possibly with some coaching, (0.5) in their classroom, (0.5) so they can see the opportunity, or them <experiencing mathematically inside themselves (0.6) through professional learning that they do>. But it's (0.4) unlikely to be a one-off event, it's well.. (0.8) So, the opportunity has to be there, the resources have to be there for the teachers and the sunstained, (0.5) I guess, experience has to be there.
61	I: it's a very important
62	E2: because I don't think is simple.. (1.2) It's a very powerful, a very powerful tool we have in mathematics, (0.6) but it's it's not a simple fast solution.
63	I: No, absolutely. And, (0.7) often, the result could be not immediately..
64	E2: Yeah
65	I: could be not immediately evident from the teacher's point of view. So..
66	E2: yeah. I remember, even my own daughter when she was in her pre-school, (0.6) they were using cuisenaire rods, (0.7) but the way that they were using it that, I felt that they were not helping <students mathematical understanding of.. (0.7) of quantity>. Because it was just replacing a number with a colour, (0.5) and they can see, you know, these colours fit together and make this colour, but they weren't then making a connection, I feel, to the mathematical ideas. And so you can.. you can embed, embodiment to activities, but if a teacher does not..

	(0.4) is not able to make the connection, then, I think it's, it's, it's worse than not doing it in a way, because it's takes that time, it doesn't <progress students understanding>, so this is the problem too. Because if we can't come in with the top down approach when we find a good idea, like this, because (0.6) in my work, as well, when teachers engage with this robust kind of activities, <they don't know what the power of it is, they don't know how to make connections>, it just becomes an activity that uses time, and adds more pressure to the curriculum. So, you can be <worse than nothing>.
67	I: Of course, because also the only effect it is the engagement when you don't have an activity that is..(1.2) That fit your conceptual goal and it's something that engage and create confusion, in a certain sense, because it doesn't go straight on (0.5) forward the objectives (0.7) of your teaching so, obviously. And do you believe that are some recent policies or curricular resources that foster the introduction of these kinds of activities in Australia, in particular in Queensland? In particular, because I know there are a curriculum that is Australian and more specific policies of Queensland.
68	E2: Oh, you know, I haven't really taken a look at (0.8) that kinds of ways that embodiment may present itself in the curriculum, (0.7) I certainly look for ways because the work I do it within inquiry based learning, and I certainly look for opportunities within the curriculum so.. (0.6) to link, I guess, the inquiry to the curriculum more directly, but I haven't thought about that in terms of embodiment itself. (2.3) I think that there are some links in the curriculum when it's talking about students learning place value, for example, to encourage teachers to work with manipulatives. (0.7) However I've seen in Queensland a strong (0.9) culture of <seeing manipulatives as for young children> and concrete, something that you stop doing when you reach, you know, 7 years old.
69	I: Yes
70	E2: Whereas, I think for, you know, adults even they're still very valuable. (0.4) I had to purchase for my daughter a sets of manipulative for her to work with, and (0.6) for herself because I know that are so important, because in her class stops using them. And I couldn't see how can you build, build your expertise if you are only working in abstract space. (0.5) So, they see the progression <from concrete to abstract as a single movement>, that is age-related, and not something that (0.7) goes through all of schooling, (1.2) that even as a student who's about to finish school, the physical, you know, concrete experiences still need to be related to the abstract ones, you don't completely work in the abstract world. (1.4) And I haven't seen that ethos[attitude] through (0.6) the curriculum here. But I do see it as an authentic (0.9) desire, I guess, to improve problem solving and reasoning (0.6) and there is opportunities, I guess, in those activities. You, know, it's well known the way the Chinese use the Abacus ((drum the fingers of the left hand on the palm of the right hand)) and the physicality of that means that they don't need the Abacus ((move the hands pushing out of the cam)), they just do this ((type fast with the fingers of the right hand in the air)), (0.8) you know. And when we learn vectors ((move the right hands pointing with the thumb, index and medium finger in the 3D directions))we often.. (0.7)we often make, you know, a three-dimensional space
71	I: yeah, yeah
72	E2: to try to imagine
73	I: for vectors ((reply the gestures the expert made))
74	E2: Yes, for vectors, for cross products and things like that. And, so, (0.7) I remember, always my students seeing them ((ibidem)), you know, to kind of manipulate (0.5) <vision in space>. But >I think the Chinese are being well known for using an abacus ((drum the fingers of the left

	hand on the palm of the right hand)) and the students being out to calculate just using their fingers like this<((type fast with the fingers of the right hand in the air)), imagining the Abacus is there and (0.7) could also be linked with the curriculum (0.5). Then we have to run fluency, (0.5) and <try to build fluency>, so.. (0.7) I don't know if that is the same with that. (1.3) I don't think we're any further ahead, except that there is a.. (2.3) I think, globally there is (1.4) a tension arounds a very, very direct, you know, <direct instruction>. (0.9) We don't give students an opportunity, it's only telling.
75	I: Transmissive
76	E2: yeah, transmission. So, they only see knowledge is something, you know, ((point with both index fingers to arcs that go to indicate the top of the head)) you pour into their head. (0.6) It is just such <an old idea>, so I see everywhere in the world the same.. (0.8) the same tension. So, (1.4) because in policy, the politicians don't usually ask people expert in mathematics education, (0.4) they.. (0.5) they tried to just use, you know, their own ideas of what might get a quick results, so.
77	I: The point of my research is that. I want to disclose the gap, because in research we say " we can't have a transmission of information", also in math, because (0.7) in math there is a difficulty to remove this tradition (0.8) and go over. (0.6) In other disciplines could be a more (0.7) fast development, but in maths we remain (0.7) stronger to..
78	E2: Yeah, there is a very strong cultural norm in the public, about <what the nature of mathematics is>
79	I: yeah
80	E2: And really the only things they can think of are <number fluency>, knowing in the number facts (0.8) and procedural knowledge. (0.7) Because that's what most people have experienced in school, (0.7) so that's what they see mathematics is. And so, (0.6) until we can help the public see that mathematics is so much more than a..(1.2) and until we can start to embed in the school (0.7) experiences for students to see the relevance and the power of mathematics, >even as they're going through school, whereas now,< I think, they don't get that opportunity until they're.. have gone thorugh all of Year 12, into university, >gone through the first-year of calculus and then there interesting things can happen<. (0.6) 'Cause you start to see all this new mathematics that you didn't know existed. (1.1) Whereas when I asked the high school students what do they imagine they learn, (0.4) what kind of Mathematics they learn at university, (0.7) they think there are just harder algebra problems and harder, you know, (0.6) things that are harder numbers to work within and harder things, they don't have any picture of.. (0.5) Of the different kind of Mathematics, because they have sorted
81	I: also direction
82	E2: yes, all the different directions you can go. So, I have to fight at my own University with some.. with some.. who is able to come into the.. the mathematics teacher education program, because people often welcoming with what they see as they have.. They are good at mathematics, but it's good at procedural mathematics. There are a lot of them have come in with, you know, expertise only in calculus and things.. they have no geometry, no discrete mathematics, no probability, you know, no complex numbers. So, there is a whole kind of.. Whole other fields that they have no awareness of. And for them to be able to make mathematics come to life, I think, in a classroom and to make connections, they need to have a broader understanding of mathematics than just the computational study.

83	I: Of course. So, I ask you what I want to ask you. So I really want to thank you for your time and precious contribution, so I also will inform you about the research result if you are interested in
84	E2: Yes, thank you
85	I: And also thank you again and having a good evening
86	E2: Thank you, have you a good morning! It must be very early there.
87	I: Goodbye and thank you again. It has been really important for me
88	E2: Ok. Thank you, good luck for your study

Expert 3

06/12/2021 (5:30 p.m. Tasmania | 7:30 a.m. Rome)

1	I: Good morning professor O.
2	E3: Hi Alessandra, how are you?
3	I: Fine, thanks. And you?
4	E3: What time is it for you?
5	I: Almost half past 7, so early in the morning, yeah.
6	E3: yes, early. It is 5:30 p.m. here, [I:Yeah] a beautiful evening.
7	I: More beautiful than my, I'm in my house because I've a bit of flue
8	E3: Oh no. Ok. I'm in my house also, the picture that you see on my background this is the (unclear name of a river *00:59) a swimming hallway with swim in the summer. It's still a bit cold but later on it will be ok.
9	I: We are in the middle of the winter, so. It starts the winter, it starts the flu, the cold and..
10	E3: Yes, yes.
11	I: So, I would really thank you for your time and you're collaboration in this project. It's really really important for me, thank you so much.
12	E3: You're welcome. And you're professor who wrote to me is a very good colleague and friend for a long time, so Vincent and I know each other for a long time, so (0.9) I'm happy to be.. (0.8) And you're in in Rome, is it right?
13	I: yeah yeah yeah. I'm in Rome and I'm a PhD student- an international Ph.D. student, so I have as supervisors (0.5) both an Italian professor and Vincent Geiger.
14	E3: Oh, good. I've need to go to Rome, but I've not being to Rome yet. So, [I:Oh] one day, one day..
15	I: One day, one day, obviously. It's a really a beautiful city, it's quite difficult to live there but it's beautiful city, obviously.
16	E3: Oh, sometimes my accent is <hard to hear>, to listen, so if you don't understand something I said, please don't feel that you are be rude if you say "sorry, I do not understand what you have said"[laugh].
17	I: yes, of course. I adopted this technique.
18	E3: Do you want to record it, Alessandra?
19	I: yes, I'm recording
20	E3: Oh yes, I'm now see it. Ok well.
21	I: I want to briefly introduct you the research project, so you can have a glimpse of the scenario in which this interview took place, in some sense
22	E3: Sure, yeah

23	I: So, firstly, the main objects under my study are the activities in which students are actively engaged with their body and movement, (0.9) like with a manipulative, tools or objects that are both <physical or virtual>, with a bit of interaction with students, and also the body movement, the free body movement like in gym or something like this. (1.2) And the investigation is on teachers' perspective on these practices, and I've designed a survey for teachers, and.. (0,7) After I want to conduct follow-up interviews, both in Italy and in Australia, with teachers to (0.5) deepening some issue that are particularly relevant. And, (0.5) at the beginning of my research project, (0.9) I studied the literature, the research results, research findings and I decided to overcome the different perspectives, theoretical perspectives, to go to the point of (0.7) taking the teachers' point of view, that are a bit different from the researcher point of view. And, to connect this two part, to understand the differences, the gap, I believe that interviewing some experts that are <in the middle between research and schools> could be a good idea. So, for this reason, I search for experts that could give me some insights on the main issues that are under my research.
24	E3: Ok. So, I'm one of those people in the middle, right? ((Laugh))
25	I: Yeah, of course. ((Laugh)). So, the first question I want to ask you is about an internal issue of my research. I want to speak with teachers, so I have to select a terminology that could be <clear and easy accessible for teachers>. So, I would like to ask you if you have some ideas about how can I describe these kinds of activities, you know, in a way that could be easy accessible and understandable by a teacher?
26	E3: Ok. 'cause by and large, I imagine many teachers, I think, are probably less familiar with this area, do you think? It's not? What is your feeling in bed help common movement is in terms of teaching, and outside of.. (0.59 in a math classroom, anyway. So, what's your feeling? Do you think teachers is gonna..
27	I: Could be
28	E3: Because one of.. (1.0) one of my thoughts on this is, (0.8) even if you talk to teachers about areas that are really close to, like you ask them about things like numeracy, <and what they think numeracy is, (0.4) and whether the numeracy is in the lessons>, but a lot of them fail to identify where it is. They don't think about..(0.8) that, that is what that they are doing, and so, (0.4)I think less about the language and more about some questions that can get underneath what they do. So, it might be almost <worthwhile at the start to see if you cannot get a picture of what they do in the classroom>, what does a lesson look like for them, you know, how they arrange it, what does a class look like. But, what language have you- (0.8) what language have you uncovered, 'cause the literature is normally formal, quite formal language. (0.6) So, how and what is the words that are used into the literature that might think about and try to rephrase?
29	I: I believe could be <hans-on, practice, (0.9) body involvement..(1.2) Something like this. Because in the research we have different perspectives
30	E3: Yeah
31	I: like <the embodiment, the enactive perspective, the use of manipulatives..>. Those are some of the main area, but also (1.6) <the multimodal approach to..>
32	E3: yes. But just.. (0.9) Just in terms of age, what year levels are you are..(0.7) I mean, in terms of school, the teachers what year levels are they?
33	I: Both primary and secondary.

34	E3: Oh well, right.
35	I: So, a a wide range.
36	E3: It is, and that has a different thing too. Because primary school teachers will be very familiar with the idea of manipulatives, (0.9) secondary school teachers less so, as we just said. I mean they tend to move away from manipulatives in secondary school when I think they probably should use them more, but they don't. So, they would be many secondary school teachers (0.4).I think if you use the word manipulatives with the primary school teachers they will understand those
37	I: Ok, ok
38	E3: Maybe, (1.7) I'm thinking in secondary school teachers in terms of (0.4) <the embodiment idea is the move from concrete>, so the word concrete might be more.. (0.7) Because I think they don't think about concrete when they're talking about algebra or, you know, so that we move from the concrete real to the (0.5) into the symbolic realm, and that's the embodiment of.. (0.5) that could use in secondary school. I'm trying to think about.. (0.49 I mean, I'm familiar with the embodiment, because I'm familiar with the literature and I researched. I'm just trying to think about (0.8) how you, how are you..
39	I: Secondary school teachers could think about something that is related to representation, in a certain sense?
40	E3: Yes, so I think this is probably, your best way of getting this is, rather than trying to rephrase it, <is trying to get them to understand what the word means, by give them an example like this>, you know. So, definitely embodiment I think for- if you want to talk about this you could say one of the, a good example of embodiment <is a representation>, where you embody or not in general. (0.3) So that would be, probably (0.6) because if I have to think of another word, that does it.. So I say, (0.3) you take some examples to show them what you what you mean would be, would be very very good. And, I mean, in the primary probably (0.3) manipulatives would be the way, you know, I think, because they are familiar with them.
41	I: yeah. Of course. The only things that could (0.6) only.. (1.5) The fact is that manipulatives are not only the activitites that I focus on
42	E3: yes
43	I: A part of the great amount. This is the difficulties, (0.9) because manipulatives are quite common but..
44	E3: One. They're quite fixed as well. >Ok, so, maybe they're just supposed to be used once but we need to get to something else, so they don't just focus on the manipulatives<. So, manipulatives is one example, and more aware..(0.4) manipulatives are used more for helps students <engage in the art of the embody>, there are taught to get them to embody it's supposed to be embodiment itself. And again, I think to mind, (0.9) you're probably too young to remember this but in the..(0,4) there is a..(0.5) there is the fruit salad algebra, from.. (0,4) it is in the late 80s , so it was the idea that we are< doing bad things for students by talking about apples>. And you had 3 apples ((indicate with the right hand a set in the air)) plus 2 apples((indicate with the left hand another set in the air)) and than you get 5 apples ((put the hands altogether in the middle)), because..(0.4) or even using manipulatives to do it, because (0.6) they fail to <recognise the variables>, right? So the embodiment happens in the apple, they embody the apple, that's an example of it. That was one example, bad example of them, where we thought we were doing a good job. And you can find textbooks from that area, where there was, you know, exercises, showing 3 apples and 2 apples and than you bring them

	together and then you've got 5 apples. But it makes no sense, you know, when you try to do five apples times two apples. And so, students couldn't make the leap ((shake the hand in the air as if something fly away)). So, ok, so what else could we do in the primary sick that are other than manipulatives, (0.4) are you talking about (0.5) <multimodal>? [I: Mm, yes] Do you- (0.7) maybe, maybe some examples in the primary school might be with a link to a cross-curricular. (0.6) You know, where you can connect math lessons with music (0.7) or art, (0.4) or something else to talk about the multimodal. But the cross-curricular will actually use something else to bring in the math might be one. (0.4) Does it make sense as another example to you?(0.5) Or I'm just dre:aming here?
45	I: No, I believe could take some sense consider cross-curricular activities because (0.7) teachers could be more familiar in other, (0.6) in another discipline in this kind of things than in mathematics. [E3:Could be fix..] In primary could be quite common also in mathematics, in primary school, using movement of students, in a certain sense. But..
46	E3: Yes
47	I: But the point is not to use the body and stop. The point is <use the body to learn mathematics>
48	E3: Yeah, sure. I had (0,7) At my first years in the department, my first three years of teaching as a secondary maths teacher, my head of department of Mathematics was also a dance instructor, (0.5) she also taught how to dance at the school, and so we used to have some quite a.. (1.5) Even a math meeting, she would be demonstrating some things where the dance goes in and beats and things to try and get. (0.5) And she talk about, you know,(0.5) base arithmetic.(0.4) So, she used to <dance to music in base /4 or in base /8, and [used] the beats of a bar> to talk about different bases, you know, and several, you know, in music we only have 8 beats, you know, we would not need 10, you know? [I:yes] (0.9) So, we use that sort of thing so, I mean, there is.. (1.4) I suppose to try.. (0.9) and you don't want, I know, (0.5) that you don't want to try and restrict pictures by giving them specific examples but I think it's somebody tell you more of the same things that you've told them, so..
49	I: Of course. An for this reason I want to ask you also if you..(0.8) if you could give me some examples that are commonly known in your school, because in Italy and in Australia we have different culture- mathematical culture in a certain sense. So there are, obviously, something that could be in common but also something that are not in common, so I want to highlight this point, (0.7) 'cause I don't want to speak with teachers about something that it's not usual, for instance.
50	E3: Unfortunately, I have only been in Australia for 5 years my self, I come from New Zeland, and we are similar cultures (0,6) but it does bring in this cultural specificity that you are talking about. So,(0.8) I suppose one of the things might be possible to tease out in the Australian school context might be (1.0) if, I don't know, where are you getting your sourcing, your interviews, your population from (0.8) have you got a certain schools that you're targeting or you going have you got..? No not, yes?
51	I: No, I don't have a target
52	E3: 'cause Vincent courses is up in Queensland (0.7) and in some areas around him there would be some school which have a <high aboriginal student population>, (1.2) and I think that in a cultural sense that might be placed where you might find some really good examples. (0.9) Because culturally they seem to (0.9) lean on different kinds of knowledge, if you like. You know, (0.6) so movement (0.6) and, I mean, their whole culture is a very embodied culture, they don't have..

53	I: yeah
54	E3: so that, that might be one place where you could look for something which,> even if it's a contract with some school that doesn't have that connection<, it might be valuable to see if you can. And I'm thinking of the guy's name, Vincent know him as well, his name is Chris Matthews, professor Chris Matthews is the. He is in charge of the, at same of the Aboriginal and Torres Strait Islander Math association, (0.9) so, he might be able to put you in touch with some teachers and schools who are doing it
55	I:Of course, could be a good idea
56	E3: I've seen them talk, yeah.
57	I: yeah, thank you.
58	E3: And in terms of, I'm kind of trying to think of examples..(2.6) Myself..(1.4) I never taught in an Australian school, I have only taught in the university in Australia, I've taught secondary school mathematics in New Zealand before I went back to university but never taught over here, and even then (0.6) it is many, many years since I was in the classroom, (0.4) so I'm gonna really struggle to think about examples..(1.8) Ehm..
59	I: Also with virtual manipulatives that are more..
60	E3: I think I've got that you're..(0.8) you're thinking at the start when you're talking about <representation> (1.4) And..(0.3) and (1.2) one of the things that I work with Michael Thomas at the Open University was <representational versatility>, when you move from (0.9) <the numbers to graphs to the algebra and backwards and forwards>, once you've got that, in secondary school level or even in tertiary level for that matter, their ability to move and (0.9) in the Australian Curriculum we call it fluency, but is the ability to <m:ove between the different representations>. (0.8) And so, (0.6) for me, one example of that was, would be in a statistical model we get the students using di:ce and then we get them to draw probability trees, and then we work it up- (1.2) we start to work up equations and conditional think, so you got that. (0.7) You're moving from one thing to the other, so that's would be one example, I suppose, for secondary level. And I suppose even to in games so, you know, <the mathematical games (0.5) would be one way>, and I think, (0.3) I don't know how many secondary teachers are playing games with the kids, (0.4) but a lots of primary ones are.
61	I: yeah
62	E3: So that might be one, one way or..(3.2) So, and one of the things that I've witnessed in classrooms when I was- and this happens when I go in and I watch my new, (0.6) <my young new pre-service teachers>, and they design these <wonderful lessons, really creative, really exotic games and physical things for the students to do, but where they miss (0.4) is drawing the math> that they have hidden behind the move. So, (0.5) they don't have the skill or the experience, to actually (0.7) scaffold the embodiment for the students, what they are doing. So, often the lesson what is tend to be quite of (0.4) <a shallow day>, you know. I find the lesson but not necessarily mathematically embedded or embodied.
63	I: yeah. Of course. So, thank you so much. I want to go to the more conceptual part
64	E3: Sure
65	I: So, the first big question is whether you think that (0.3) this kind of activities are important in schools? They're implementation, do you believe could be relevant for learning Mathematics? And Why, if you think yes or no.

66	E3: Absolutely yes, I think my..(0.6) I have <a view of Mathematics learning that actually encapsulates a whole range of activities>, you know. So ,I think all students learn in different ways and all people learn in different ways and, I mean, we've got visual learners, we have a kinesthetic learners, we have people who learn.. (0.3) So, for start, <just providing different range of activities that might give a different group of learners> is important. So, yes, even if it's just- I think one of the,(0.3) one of the issues we have at the moment is that a curriculum keeps getting captured by certain theories in theory groups, you know, so, one particular activity becomes very popular for a while. And one of the ones it's been very very popular in Australia, in recent years is..(2.5) What do they call it? (1.6) I'm trying to think of the name..(3.4) it's too late in the day! You know, when you should student we're going to do their own guarded investigation, you know? That's become very very popular
67	I: Yeah, yeah. <Inquiry base learning>
68	E3: Inquiry-based learning! And of course there is a countermovement against inquiry-based learning,(0.4) because, (1.2) of course, <no class and no student and no learning should be all inquiry-based>. I mean, it should be elements than inquiry learning involved and this should be absolutely elements in a math class, and in the same way that although, as you said, manipulatives are not soul source and now just heard means, but we should have these present all the time and say yes, if, (0.4) I mean.. (0.8) there is it all that research about gesturing, as well, you know, (0.5) and one of the things we've seen in the Zoom environment is I've lost a lot of my ability to be the dynamic teacher that I am because a lot of mine is actions ((shake and move the hands all around)). You know, I move around us, I gestured, I bring my body into my teaching so I've embodied learning through my, through my own personality, my..(0.3) So, yes, (0.4) and I think, I mean, it's a very kindly research because we now have face.. (0.3) Probably could be a future where we going to be doing more online learning. If I can go back to what we were before which was nothing, and so, why is it a finding how we can embodied than for a student, and such activities I think are really really important. And also I've the suspected that a lot of teachers, especially in the secondary school, <don't have a clue about this thing>- but don't have even a clue about it, <they never thought about it>, they're probably actually doing some things, but you have to dive pretty deep to find out what you're doing because they won't be aware that that's what's happening. (1.0) That's my think. I mean, even when (0.4) they do a game, in the classroom, they probably don't see..(0.9) I would suspect most teachers would take that the idea of the game is not so much about the activity, and the action and the embodiment, as it is about (0.7) a hock, (0.3) it's just a fun hock to get the students interested, (0.4) right?
69	I: yeah
70	E3: And.. and they're not seeing that it's almost a deeper connection and the value of getting the students involved in an activity where they actually not embodied the learning.
71	I: So, the point is to engage, not to learn
72	E3: yeah, yes, that's right. Yeah, it's more for the engagement, just a hock. (0.7) And so, that might be new area for you to explore as well, because I think there might be (0.4) quite a lot of teachers who are doing things that might be in the same realm as what you were thinking about, but they're not connecting in like that, they do not actually..(1.2) that might be. Yes, I think they're very important, and all lessons should have some- (0.4) or not every every lessons but two in, you know, every week lessons, should have some elements of the activities which do just that, otherwise we are..(0.5) I don't know, how you lernt mathematics, but I lernt mathematics in the classroom where the desks were arranged in twos ((fix the hands at a certain distance in front of him)).Two two two two two ((show a sequence of patterns in

	the air, organized in several lines, taking the index finger and the thumb of the left hand at a fixed distance and moving through horizontal lines)). And I sat next to one person and, you know, we didn't move from that desk ever, and the only person that I even talked to was the person next to me and it was all (0.4) a textbook and the teacher at the chalkboard, and, you know. (0.6) I lernt maths successfully, I'm a successful student but it wasn't what I would call an ideal learning environment ((laugh)) (0.6) I think at least it inspired me. [I:Of course] (0.7) So yes, I think the answer is, we know, we need to..(0.5) we need to move our classrooms to a different level. (0.6) So, yeah, a long-winded answer, wasn't it?
73	I: Yes [Laugh], fantastic! The question that I want to ask you now is about your point: what-(0.9) in your opinion, what could be <the beliefs, the awareness, the convinctions of teachers when implementing> this kind of activity in school to have a good impact on students' learning, in a certain sense?
74	E3: So, are you talking about that from a kind of professional learning perspective when you're trying to work with them, to start them doing it? it's got convinced..
75	I: But also at a theoretical level, both pratical and theoretical level.
76	E3: Ok, mm..
77	I: If I think about <implementing> this kind of activities at school, the individual that have to implement are teachers
78	E3: yes
79	I: and what kind of things do you think could be important that they have in their mind when they implement this kind of activities? Like beliefs, at a theoretical level, but also awarness and convinctions that are more practical, in a certain sense.
80	E3: yeah, (0.8) the beliefs are very important, certainly. (0.7) I think somehow or other you have to.. (1.3) to get them to connect their beliefs to the value of that sort of activities. So, I mean, if you've got.. (0.3) if you got a teacher who has strong beliefs that the way to learn mathematics is explicit teaching and coughing examples, >you probably not going to get them on board or something like this, because you're not going to be really interested in any kind of activity<, need alone what you're proposing. So, I think, you probably going to need teachers who are <open to things for a start> and the next thing I would think would be.. (0.4) maybe (1.2) it's always easier to move anybody, if you can get them to see, or, at some level, they're already doing it, or this is not a huge amount of change (0.6) to what they already doing than to try something different. You know, if I see there's a (0.3) h:uge gap, (0.7) and that was what I am talking about before in terms of, you know, if you connect some things these teachers is already doing, like games or, you know, (0.5) different representations they doing, and saying them "you know, you're almost there, you.. what you're doing is.. all we need to do is play around with this a bit more to actually do it" and then,(1.7) presumably, they are doing those things <because they see the value in them> and so, then, you are sort of pushing them in a sort of..(0.8) It would be very nice, I think, if you got one..(0.9) if you can find one activity, that sort of reasonate with what they already doing in their classroom, which comes back to what I said to you before, that would be nice <to find it what they do and how they do it<, because often (0.7) <what they say their beliefs are>, as we know, is not what they actually end up doing in the classroom. Because I can say I believe in students seated learning (0.6) but then I can stand up at the front of the classroom and go bla bla bla. You know. (1.4) So,
81	I: yeah

82	E3: Beliefs could be a barrier but if you can move behind the beliefs to what they actually do, and you're talking about they are next to here, (0.7) I think, you know, so this is what we.. (0.6) So, I think probably the biggest way for you to get to see, to try something, would be to do something which is not too big escape from what they are already doing! (0.7) And that you can connect to, you know? (0.5) So, I mean, I'm sure, you got some wonderful activities there, and if you think.. what sort of teacher, what would I be looking for in a teacher's practice that would make them receptive to try this particular thing out
83	I: Of course
84	O. And the other thing I would say is, (0.7) particularly- (0.3) I don't know, I imagine it's the same in Italy, but in Australia <the biggest thing that teachers, that enables teachers to try something> if they can connect it clearly to the curriculum. (0.4) So, if you got, you know, they will want to know <what is this going to help my students l:earn, what is this, what am I.. (0.4) how can I connect these>. Because that's what is driving all their lesson planning and their reporting, everything, you know, and so. My own PL activity was, you know, we started research activities in schools, we always had to make sure that the teachers can see (0.5) that it is connected to the..(0.6) what I have to say I have done yeah, you know,(0.4) and prove that I had done and..(0.4) or shown that the students have learnt otherwise, they would say "Well, we know this" all that sort of -- (0.4)," that's a wonderful activity, it's a wonderful idea, but!" Right? (0.8) So, I think that's another important thing, it is better show clearly and say so, that if you've got an activity and you can say that this is connected to this component of the curriculum, this is the statement, this area of the content or whatever, (0.5) and show how this work comes out, so, this is important, you know?
85	I: Of course. You are right. Absolutly
86	O Is that make sense? yeah
87	I: yeah, yeah, yeah. Of course. Absolutely, because this is also the <main point in Italy>, that teachers think about these activities as something that is important to engage, (0.9) Ok. (0.7) But only for <short time, (0.6) sometime, (0.4) as an extra activity, not as something that is useful to conduct curricular activities. This is the point
88	E3: Ya
89	I: So, thinking about the activities <themselves>, I want to know your opinion about what are the main characteristics, concerning the implementation, that could be essential to have..(2.3) the effectiveness of these activities. And I don't want to specify what I mean for <effectiveness>, ((laugh)) because it depends on the point of view.
90	E3: Oh yeah, ((laugh)) >I know, I know<, that's the holy grail, (0.6) we could specify and prove that it is effective, and we wouldn't have any idea of what it is at all, right? ((Laugh)) So, yeah. (3.5) I think it comes back to the same thing I've just said, I think if you can, (1.4) right, there hass being some big projects in Australia for..(0.8) I'm not sure if you're familiar with the Resolve Project, but the Resolve is called the Math by Inquiry Project, you can.. (0.5) you could look it up on the.. on the net. What I've done is so produced the whole lot of activities that are connected to a year level, connected to the curriculum <descriptors, contents and achievement statements> and so on. And then I also have.. each of the activities has almost like a lesson plan, a text to look at how to do, coin new thing, what the teacher should be doing. Now, I'm imagine, >you're gonna be working with them so you're going to be providing a kind of< scaffold for that. I think a clear indication of its scaffolding and a clear indication of.. (0.6) of the timing of the lesson, you know, (0.4) the time of that activity and how it fits into another. So, you're almost want to work with your chosen teachers and look at

	their.. (0.5) their syllabus, so the term plan or, you know, (0.3) that sort of, you know, what you're doing is actually integrated it into their practices, so that's not seen as another on it, not seen as <just an another wonderful research idea> or another potentially Friday afternoon activity. (0.4) So, it is almost like you've got to (0.7) look at what these teachers are doing and know something about <their curriculum, their school or their scheme>. So you can t:arget, you would make something quite targeted. As opposed to.. (0.6) .and this is really hard because, you know, I've struggled with this myself. So, I have some ideas on my head, I have some things that I want to do, (0.5) but when I go to the school I realise network failed. (0.7) I need to think of something different because it's not.. Now, it might be that you can find at classes in schools and teachers that will fit exactly with your ideas in the activities you already have. But I think that, (0.5) for me, the criteria..(0.7) <you have to make, make it clear that what you are doing is gonna fit within near their realm, their practice>. As opposed to <a wonderful idea that might>.. might be good but (0.5) if it doesn't fit with what they are doing, that's not going to resonate, it's not going to.. (0.4) you are not gonna buy in, I don't think. So, I think "teacher-buying" is probably one of the biggest criteria.
91	I: yeah. Of course. And about <the main limitation> that this activity, (0.7) and not only this activity but also the implementation of this activities in school, that is the main point, could have in some context, or..?
92	E3: Mmm.. What I think is what any (1.2) new kind of practice we embark on is often requires almost like so, I am afraid of saying some- I don't know if you are familiar with team-based learning,[I: Yeah] but I believe that team-based learning quite a lot, (0.6) but it takes (0.8) quite a lot of <initial investiment>, (0.5) the students and the class and the teacher, all have to get used into that, right? [I: Oh, Yes] So, at the start and I'm thinking, you know, if you're (0.9) implementing this in a class which hasn't even really done anything like this before, they're going to see at this strange or they going to wonder what the point is. So, it could.. one of the limitations, one of the things that I can see is almost like a kind of practice period when you actually build up some, some ideas. I mean, that the show is actually.. (0.9) the students in the cl:ass started to buy into what the teacher is doing, you know, they understand, "oh, yeah. This is yeah, cool", you know? And we are even getting at the point where, if you are working in the class, they say "Alessandra is back with us today, we can do some fun activities and we are going to do..". I mean, you know, what I mean that kind of (0.7) familiarity with everything I think could be important as well, in terms of.. (0.5) Because a class has quite a routine and they are going to work on routine and you are talking about distrupting the routine to a certain extent.[I: Oh] Oh no, not to a certain extent, to a big extent possibly.
93	I: Yeah, there are resistence of tradition and usual stuff. Yes, of course.
94	E3: yeah. I don't know if you are familiar with the term the didactic contract
95	I: Yeah
96	E3: you know, when a classroom survive on the course, and then the contract extends way beyond <the teacher and the students, the parents and the principal and the whole school community>. Every school has its own version of <what's expected from the teachers, what's expected from the students> and when you go and you want to do something different, it's like you've challenging the contract
97	I: the paradigm. You change the paradigm, you change the no written rules.
98	E3: yes, you do
99	I: which are the more difficult to grasp away, in a certain sense

100	E3: Which comes back to what I said before, I think, the closer you can bring your.. (0.4) the closer you can make the connections between what you're suggesting and what they are already doing, the easier it will be, you know? (0.3) So, if you can find some classes or some teachers who are doing things that really aren't that far away, or maybe just need (0.5) a change of focus to bring them into a real embodied and enacted thing as opposed to a big leap, then you might.. (0.5) you might have more success, I think.
101	I: Of course, I believe. And for this reason I want to ask you the very last question that is about what do you believe could be some factors that could hinder or foster this kind of implementation in schools?
102	E3: In the beliefs again, ok. [((Laugh))] I have four, (0.5) currently four Ph.D. students who are doing their studies in various areas of beliefs, you know, so..
103	I: But not only beliefs, factors also in general that could be also practical
104	E3: yes, well, ok. I can see some.. the nature of the school and the way in which the classrooms are organised could either <end up or support>, you know, and so (1.4) I believe they are an important part. (0.4) Because, you know, some teachers believe in very orderly and very quiet classrooms and, you know, and what you're proposing is probably not quiet, (0.6) you know, it's a.. the study results into bringing these sort of selected activities, you know, we can get quite noisy. And one of my colleagues has amazing activities where she takes Allan Check, I don't know if you know Allan Check's work, (0.5) but she does things with the kids where she does human number lines. (0.5) Well, I get a big long piece of rope, and they use close peaks and they have to put the numbers there and they have to stay in and standing up the number line where they are, with the close peaks, (0.5) and she does where they are <on the field>. You know, and she does this as a competition. So if she will have three ropes,(0.5) and three teams, and they're competing against each other to complete the number line, you know. (0.9) And it's an amazing and noisy and striky but, you know, I mean they have one person who is designated to be the observer and that is going to stand back and look to see, and then they say "Oh no, you wrong" and then the kids are running around and (0.9) at the end of the lesson they're hot, sweety it's like a PE lesson, and, you know, the value of that in terms of cementing ... knowledge and every student has a part to play because everyone's got a number. So, it's a beautiful activity, (0.9) but quite it isn't and she did this is a P&L, a professional learner exercise, for a number of schools, and then she did a little study and went back to see how many schools were still using it, (1.2) and there were 10 schools that she went with teachers from, (0.5) and among these 10 schools only three of them had taken that activity and built it into their standard practice because..(1.5) And I don't know why. But one of the school differently, 'cause back to the impediment, one of the school say "No, it just didn't' fit. It was too noisy, and the students cannot have a shower afterwards, and it was not a math lesson because there is not place for P&L for math lesson, you know, it was a very structured view of what a math lesson should be and that wasn't that, you know. So, whereas the schools that they did it and keep it on board, (0.8) they saw that is valuable on so many levels, because if they seen the value of the learning for the students, in terms of understanding this most place value. So
105	I: of course
106	E3: So that's a one-year, yeah, I know >it took me a long time to come up with that example but it's a beautiful activity< and it really does for me bring up the whole of embodiment of learning. So, in terms of that, you know, >the teachers and the school beliefs about what a math lesson should look like, and what a math class should look like< (0.8)I would suspect that teachers who have tried some of the (0.7) learning by enquiry are probably open to

	different- I mean, although some of the enquiry based learning teachers wouldn't because they are so fixed on this, is the only way of learning, and >you're not proposing an enquiry, you are proposing, you know, yours is actually more of, structurally, a sandwidch where the teachers are directing some activities that the students are gonna learn from<. So, (0.9) I think beliefs and styles that these schools run are going to be your <biggest obstacles> (0.8) and an advantages as well. They will be the one: (0.9) he schools where are they open to doing different things are going to be a real..
107	I: A two side point, is the hinder and the foster factors at the same time.
108	E3: yeah. (0.9) I mean, I know, I've been here enough now, I've got one school where I take my.. (1.4) I've got a year, I've got a class and the students are actually HPE students, so..(2.1) I actually should have talk to you about this before, (0.9) but this students are doing an HPE course. (0.6) But in Tasmania a lot of the hpe students, in that teaching maths, because there's a short- a) there is a shortage of math teachers and b) there's a certain surplus of HPE teachers, (0.7) so, to get jobs, I'm..(0.6) Also, a lot of school find their HPE students are very very good classroom managers, (0.7) because to be a good hpe teacher you've got to be very good at managing the class, so they have also some (0.6) <math pck> that can become quite good math teachers, right? So, I've got a school here, (0.4) the school St Patrick's, and in the Middle School the head of the Middle School, which is here seven and eight, (0.9) he takes my HPE teachers on placement, (0.4) and he's got three health-and-physique trained teachers in his department, (0.8) and he loves them, and it's quite funny because the reason he loves them is because he sees their embodiment, he sees these guys really do, understand embodiment, because that's what their field is, you know, and they bring it into the math classroom. (0.7) So there's another example for you, I think.
109	I: Of course, yeah thank you.
110	E3: So, if you could finds, maybe finds that might be another way of delving into it would be to find some teachers who are actually ended up being math teachers, who start off the training exam, (0.7) in health and disease area. There is a lot of them around.
111	I: yeah
112	E3: Because it.. (0.5) they might be open to as well, even if you're not doing. Because sometimes these HPE teachers they are open to embodiment, but they maybe lack the knowledge mathematically of how they might link that to the math lessons. So, you now, weakly in my team we show them ways in ways they may link the two up. (0.9) One of.. ((laugh)) A funny example of this is of, one of my ex Ph.Ds. student,- are you familiar with burpees? [I:No] Burspees are the PE exercise ((pump with the hands in the air, miming harms bending)), that you do for
113	I: Ah burpees! Yes yes, burpees. Yeah
114	E3: So, this is the exam. So yes, (0.9) he did a lesson, (1.2) a math lesson basically on this. (0.8) And he build percentage into it, because he had the most outstanding, you know, >doing these exercises waiting for the hard bit to to come down and talk about how long it took for it to happen and what was- what, you know, how long did it take for the hard rate to get back to 80% of its<,you know? (0.9) 120 % of this is normal. (0.8) So it was quite a strong lesson and there was a lot of, again, a lot of running around. And.. (1.3) it was different than doing it in a PE lesson, because it's that..(0.5) Because student course they solo the knowledge, you know, so that. They knew that was a math lesson, so why they were doing this? (0.9) So, I said it might be another, another way is teachers who are doing that.

115	I: of course, yes. You're right. It's a good example of this kind of things ((laugh)).
116	E3: It's a pretty extreme example of course. (0.6) You look in some cases more subtle examples, (0.6) but it's probably yes, another example that, (0.3) yes, manipulatives could be no so much really obvious..(0.6) But if you draw the (unclear *48:00) population, it's told is a very good example of embodiment there. And of course (0.8) the other one I just think, that I've removed, Helen has done in the past was with <human gr:aphs (0.5) on the field>. (0.5) Or you can do it in the classroom, as well, we actually- (0.5) you actually draw your graph on the floor using people ((indicate a plane moving hands horizzontally))
117	I: But do you refer to something like, using some..(0.6) some <detector of position > of..(0.7) that could represent into graphs what the movement is
118	E3: yes, yes. (1.8) I remember Helen doing that with running, it's a sort of <time-motion graph>, and she let the student doing, they had to space themselves all along the graph ((put the harm diagonnaly pointing the high right angle of the screen)), in a running form, and they did it on the floor ((move the hands on an immaginary plane)). Because I had to decide a scale for themselves, because they're people right? And I had to work it out that, you know, a few in a line are doing side by side, or I may have to be croutch a bit to have the same scales, (0.4) it is harder.
119	I: It's powerful. It's incredibly powerful exercise I believe.
120	E3: yeah, it's a good example, I believe. (0.7) This, you know, if you're thinking about doing it in schools, it might to must be worth with <climbing through the sites like Nrich and Resolve and these places which have a lot of that activities that teachers are already using>, and using your expertise to decide which ones of these could be used or already do, have embodied that kind of learning in them, because of teachers are using those activities then all you have got to do is show them how they can become more an embodied lesson.
121	I: of course
122	E3: So that's, you know, that's (0.8) because in some ways I think (0.6) a lot of these lessons that exist yet there, fail in the origins because the teachers don't see those values in them. They lack the ability to draw the math. (0.5) So they become just another, whereas a good activity or useful at least, but they don't really.. (0.3) so, I see the,> one of the powers of what you're doing is allowing teachers to dory at some of the richness that has already had in this past, more than what they already are the opportunity for students to really actions and do some real body movements in things
123	I: it's really important, I agree.
124	[...]
125	E3: Yes, six year levels. Yes, it's a year they've got to do it, because they've got a lot of level behind them but they still haven't got into the heavy higher levels where algebra becomes very very dominant, and you, know, abstraction becomes.. They still be in the concrete world, I think in the year 6.
126	I: The fact is to start from the concrete and then leave the concrete and only do in an abstract level things, that's the usual path in Italy.
127	E3: But it is for your supervisor, you're saying, you know, that embodied activities can help them move from.. when we know that they leave from the concrete to the abstract, this is the biggest challenge for students, that's the thing that we can.. so activities that can help them do

	that.. The five apple plus three apple was a failed activity but was an attempt to do that, you know. (0.5) It didn't work but was an attempt to try.. try bridge that gap, right?
128	I: Yeah. But also the thing is that, like Montessori said, but not only Montessori is a common think, you have to come back to concrete and then go to abstract and come back to concrete and go to abstract
129	E3: That's right, the human learning practice goes round.
130	I: yes, it's a round, it's not a path that come from concrete to abstract.
131	E3: No. Even even with that what we do in our standard school system is, we say "right we start with concrete but we're going to come up the linear hierarchy of the curriculum and we're gonna.. you're not kids anymore so you don't need concrete, right? you know. you're going to be able to. Now you are grow up and you gonna do real maths, you know?". (1.6) It's so frustrating. I am one- one of the things I used to do it in in my year and in New Zealand it is, right, Year 7 here, >because the difference is one year from New Zealand and Australia. New Zealand goes youth, because we start.. what would be here, north here, we start as year one, right, so will be my year a class in New Zealand of year 7<. (0.8) You know the childrens' game with kids ((shape an imaginary ball)) where they put shapes into a ball ((fix the left hands shaping a side of the ball and with the othe hand point the index finger into the imaginary ball)). I have little kids, twenty kids, and they get a ball and they put in a triangle, in a square and stuff in it.
132	I: yes, they have to fit the shape.
133	E3: yeah. So, I used to bring.. I had a set of th:ose (0.7) and I use for kids in groups, and I used to get them playing with those and they want, you know, one can start and other say " How are you? Finish one of these, ten for him and one for I". They said "What's? What is he doing? You know, this is kids stuff", you know? And, you know, some of the kids say, while little sister is doing this "Why am I doing it?" you know? And I "So right, so, how did you know which one could go here? (0.7) What it means? I have to know, so tell me", and they said, "What?", "No. No, <tell me what do you do>". And I see that for bridge geometry and algebra, because, you know, the idea of variables is not, you know, an easy variable and 1 = 7 it is not different to a triangle and putting it in the triangle inner, you know? And so, you know, (0.6) from this they would start to realise what I was doing >and how the kid works with this and how it was the most powerful, it is not the word the same, they remember math<, because, you know. First it makes me angry, because they don't know what I can do with a baby stuff, and then I realise that it had a connection to what we are doing, yeah. And then, with microcy are used to use e-cups e-trace, and put numbers on the back of the eye-trace ((show an imaginary thick line in the upper side of the screen))and I also, when you doing.. when you doing anything you can, you can step it ries up ((move the open right hand like to squash down something)) and you can actually show them the multiplication, because you can have an egg-try-n-y ((show with the left hand an imaginary horizontal line from the left side to the right side of the screen)) and egg-try-n-y ((show with the right hand an imaginary vertical line on the right side of the screen moving up and down, and then you can just do a one-to-one metric from each one ((indicate with the index finger of the right hands the diagonal from the left to the right part of the screen)) to show there are a wigs, you know?(0.9) So, that was very familiar with concrete manipulatives. l was doing it at years 10 but at 11 they also use the e-trace and the students remembered microcy even because of it.
134	[...]

Expert 4

25/11/2021 (6 p.m. Brisbane | 9 a.m. Rome)

1	I: Good evening
2	E4: Alessandra, Hello!
3	I: Good evening, how are you?
4	E4: I'm well, it's nice to meet you
5	I: it's a very pleasure to meet you, even if it is only online
6	E4: It’s the way the world goes these days, isn't it?
7	I: Yes, Of course. I would really thank you for this opportunity and the time you’ll give me for my research project. It’s really really important for me. Thank you.
8	E4: It’s a pleasure and It looks very interesting, it looks like a very interesting project too.
9	I: I hope it will be.
10	E4: Yes. So, you must be at the very beginning? So, you've just started?
11	I: No no no, I’m at my third year, (1.3) but in my first year there was the spread of the pandemic emergency, eee.. So, my Ph.D project is totally different because I have to, to come in Australia, and I want to go in school, and then I have to refresh all things, and I restarted at the second year. So, I'm not at the beginning of the project, the project is already designed and the instruments are ok, but I started to collect the data in this period, so I’m at the start of the data collection in..
12	E4: Thar story of having your PhD disrupted by Covid,.. (1.2) one of my PhD student had the same experience, so I wouldn't Ireland for the last 3 years, I've only been back in Australia for 1-year and I still have three Ph.D. students in Ireland and they all finishing their thesis right now, so I've been doing nothing that reading their work for a while. And one of them, her data collection was stopped because of the pandemic, she couldn't get into school. And she was <devastated>, and it was (1.2) very hard for her so, the other supervisor and I had to, first, leave her alone for a while and just let her experience sad and, then, help her redesign her study. And she was fine, she was happy to do that and I think it actually turned out to be a better study than what she had originally planned. And she said that it is so. So, it’s very relieving to hear that and she's nearly finished. I finished reading her final draft of the thesis <today>. So, she doesn't need to do <a little bit more> work, and so hopefully we will talk to her next week, online, and she'll be able to submit probably in January, I would say.
13	I: And we hope to have time in the future to experiment in schools.
14	E4: Yes, yes. <I kno:w>. I mean, I think it's interrupted most peoples, research, but in education when so much of our research is done in schools, and schools are closed, or even if schools are open again they don't want strangers coming in
15	I: Of course
16	E4: totally unavailable

17	I: Ok, I think I could briefly introduce to you my Ph.D. project to have an idea of the <scenario> in which you are invited to contribute with this interview. (1.2) Firstly, my main interest is in the activity in which students are actively engaged with the involvement of their movement, whole body movement or manipulation, both virtually or (1.0) physically. But in particular I'm interested in searching, in investigating teachers' perspectives on these activities and also what are the main results coming from (1.2) the research, empirical research and theoretical research, (1.4) and also the view of experts in education that are in the middle, between working with teachers and doing research. So, this is the frame and (1.5) particularly I think about some questions: (1.2) the first two questions are about an internal issue under research. The first question that I want to ask you is that.. Mmm..(2.3) My aim is to (1.6) reach teachers, so I have to (1.3) overcome all the differences- theoretical differences, between <the embodiment>, <the enactive>, <the manipulatives> research and I have to use a terminology that is more confident for teachers and <easily accessible>. And for this reason I want to ask you, what do you think could be a good terminology to think.. (1.2) with teachers, of these activities, in particular?
18	E4: Mm, I have given some thoughts to this today, yeah I just..don't want to just <pull ideas> out of my head. This is <such> an important question, which really (0.8) came home to me when I worked in Ireland for 3 years. (0.8) Now, Ireland is an English speaking country, but the terminology for describing things is sometimes different and I found it really interesting. So it's very good that you're asking that question. So, what I thought about, and I think <what I'll say might even answer> some of your second question about examples. I think it is important to give teachers <examples>. So I tried to think about <what kind of experiences do I think that teachers might have had in Australia>? And how would I describe it? So, I brought some categories, if you like, and some examples of each that might be helpful? So, I think if you use the term <hands-on> activities, that will be very familiar to Australian teachers, and that can involve things like the use of manipulables. So, if you use that term manipulables teachers will know what you mean, ehm..(0.9) and that will be quite very familiar for primary school teachers. So, in Australia, primary school classrooms are full of manipulables and resources, things that children can touch and can use. Also in junior secondary schools mostly,and <less so> than in the senior secondary school. But, I have worked with senior secondary school teachers <who use> manipulables in wonderfully creative ways, so you might find some people there. Other terminology could be things like, ehmm, physical resources, or (0.6) instruments, or to:ols or even games, could be a word that you can try using as well. So that's the kind of physical things that you can touch but, of course, you're interested in the virtual, as well. So I think if you could use the term virtual, and you could talk about technology, as in calculators, or computers, or software and so on and teachers would, (0.9) would know what you mean. So there's those kinds of, of activities. Then, that is another kind of activity (1.0) that will also happen in Australian mathematics classrooms, that involves (0.5) <students moving around>. So, getting up from their desks (0.3) and m:oving. So, hands-on things you can do with children and students still sitting at their desks. Some teachers will be brave ((laugh)), >and I will talk more about why need to be brave<, and may have students move around. Sometimes this will involve moving around <inside the classroom>. For example, and I'm thinking about things that I have done with <student-teachers>, to demonstrate the kind of things that you can do in classrooms. So, for movement inside the classroom, one example might be to get the whole class, or some of the class students, lined up at the front of the classroom and tell them to line themselves up from the shortest student to the tallest student, and then find the median, (0.5) for example, in the range. And, (0.6) we can do things like asking the question "How many people do you think we could fit into our classroom?" (0.8) and leave students to work that out. So they might decide: "we let's measure 1 square metre, and see how many people we can squeeze into that and then we need to

	measure the walls and so on". So, that gets some up out of their seats, that's kind of movement. And there is movement <outside the classroom>. So, that could be things like involving measurement, for example, and trigonometry,> if you want to work out the height of a building, or a three<. It can be measuring your running spe:ed, and the time it takes to one or more walkers walking a certain distance estimating your pace length and so on. It can involve things like looking for <geometric shapes> in the world around you, so go for a walk around the school yard and (0.5) an excursion. So, go somewhere else and see what mathematics you can find, so like a, a mathematics trail which is a sequence of outdoor activities (1.2) which you can get students to, to use. So, you know, some teachers will make those outdoor experience those. Certainly, in the secondary school, if, if teachers are doing some mathematical modelling, >then math involves taking students out of the classroom< to do some, some measurements or to collect some data, for example. (0.9) But, what's I mean, that's not necessarily- math statistics may not necessarily <using your body in ways to learn concepts>. And then, they.. (0.5) Some sort of going from the, from the least <disruptive> to possibly the most disruptive or unusual, then the final category is activities where students are <using either gesture or their whole body to explore and embody mathematical concepts>. And I know there's a really good tradition of this kind of work in Italy, in a people like as <Ferdinando Arzarello>
19	I: Ferdinando Arzarello, of course.
20	E4: They might be some incidental examples of that in Australia ((caught)), but I think that is <less known>, less familiar to teachers. But I think the teachers will (1.5) notice when students are using- say using their hands, using gestures, if they're working together on a problem. And I've seen this myself, students will use the..((move the hands in the air)) their hands to accompany, ehmm, their conversations, about.. And they are using gestures to help themselves represent mathematical concepts. I've seen them do that, and it's very memorable when I do it. And then I have.. As a teacher educator, I have used activities, or shown my student activities that involve students using their bodies >to create an understanding of mathematical concepts<. So, for example, ehm, (0.6) helping students, students understand what is a circle. (0.8) So you can get a long rope ((mime the lenght of the rope, tracying an imaginary segment within her two hands))and have one student hang onto one end of it, one student at the other end ((point to the opposite side)), and so I want you to w:alk (0.7)((point the finger in a sequence of successive position circling her head for two times)) and you realize what a circle is, you know, it's >the locus of the set of points that are equidistant from the center<. You can use your body to <draw grI:phs>, where your body is a point ((touch her with both hands and then lower hands with fingers pointing downward to indicate her position on floor)), you now, you can draw a ch:alk, ((move hands horizzonally, tracying axes on an imaginary plan in front of her)) axes on the ground and students move on, and so on. That's incredibly powerful, but I don't know that many teachers in Australia might really use that. Thus, I think it's worth investigating. So those, those.. At the moment a kind of example and experiences that I can think of that would be familiar to Australian teachers, (0.8) and that is the word that I can use to describe them.
21	I: Of, course. Thank you so much. And,.. I want to know.. (2.3) Is there, in Australian curriculum or policies- are there any references to this kind of involvement of students in (0.8) manipulatives or so on?
22	E4:[((Laugh))] ((She take from behind the the book MCTP Activity Bank, Volume I and show in front of the cam)) This, I have got this book over my shoulder (1.4). This.. there are two these books, (0.8) they have origin in the mid 1980's, <so they are quite old now>. I think that older teachers will remember these.[I: ok]. This is a collection of different kinds of activities,

	and..(2.2) There is a whole section here on <physical involvement> in mathematics learning. So, (0.8) this history goes back to a long time, and a lot of these activities are now been transferred to a website, the MATHS 300 website, which (0.5) you can only get access to by paying a subscription
23	I: Mmm. Ok
24	E4: That will be a familiar resource in many schools. So this is probably the best known resource ((drum her finger on the book)).
25	I: Is it currently used also in professional development courses or something like this?
26	E4: Yes. (1.4) But it is quite..(0.6) a long time ago. So, it may not be so familiar to teachers now, but it was a very well-known resource. >So this states from when I was a student of teaching myself<.
27	I: Thank you. So, come across to the most conceptual part, (0.9) away from the terminology and example. (1.3) And now, I want to know your opinion about these activities; (1.5) whether they could be helpful to understand and learn mathematics at school and, if you think yes, why?
28	E4:Mmm.. Yes, I think the answer is yes. Now.. I don't..I haven't myself undertaken research that will provide any evidence to support that answer, (1.3) but just thinking about the kind of <research evidence> that's out there, I think there's a range of possible reasons or explanations (1.4) that might provide a justification for using these activities. (0.6) One would be motivation, interest, engagement of students. Ehm.., (0.9) so, you know, we know that many students don't enjoy learning mathematics, because >they think mathematics is something else, lives in the textbook, it's boring<, it's dry, it has no use in the real world. So I think teachers are always looking for ways of engaging students with Mathematics and showing them that it's not what they think it might be. So, I think that's one..(0.5) one important reason. And related to that is <changing students' beliefs about what is mathematics and how are you meant to learn mathematics, and how am I meant to be teaching mathematics. (1.3) An interesting thing that can happen sometimes if a teacher (0.8) decides to start using activities like this, which is really different from what students have experienced before, is that the students will resist. Even if they don't like mathematics, ehm.. they will say "no, this is not the way it's meant to be, leave me to sit here and you were meant to tell me what I'm supposed to learn, don't make me think" [laugh] Even though, in other subjects, they will be very experienced in doing group work, investigations and projects, the minute they walk into a mathematics lesson, no, they know that it's meant to be different here. So it can't be a maths- you know, based on students' beliefs which come from <many years of experience> of having been taught mathematics. (0.9) Ehm.. so I think it's, it's valuable for that reason. (0.7) More.. more ehm- equally importantly and possibly more importantly, I do think that (0.8) activities that have physical involvement are a way of students to represent mathematical ideas and concepts >and we know that multiple different ways of representing concepts can be very important, we want students to be able to translate between< numerical and graphical, physical representations. Ehm, so that's another reason, <to be able to represent a concept using your own body>. Ehm.. when I've done this and seen this, it is..(1.2) is amazingly memorable for students. It seems to create some kind of memory trace which stays there. (0.4) And it's almost like it's codified and the teacher or the student can call that experience again (0.6), <in future>, just by saying a word or two. I remember, >in particular<, when I (2.6) was doing research in Vince Geiger's classrooms. It's his Ph.D., you know, he's doing some observations (1.7) ((move the hands from the eyes forward)) and I was watching a pair of students, and they are working on a problem which was about (1.2) simple harmonic motion. There was a mass ((raise the right

	hand holding a fist)) suspended from the spring ((raise the left hand resting the fist on the raised right fist)), so when you pull it down ((move the right fist positioning it lower)) and let it go ((move the right fist to the former position)) it bounces up and down like that ((move fast the right hand vertically between the two indicated positions)), o:r,(1) if you push the spring up ((knock with the right fist under the left fist)) and let it go it will..(0.4) it will still do that ((move fast the right hand vertically between the same two indicated positions)). So, they would trying to visualise ((indicate with the index fingers the temples)) what does this look like ((shake the head horizontally)) and they were using their hands ((take the left fist raise and move fast the right hand vertically between the same two previous indicated positions)) and (1.8) , and they had a disagreement about how the body would move and one said: "No, it would go bo:ing, bo:ing, bo:ing" ((take the left fist raise and move fast the right hand vertically between the same two indicated positions)) and I was watching and they both start laughing.. (1.9) ehm.. (0.3) and then I interviewed them sometime (0.5) later, after they done an exam and there was a question like it in the exam. >What I said is< just: ((make small circles with the index finger next to the head)) <Remember bo:ing>"[((laugh))]
29	I: [laugh]
30	E4: And the hands, you know, going like this so that something seems to make students remember. So, it's a powerful learning experience. And then.. (0.8) The really interesting works has been done in various places in the world, not just in Italy, the people like <Natalie Sinclair>, I'm sure you know about her, in Canada, her work on the embodiment. So, (0.7) this, (0.8) you know, this developing work on theoretical understanding about the role of the body in learning mathematics. >I'm not an expert in that theory<, but I find it really (0.7) <interesting>. I feels like this work could provide the kind of powerful theoretical justification that probably isn't there, as strongly with those other reasons, >but I can see a range of reasons<, ranging from the sort of affective <emotional response, to beliefs, to the cognitive, to the physical and embodied>.
31	I: Thank you so much. I agree with all the things you said. So, about (0.9) being a teacher, when they are the individual who implement this kind of activities in schools, what do you think have to be the beliefs, the knowledge, the awareness..(1.4) all the characteristics that a teacher has to keep in mind when she implements these kind of activities in school?
32	E4: This is important ((Laugh)) This is a really important question that (0.8) has probably shaped most of my research I think ((Laugh)), (1.9) trying to work it. Because I believe that there are many factors that influence learning, we know that, but I think the teacher is the number one. (0.4) It's really important. And..(0.8) So, I thought about things like beliefs, the <teachers beliefs> about what is mathematics, (0.5) and (0.3) what is good teaching, and how does students learn. So, you know, that's a very big area but certainly that influences what teachers do and not in.. not in a simple way, but (0.7) it's not just my beliefs I translate into practice, it's more complicated than that, because (0.6) I may have certain positive beliefs about mathematics, but feel (0.5) unable to teach in that way for a wide lot of reasons. So I think the two things need to go together, the beliefs and practices, they are related in complicated ways. And.. (2.3) One belief that I've come across in my mind as teacher is "what kind of students are these activities for?". (0.7) So.. (0.5) when, when really, I think it's for all students, all students. (0.5) But sometimes teachers will believe "Oh, I could only do something like this with a really good class, (0.6) in a high-achieving students and well-behaved class. It just wouldn't work for my lower achieving students", but on the other hand I've also work with teachers have said "Oh, you know, I would do this with my struggling students because they need to have this kind of, you know, physical activity, but I wouldn't use it with my older students, or my high achieving students. Nonono, they can cope with the textbook.."

33	I: It’s not necessary for them
34	E4: Yes, it is not necessary. Yes, that is. Those kind of beliefs are interesting to bring out and challenge. Ehm.. and that's related to a belief, which I think is fundamental for teachers: <you have to believe that all students can do mathematics>. Not in the same way, not the same speed, not the same level, but everyone can do mathematics. Ehm..(0.8) another belief, I think, (0.4) which is related to practice, and this is, this comes into play any time when you're proposing something to teachers that is different or new that you want them to try, they will <tend to treat this as something “extra”, something mo:re, something additional> and in addition to what they're already doing. So then you're up against <time>: “I don't have time to do this, I have a curriculum to cover, there's exams and so on “. So, helping teachers understand that no, what I’m proposing can actually <replace> some of the things you are doing, without losing anything. So, (0.5) by doing things this way instead of some other things you are currently doing, you will still be able to achieve, >or the students will still be able to achieve<, the learning outcomes in the curriculum. (0.5) Now, that is not something teachers might find easy to accept. Right, at the start. So, that brings me to assessment, ‘cause I know this to ask that.. assessment. And.. And if you find it in some, in some of mine research studies. So, if you're trying a new teaching approach and you wouldn't know if it works, (0.4) and then you'll see but you're using the <old assessment> of students so: “why are you using the assessment that you use for your old pedagogical strategies; you change the way you teach, you have to change the way you assess! Because you’re shifting what you’re valuing in students’ learning." And that, of course, can be a big barrier for teachers, because some- >often teachers don't have control over their assessment<. So, if you're preparing students for an exam, you know, written by someone else, and (0.8) that can be difficult. So.. curriculum and pedagogy and assessment should always line up, <be aligned>. So, (0.6) one changes, then everything else have to change. (0.4) Often it doesn't or it can't, ‘cause the teacher doesn't have power to do..to do that. And another thing I thought of is “What kind of knowledge or beliefs- knowledge and skills do I have?” Ehm.. (0.7) This is, I guess, a question for you too. (0.6) So if, (0.6) if teachers are expected to, to create these activities, they might not have <the knowledge and skills to design these kinds of t:asks>. (0.7) So it is always an interesting tension, I think, between <the creativity of designing a task yourself and the practicality of do I have the knowledge, skills, time, to be able to do this>. Oh, no. Why should we expect all teachers to have to design every task from scratch? So that's one extreme, which I don't think is sensible. But neither do I think that it's appropriate to just give teachers, you know [laugh], all the tasks they are going to use. (0.6) Ehm, (0.7) because I think that kind of lowers the professionalism of teachers. I think somewhere in between (0.7) would be good. So, thinking about how much do teachers need to know about task design, for example. It is..(0.7) is an interesting question. I think they need to know something, (0.8) >but you wouldn't expect every teach to be an expert in<. Ehm..
35	I: Neither it is their role.
36	E4: No, no. You know, there are the experts that can do (0.6) that kind of things. And the other kind of knowledge they need to have is the practical knowledge of how do you manage these kinds of tasks in a classroom situation, <for the particular group of students that you were teaching, (0.8) in your particular school culture, (0.6) with the resources that are available to>.. Ehm..
37	I: A <contextual pedagogical knowledge>, in a certain sense.
38	E4: Yes, yes. How, how do you actually (0.7) implement these activities. (0.6) It's not just a matter of handing over some materials, (0.5) or some written instructions of what to do. Ehm.. (1.3) Every teacher <has to translate an activity that they find into something that will work

	for th:em>. So, I guess in a way all teachers are creators of tasks- no as creators, but they're adaptors. They adapt the tasks.
39	I: Of course. And so..(2.4) I also (1.4) want to ask you what do you believe are the main characteristics of these activities, the implementation of these activities, that could influence positively..ehm..(1.5) these activities at school? Such as..(0.5) I mean..(1.4) An implementation (0.4) that could be effective in a certain sense. (0.3) I don't want to specify the meaning of this effectiveness, but this is the thing I have in my mind:(0.7) you've just said that teachers are a fundamental element in the implementation but..
40	E4: But it is not everything. So, (0.6) obviously, I have already talked about teachers' beliefs, and knowledge, and pedagogical skills and..(0.5) and so on. Ehm..(0.6) So, if you think about teachers as being part of a <bigger system, or ecology, or landscape>. (0.7) I think teachers will always have in mind <the goals that they hold to their students>, or they should. (0.4) So, "what..(0.3) what is that you want your students to learn?" (0.3) And, yeah, it should be written in a curriculum document that >teaches will then personalise that to the students who are in front of them<. (0.6) So, for something like this to be effective, (0.6) <teachers need to be able to see the connection between doing this task and the learning goals that have for their students>, or that the curriculum has for their students. So, that they being held accountable for. (0.6) So, teachers are accountable to, you know, a curriculum, to the school principal, to parents, you know, to education authorities. Then, they need to see that there is a pathway <from teaching like this, to students learning the things> that they are there to be learning. That's really important. (0.5) And there's a whole other things that can been getting the way ((laugh)). So they (0.8) they need (0.9) they need to believe that they can manage <the students>, particularly if it involves students moving around. (0.8) So, knowing <how to manage students> when they not sitting at their desks. >It's easy to control students when are sitting at their desks<. (1.3) But it's completely different when they're moving around the classroom, it takes a different kind of ability to.. <to plan, to anticipate>,.. (0.8) Ehm..(0,7) And not just for the class as a whole, but individual students, and groups of students, and to be able to <open all those plans> on the run. (0.6) So, (0.9) there are sort of personal qualities that teachers need. But I think there are other things too, >and I know, you know, you're interested in what it is been helpful in implementing< but, what are also the constraints and limitations, I think those two things go hand-in-hand. So, (0.4) I find it helpful to talk about them together. Because (0.8), ehm, (0.7) what's that a limitation in one place could be something helpful in another place. And it's: <even within the one school, if you're working with teachers and a context looks the same, different teachers will interpret things in..(0.4) in different ways>. (1.3) But.. so things in the context. (0.6) So, (1.3) I mentioned the <school culture>, what is school culture? It can be things like: (1.1) <your colleagues in the school, other teachers>. (1.4) So, (0.8) <if this is not the normal way of teaching mathematics in the school, then that creates a culture of expectations> that can be difficult, it can make it difficult for a teacher to do something different. Especially if you're a new teacher, or inexperienced teacher, or.. (0.9) Wh..(0.6) what happens a lot in Australian secondary schools is that we don't have enough qualified mathematics teachers. And so, teachers who have been trained to teach other subjects, if I don't have a full timetable, >the principal might say< "Well, you can teach this maths class." So, if you are not even a qualified mathematics teachers, then you are not going to or want to do anything out of the ordinary.(1.4) Because you want to be part of- you want to be part of a professional group of maths teachers, and if you stand out as being different, that's not, (0.4) not an easy place to be for a teacher. (1.5) So, what your colleagues are like, can either <support you>, in if there is a very open culture of, you know, where we are happy to think of new ideas and try things that we think might be good for our students and that's beneficial, >if it's not that kind of culture, or the teacher believes it's not that kind of culture< than it had to do something different. I think the role of the principal, head of

	department, the leadership in the school is very important. Because that (09) establishes the culture about what is possible and what is not possible, and this is the way we do things in this school.
41	I: Are you referring also to the <not written rules>? Or something like this?
42	E4: Yes, exactly, <the non written rules>. So, when you are new to with school, it takesa while to work out what those rules are, >because they're not written down<. And you can end up doing something wrong ((laugh)), what we are knowing about. (1.5) And there is a sort of tangible things like- or maybe less tangible. (1.7) Ehm..(0.7) Time, the way in which- (0.6) particularly in a secondary school, <how is the school timetable structured>? And.. and this is being brought home to me after working in (0.7) in Ireland. In Irish secondary schools, the length of a lesson is no more than 35 minutes, (0.5) ever.
43	I: Ah!
44	E4: Whereas in Australia lessons that will often be longer than that, you can have double lessons.. (0.9) So, what does that mean at this if these types of activities often take more time (0.9) to set up and implement. If you've only got a timetable where lessons are quite short, then teachers might be reluctant to do that. Ehm..
45	I: it's not time-convenient to implement these activities.
46	E4: It's not. No. And they said no, no.
47	I: Not at all.
48	E4: I can't do this in, you know, less than 40 minutes lesson. Ehm, 'cause you know,> it takes 5 minutes to get them into the room, sitting down, listening, giving instructions, and you just do not have time<. And..(0.4) Some of this thing involves the use of materials, material resources. So, (0.8) the availability of those resources and the money to buy them can vary a lot from school to school.(0.8) So that is (1.5) schools are not equal (1.2) in the access to..ehm..(0.7) to money ,to be able to buy things. I once worked with the teacher in a very big High School in..(0.3) in a very poor area. And he was able to <borrow resources, beg for resources, make resources and>.. So, he and a lot of the people who are teaching maths were actually manual arts teachers, they taught woodwork and metalwork. So they were able to make things. And..(0.7) so, lack of money is not necessarily a constraint but it can be. So it's.. it's not
49	I: That is extra time that is requested to teachers that have to manage those kinds of things and it is too different to buy something and taking it from the school. It discouraged in a certain sense.
50	E4: That's right. And for some of this isn't anything to do with technology. (0.3) Ehm.. it's important to have some technical support and not all schools might have a person who does that job, just provide technical support. (0.8) Sometimes, particularly in the smaller schools, >it might be one of the teachers who also has to provide technical support<. And I know, we know, having done some work in this area around technology, (0.4) it can be very frustrating in a school if you've got, you know, a piece of <software>, that you want students to use, you have to get it installed on thenetwork, there is <firewalls>, you know, if the internet connection is <bad>, if there's a lot of frustrating things that can go wrong, where a teacher can than think " Ahhh..forget it it's just too hard. It's just too hard to do." (0.9) Ehm.. (1.6) and another thing that I know (0.5) teachers want to know is- (0.5) and like to see, they would love to see. (0.5) If before they try an activity, <they would like to know from another teacher "how it works">. So that, >it would be good if I could<, if I can see the activity being implemented by another

	teacher, when I'm in a professional development setting, <if the presenter is a fellow teacher>, who is showing an activity that I have used with real students and I can talk about, you know, "here is what I tried and this didn't work. So, I tried that, and this worked much better". That can be very powerful, but I think teachers tend to like <to see something demonstrated, before they would try themselves>. (0.9)And than ones- (0.7) What that provides is evidence that they can see with their own eyes, so they can see <how students could engaged with somethings>. (0.5) That seems to be something that..ehm.. (0.8) Motivates teachers to try..try an activity themselves. (0.5) And how to provide that is, can be, a challenge. Yes, you can simulate it in a professional development setting but they are not the real students, they are teachers.
51	I: Yeah, of course
52	E4: So that thing comes down to, again the culture of schools and how (0.6) <open a classroom> is and it comes down to <time and the timetable>. (0.9) So, how feasible is it for a teacher if I have a lesson, you know, a spare lesson, where they are not teaching?> Is it possible for them to go and watch another teacher?< (0.6) Is that a <normal kind of thing to do>!? Ehm..(0.6) I think Australian classrooms have become much more open (0,3) to that kind of practices, yeah, in the last 20 years or so. Whereas in Ireland, where I've been recently, (0.5) it does not happen.
53	I: Also in Italy, it's not common.
54	E4: Very interesting differences between countries. Yeah, and I think the things that I'm saying (0.5) would apply not just to the kind of activity you are talking about but anything that is new (0.3) for a teacher.
55	I: It could be that, with the emergency and the distance attending courses, now teachers are more linked, in a certain sense, because they are in an emergency and then they have to take the strengthen of the group, and they have to share some ideas because they have to react to an emergency situation. But I think before it doesn't happen (0.6) at all.
56	E4: No. So I think, even though the pandemic has been terrible, and I think it's caused <huge disruption to schooling around the world>, and, you know, that will only become evident in years to come, but I do think there have been some positive things. (0.4) We can take some positive things. (1.4) But the development of online interaction and resources, and (0.5) has just escalated amazingly, that's because empty [??]. So, I think, that's a lot of good things can come from that. (0.8) And, hopefully, that might encourage teachers to collaborate (0.3) some more and try different things. That here, at the moment, I think..(0.7) I think teachers are exhausted, (0.4) absolutely exhausted.
57	I: Of course, it is a terrible time for this kind of people because they have to change the way they work, all the time. It require a lot of extra work because they have to reinvent their practices
58	E4: Yeah, and the other interesting thing too is how it's impacted on teacher education. (0.7) So, when.. (0.3) when schools and universities closed down in Ireland in March last year, as student teachers were out in schools, on school placement. (0.6) And it was a year and a half before any kind of school experience could start up again for them. (0.9) <So, not only where>- no one has been on campus at the university since March last year, <so, not only have the university lecturers been trying to teach students how to teach, when we can only look at them on the screen, but those student teachers can't go into school<, (0.5) to do anything with human interaction, so there is still many layers of problems and difficulties, <there is incredibly challenging>. (1.2) I was talking to a colleague in Ireland this week, so, she has just gone out

	to visit some student teachers in school for the first time since March last year, and their student teachers has spent <the last two years learning online at university>, and they haven't been in school. And she said "you can see the difference"- And then now they are at their fourth year of a degree, so they're going to graduate soon,you know, in the middle of next year. And she said (0.7) you could tell that <they have not had enough practice in schools, in classrooms>. (0.7) She said you can see that they haven't been able to develop this skills, you know, what's.. what is this going to mean? I don't know.
59	I: But I hope, personally, that this kind of.. (0.9) this kind of (1.5) - The avoid for them to have the possibility to interact in a classroom and to have some kind of <feedback, also physical feedback, also gestures, communication> could also give them-(0.7) could highlight that this is important, when you are teaching that is important. And when you cannot do this kind of things, teaching is very very difficult. It could be, but it is very very difficult.
60	E4: Yes, that is why your topic is so important. Because, I think, human beings need to be close to each others and it's.. Zoom is wonderful, this has opened up so many new possibilities for collaborating with people who are not in the same place, it's.. it's fantastic! It's changed the way we work as university academics, it is. But I want real human interaction, to be able to.. you know, if you're teaching a lesson or giving a lecture or a talk, I want to be able to see people's faces and see them shift in their seats and it just makes you realise how much you depend on those kinds of physical signals, and how much you use that kind of physicality and gesture and touch and movement as as part of teaching.
61	I: Of course
62	E4: Just it.
63	I: I would really like to thank you for your time and this kind of interaction [laugh], only online.
64	E4: That's really interesting
65	I: It's a really interesting interview, thank you so much
66	E4: Thank you for your questions
67	I: I hope I could meet you in person, in the future. Of course, I will send you some emails with the progress of the search if you are interested in, because..
68	E4: That will be great. And I miss conferences, I miss face-to-face conferences because that's where you get to meet people and, yeah, you know them for the rest of your life. So I hope I get to meet you at a real conference in the world, somewhere.
69	I: I'm now a member of MERGA
70	E4: Of MERGA?! Ok, that's great. [laugh] Very good!
71	I: I hope to have the possibilities to present something in this summer, but I don't know if I can. But I hope and than now I'm subscribed, and after, by the end of January, I think about these things. If I can present something I would really like to be there.
72	E4: It would be wonderful, we love having people from other countries, and Ph.D. students coming to theMERGA. You will find the very welcoming community and.. so, Australia's borders are opening up now people, the government is starting to allow people to come in. So I'm sure that by the middle of next year people like yourself will be able to come. So that would be wonderful! I really hope you're able to come.

73	I: Thank you very much. So, have a good evening and thank you again
74	E4: Alright. Thanks Alessandra.
75	I: Bye. Thanks.
76	E4: Bye bye.

Expert 5

02/12/2021 (2:30 p.m. Brisbane | 4:30 a.m. Rome)

1	I: Good morning professor
2	E5: It tried to redirect me, wouldn't let me in and I have my dog here who, hopefully, won't come back and she wants to be recorded there.
3	I: Fantastic! So, thank you so much for being here, and it's a great pleasure for me to meet you even if only online.
4	E5: That's right.
5	I: Also because I'm in Italy.
6	E5: So, what time is it there for you?
7	I: The 4:30 am, so we are in the middle of the night.
8	E5: Oh, bad thing. Oh, Sorry about that.
9	I: No problem. I know that the distance is quite an issue when we work in different continents.
10	E5: Yes, yes. You look very awake. Ahaha.
11	I: Ahah. Thank you so much. So, ehm..(0.8) I want to briefly introduce you, present to you my Ph.D. project, so you can have an idea of the scenario in which your contribution is called to have an impact on my research. And (0.9) I start with the focus: (0.6) the main focus in my research project are the activities in which students are physically engaged, in an active way, for instance, <using manipulatives, or whole-body motion, and object, tools that could be both physical or virtual, but with great interactions of students>. And, in particular, I'm interested in what are the (0.9) teachers' perspectives on these activities, (0.6) also considering an overcoming about the different theoretical perspectives on these activities. So, it's particularly important to know what could be the experts' point of view, because experts, in particular the experts we have selected, are in the middle between the research word and the word of the school. So, it could be important to (0.6) focus on their point of view for this reason. So..(0.5) ehm.. (0.3) I have a first question that is about an internal issue of the research. (1.2) When I wanted to..(0.5) to design the survey for teachers, I encountered a first great problem, which is the problem of the terminology. (0.4) So, I want to..(0.5) I would like to, to ask you: what do you believe (0.3) could be a good terminology to speak with the teachers of those activities in a way that could be familiar for them and easily accessible? Also considering that I include teachers that are from primary and from secondary school. So, (0.3) thank you.
12	E5: So, like a question, well, it could be like: could you tell me, like, <"what real materials you use when you teach your students?"> (0.4) So, understanding that we might use the term manipulatives, but they might not know what they are. So, you could say, you know, what..(0.6) "What real material do you use? For example, do you use countables? Do you use.. (0.4) ehm… (0.3) materials that students can physically touch (0.5) and move about?". I guess, is that the sort of thing you are thinking?
13	I: Yes, but also I want to include the whole-body movement, like in a gym, for..
14	E5: Yeah, so, (0.6) So: "when you're taking-(0.4) when you're doing your maths lessons, do you give your students any opportunities when they can move around the room? (0.4) When they can become actively or physically involved in the mathematics?" And another interesting one is like, whether or not they do it, just as "Ok, we've been sitting there for 20-minutes, >let's everybody get up and stretch and do this<", or whether it's an actual <integral part> of their mass where they deliberately get down to work in groups and move around and whatever. So, like, you know, I could imagine that with little (0.4) you might say "ok, like now I want you to get into groups of pairs, so they will move around, so they are

	in groups of pairs. But now I want to get us in groups of eight, can you do that?" (0.8) So, yes, so that's a bit different to just stand up, you know, let's do five star jumps and then sit back down, yeah. So, that's fun but (0.5) just sort of interesting on that like. In a primary school near where I am, they're being numerate in the playground, so >if a child goes to the toilet they have to go like hopscotch thing and they have to count, they have to do that<. So, that is done in sort of the opposite way, that <brings math into movement>.[Laugh].
15	I: Of course. So, (0.4) do you believe that using some examples could be of any help for teachers? And, in particular, what kind of examples, in addition to the ones that you already said?
16	E5:Yeah, yeah. So, yeah, so I would begin openly, so that you don't leave them to think of things but, so if they haven't sort of said very much, they echo. So, for example, you know, "Do you make use of, like, uhm, (0.4) like dice and spinners if your teaching about chance and data? If you are teaching shapes, do you have the actual shapes or patterns blocks there for the students to play with? Do you use..ehm.. black", and you would talk about, like, virtual manipulatives as well, so: "Do you use a sort of..ehm.. Materials on the internet?" Like "Do you have websites that you go to when you don't have the materials that students could use or access (0.4) from the internet, or from the computer, if they don't have their own? Do you have- and I would ask the teachers to have- enough materials for everybody in the class?" Today, think about that. And I'll ask them: do they-(0.8) and if they don't have enough materials with that, then make them change the lesson? You know, so, that they might compromise what they are going to do because they'll think "oh, we haven't got enough pattern blocks for everybody in the class". (0.6) Yeah, I'll ask them "what, what would be the most, like, common one that they would use?" Because that would be interesting to see (0.4) secondary ones (unclear *08:50). And I'll ask them about what I call MIB blocks. So, they're like the Dienes blocs, with the tens 10, and the hundreds 100 split in the middle ones. (0.4) So, I'd say "Do you use those for teaching place value?" (0.5) So I probably would ask them some specific ones about that. Or I might ask or I might show them the MIB blocks and say "Are you familiar with these? Have you used these in your teaching? And in what way?" So, ehm (0.9) yeah, (1.2) I think they will probably need some exampl:es of what languages.. (1.2) Cards, maybe, like plain cards, that you might use to (0.7) playing cards games. (0.5) "Are there any particular maths games that you u:sed,(0.4) and you get children to u:se?" Yeah, I guess you could show them like an abacus, you can find it, >I never use it very much but, that might be something else<. So, that might be another way of doing it, like "How often do you use them? or "if you haven't used them, why not?"(0.8) Yeah, and "Do you think students should always have access to materials or are there things that you actually don't want them to use materials for? ((Laugh))
17	I: Of course, the level of interaction! Because a particular feature of this kind of activities is that teachers decide what kind of interaction students could have with the material. That could be to have one for a group, for a students for each group, (0.6) or also I, as a teacher, show you how to use something (0.4) and you don't touch this object.
18	E5: Yeah
19	I: It's another way to (0.8) approach.
20	E5: Yes
21	I: Go over, to the more conceptual part of the interview, I would like to ask you if you think whether it could be important to implement these kind of activities at shool,(0.9) and, if yes why? Or also, if not, (0.6) why?
22	E5: So do you mean " You think is important to use materials in the classrooms?
23	I: Yes
24	E5: Yeah, as in my personal opinion?
25	I: Yes, in your personal opinion
26	E5: Yes. Wel, I do think their use is of great importance because I believe it helps to facilitate <conceptual understanding>, so that they're not just doing things like following a recipe, or following a

	method, or following a process. >So, for instance if we were going to go back to the MIB materials<, if they show me, you know, that they could show me that's 365 and then they could subtract 298 from it, by doing regrouping and show me all that and then that would probably convince me that they had a good conceptual understanding of how that algorithm work, with all the regrouping and that goes on. Plus it get you a good opportunity to talk about the proper terminology and you don't say "Borrowing", and you don't say "Carrying, Carrying", you know, it's like regrouping: "we have enough to make a ten" in modern math language. But in something like, like another really good material I think is something like a fraction wall. So, do you know what I mean with a fraction wall, something like >we have one and then a half and a half, and then a quarter, a quarter, a quarter and a quarter<. (0.5) So that they think, you know, that they think they cannot speak of a quarter, because they're assuming that nine is bigger than four, because they don't have the concept of how is broken up, so fraction wall is a visual,(0.5) you know, it's in your face, you can argue that an half is bigger than a quarter if you're looking at a fraction. (0.6) So if you doing some things like that I really think that (0.9) there's a case for using (0.5) <the visuals as much as possible>. (0.7) And (0.6) like if you take another example, ehm..(1.7) some things are better for teaching some concept than others. (0.8) So, (0.3) they may be it's not appropriate to use those MIB Blocks to teach decimals, (0.4) because suddenly we are telling them that little one ((Mime to cluch a square between thumb and forefinger)). (1.2) It is like if you're going to do that, (0.3) you would have to chop that little one up into tens ((Move the index finger up and down while shifting in front of the cam)), because it was a one , and now, tomorrow you're telling me "Oh, we are gonna do the decimals and for doing the decimals the big block is the one ((show the palm of the right hand to the cam)), but yesterday it was a thousand!". (0.3) So, you need to be consistent and make sure that <the materials you cho:ose> are going facilitate the concept that you want to do. And so, for something like the decimals, you can use what we call Linear Arithmetic Blocks, which has only a linear part, divided up, and so, (0.4) here's the whole ((move the right hand from the right to the left side of the screen while keeping his index finger and thumb fixed to indicate a certain thickness)) and here's the tents ((ibidem)), here is the hundreds((ibidem)) and you claim that thousands ((move the hands up and down while keeping his index finger and thumb fixed to indicate a certain thickness, thiner than previous)). (0.4) So, that's more appropriate to have a different model of decimals, and then it extends the plus value from one, through. So, I think, (0.5) here I'm in Africa and we use and I use the term with my pre-service teachers called epistemic fidelity, which means that the materials got to actually teach what they're meant to teach. Yeah.
27	I: Yes, the transparency of the mathematical concepts behind the material
28	E5: Yes, very important. Informs Horses, it is another good example of that. So, (0.5) so when you're getting student, like in the early years, that they can line up the counters ((trace with the index finger several horizontal lines)) and then they can see that there I've got four and I need six more to make ten, so that they it's two lines ((trace with the index finger two horizontal lines)) of five and I can place the counters on the.. (0.8) It's not very helpful that you can place them all random, like if you can place them fill up the first line ((trace a line keeping a fized distance between the index finger and thumb)) and then you can start along the second line and say this is five and this is two ((trace with the index finger two horizontal lines)). So, if there's a way of using tools that makes sense, or <sense making>, ehm..(0.7) and it will help them making this connections. Yeah, so you can use materials for better. [((both laugh))]
29	I: I also..(0.6) I really agreed with it. I want to focus on the implementation because I believe it is too important. So, I want to (0.4) investigate this.[Expert 5: Yeah] (0.4). So, another thing that could be-(0.7)I could have good insights from you, because you are an expert of the effective teaching, and I believe it could be really good for me. What do you believe, in your opinion.. (0.4) what could be the beliefs that a teacher has to accompany when implementing this kind of activities at school? Not only beliefs,(0.5) but also, for instance, <knowledge, the awareness, the convintions- internal or external convictions>, about (0.6) what (0.7) this activity could be helpful for? (0.8) In your opinion, what beliefs should accompany this kind of activities in school?
30	E5: Yes, what I guess is first that they need to believe in the value of material, that it is gonna be helpful in facilitating their understanding. They have to believe that (1.2) developing a conceptual understanding is the ultimate goal and then they should want all students to do that. 'Cause if they don't really want them to understand, [but] they just want them to complete worksheets for them, >they might not see the

	value of the material<. (0.5) Ehmmm.. (0.9) And I think, you know, like secondary teachers, they need to see that it's <appropriate to use those materials> and not only in primary school or they're not only for babies for sure. (0.6) What I think is that, they actually have a valid (0.9) reason for using them. Then, you know, like this something, you know, particularly some of the interactive online materials, that actually have their knowledge and you can actually do the task without them, so like..- I'm thinking about like (0.6) simulations for instance, and tossing the dice a thousand times on (0.5) whatever. (0.4) There is value in, you know, like in the material being able to.. to be used for a purpose, to actually further student understanding that you couldn't easily achieve in the past. So, I guess, potential (0.6) for doing that. (0.4) And the things like Geogebra, like.. (0.4) >that I am not that familiar with< but I know that's another good programm for developing students' geometrical thinking that's not easily achievable unless you've got the technology. And inheadst a performance to be able to do it. (0.9) So, yeah, (0.7) I think, I think it does tie down to [the fact that].. probably we have to believe that there's a purpose sort, that they're not (0.7) compromising the learning or (0.6) that they are really focused on the conceptual understanding, and that is the goal that they [the teachers] should want for all students. Yeah.
31	I: Of course, and what kind of characteristics (0.7) could determine the effectiveness of these activities and of the implementation of these activities in classrooms, in your opinion?
32	E5: Well I guess, I mean, one which I hope doesn't happen but one would be that they just said the students who are not good at maths "use the materials", and they expect the more capable students- sounds awful as well- that they should "Oh no, you don't need to use those." [((laugh))] "I could do that without- carry on! -using the materials." (0.5) So, I guess that is the message to don't do that, you know, and they shoud be sort of inclusive, and that they don't see it's just like a <r:emedial type of strategy>, so that they see that there is <inherent v:alue> in and on themselves. (0.9) Not just to help students who might be having problems.
33	I: Of course, (0.7) and what do you believe could be the main limitation in using this kind of activities?
34	E5: Oh, well, the availability might be a limitation. So they're, you know, always sourcing, so, the school does not have the materials and it is gonna be a bit difficult to get access to materials, even if they believed that it was good and that they wanted to do it. And it (0.6) may be that, you know, >I guess maybe the students might compel a bit lot< the materials, so that might turn them up using them too because that's *splicking the joke* when they're playing with the Geoboards or flicking their rubber bands. (0.9) It might be, you know, like <management issues, I think, using materials>. Ehmm.. (0.9) Yeah, (1.2) they might not know how to use, so, for instance, someone might have told them about the <linear arithmetic blocks> but they really don't know they've never seen that models, and they don't really know (0.5) <how to use them>, or may, yeah, how to make use of them. Oh yes, so that may be another barrier, I think. I woulnd't mind use it, but what if I teach the wrong thing or what if I teach the (unclera *21:58). So yeah, that's probably about it.
35	I: And do you believe that there are factors that could hinder or foster the implementation in school of these activities?
36	E5: Oh, (1.5) I guess, you know, maybe (0.4) colleagues, for instance, like, you know, or the principal or there are someone on the leadership that might not see the value of doing that, so they might compromise. A set of parents, maybe, (0.5) may not see the value and why you're still doing that, you know, after the age of 6. So that might be infecting the model, (0.9) inhibited a bit. (0.7) I think having, you know, like, (0.6) pictures who were on the same way when did you life is you who may be collaboratively planned so that would do some consistent practices would be a better that would help to promote. It maybe, you know, some professional learning that was available for them around (0.7) <materials, the purpose of materials, ...> (0.8) and even in some professional reading. Some of their professional journeys. (0.7) And maybe it's all.
37	I: And do you believe that there are, in Australia, some references (0.7) to the use of concrete representations, or manipulatives, or whole body movement for students in curriculum resources? Some policies- educational policies or, in official professional development courses..- something that could be like policies, a written document and in which teachers are invited to use them in schools?

38	E5: I would say <not with the movement>, that exactly expressed like (0.9) I don't think this, you know, that's really in teachers' minds >other than that will likely keep them away from them get up and move something<. (0.4) I think really that there is a lot of roundabout that so, you have to know another (0.8) every new research that somebody could explore. But I do keep like think of it now, <the curricular document does not mention in specifically, and there are links to things like to moves around and links to (unclear *24:55) and so on but it has not actually stipulated that the child must be able to use a thin branch till the age of 16. (0,8) But it has like, some useful links to materials and resources like, you know, like pictures booknotes, that have need of resource to talk about the concepts. (0.4) And we have the Australian Association of Mathematics Teachers, which has a journal "Australian Mathematics Classrooms" and so, (0.5) often in that it could be, you know, like examples of what lessons have happened and it have pictures of children using ten-primes or seomething like base-ten blocks, that sort of things. So, it is not necessarily explicited but, (1.2) yeah, (0.6) I guess, (0.9) yeah, referred to a lot. And now, in professional learning that we got down with teachers it's -we talked about things like the 1 to 103. Clearly that was a big one, that was very popular that. Five years ago, or maybe 10 years ago, (0.5) the schools, would buy them laminate that every class have got this box ((draw a box in the air)) of maths materials, so that every classroom so it would have DAS, it would have counters, it would have 1 to 100 charts, it would have thin frames, it would have cards inside that. So that, (0.8) every class has this physical scales, (unsure: topdown *26:23) scales, calculators and so on. So, (0.5) that's quite nice and I don't know if some schools still do that, you know, putting their packs together this time of the year.
39	I: Do you believe are associated with inquiry-based learning, or some kind of active learning, the references to the movement, the picture of children that moves, and so on? What could be the common link with those kind of activities, in your opinion?
40	E5: I'm not so clear on that. (0.8) I think, (1.2) I think to me has a different meaning. Active Learning to me means that you actively engaged in the moment so we're actively engaged in the moment because >we are talking to each other, speaking to each other and all the rest are not going to moving around the line< but we are actively engaged. And inquiry, it's not the same to me, so, you know, you might be working in groups and you're investigating, you know, (0.5) a problem that you want to find the answer to, (0 that does not necessarily involve the movement, but it does mean that you will be active, because you're thinking, yeah, actively involved does not mean necessarily physically involved.
41	I: Of course. So, I believe I finish my questions. I don't have finished the questions that I would like to ask you but I believe it's enough for my research. And thank you so much for your time and your precious contribution. I I will inform you about the results of the research, if you want.
42	E5: Yeah, yeah. although I don't think I'm like, you know, so much of an expert but, hopefully it was a bit useful for you.
43	I: yeah, A lot. Thank you so much.
44	E5: No, thank you. You are going to the bed now?
45	I: Yeah, I I believe I will sleep some hours again.
46	E5: All right, nice to meet you.
47	I: Nice to meet you too and thank you kind help.
48	E5: That's all right. Thank you, bye.

Expert 6

02/12/2021 (5 p.m. Brisbane | 8 a.m. Rome)

1	E6: Hi
2	I: Hi, Good morning,
3	E6: Hi Alessandra, how are you?
4	I: Fine, thank you.
5	E6: It must be last time there, it is night time where you are.
6	I: Yes.
7	E6: Ok.
8	I: So, (0.7) nice to meet you, even if only online, and thank you so much for your collaboration and participation in my project. This is my PhD Project,
9	E6: For sure
10	I: I am an Italian Ph.D. student at the LUMSA university but we have a partnership with the ACU University and professor Geiger is my external supervisor. So, (0.4) If you want I briefly describe my project
11	E6: Sure
12	I: to go straight on..(0.5) on the topic
13	E6: Sure
14	I: So, in my project I focus on the role of perception and movement in the learning of mathematics, but particularly I'm interested in teachers' perspective on them.So, I want to investigate with a survey (0.4) the beliefs and practices of teachers about the involvement of perception and movement in active learning activities at school. And my- the participants are teachers from all school grades: primary, secondary and upper secondary, (0.4) no tertiary education.
15	E6: yeah
16	I: And for this reason I'm interested in the opinion of experts, both in Italy and in Australia, on the main question that underpinned the survey, (0.6) to catch their opinion of the conceptual framework of the researchers on these particular questions, that are key questions also in the questionnaire for teachers. And I want to have a glimpse on (0.8) the different point of view, the research point of view and also of the people who stay in the school. So, this is the point
17	E6: Sure. It sounds very interesting and it's an important topic.
18	I: Thank you so much. So, (0.5) the first questions are about- the first two are about an internal issue of the research, that is..(0.7) the one is about the terminology, because in research we use terms like <enactive learning, embodied learning activities>, but that are not commonly known- in Italy I know that are not commonly known in schools, and in teacher professional development courses. (0.8) So, it is not the right terminology to refer to the activity. So, I want to ask you what do you think would be the best terminology to identify these kinds of activities that are a big umbrella of activities
19	E6: That's a, that's a, I mean, it's a tricky question. I mean, <enactivism>, really was the theory that tried to bring the importance of the embodyment and the movement a kind of central stage. (0.5) I

	haven't actually used enactivism as a <theoretical framework a lot>, but I have used the term like in, in all of my work with young learners and the..(0.4) with kind about the sort of math story term activities that the young learners will do with their parents and then they really enact the story, so they got these little finger puppets ((Show and shake fingers)) and they re-enacted and they've got a blank story page, and they tell it and then they move the monkeys around ((Her fingers hop on the desk)) and they can play games of how many are hiding ((Show her open palms in front of the camera and then hides them behind his back)) and certainly the movement is seen as a key (0.9) <conceptual resource> ((Rotate the hand around her ear)),(0.6) <just like a number line> would be seen as a kind of <key conceptual representational resource>. (0.8) I think the (0.7) <picturing of movement>, or the..(0.6) For young kids, <being able to move>. So I think it's <the movement and the picturing of movement> ((draw in the air with her hands two arcs strarting from the head and going in front of the eyes)), so it's like..(0.9) a number line is a <representation> but in fact what the kids are doing when their representation become powerful is often <picturing the movement> on it. (0.5) And so, (0.6) I mean, (0.8) sometimes in my writing I've said the torrent <enact the story>, but yet I am not using the term enactivism as a straight framework. So, I think these terms about, (0.6) these terms like <enacting the concept, we>.. (1.4) For me,(1.0) for all of my work this kind of <sociocultural Vygotsky's kind of theory and language being centre> stage and a whole lot of the linguistic stuff, especially in the South African context, >where most of learners are learning in a second language<, I've kind of <seeing the gesturing ((rotate and shake her hands)) or the showing the movement of concepts>> ((draw waves in the air with her hands/ winden and narrow the space between the hands)), as key and important. And where are place that is.. (0.8) So, I think it is (unsure: Mostow? *07:11) who said (1.4) <"thinking is a boat on the sea of talk"" and (1.5) that we talk our way into reasoning>. (1.3) So, I think, in the same way that we talk <our way into reasoning>, (0.7) an aspect of that talk and communication, with each other or to ourself, is about <enacting, or gesturing>. (0.6) Someone's monkey jumped ((put the two index fingers next to each other horizontally, on her left side, and with one drawe an arc in the air ends in the same horizontal plane on the right side)) or even 27 plus 8 is 27 + 3 + 5 ((in the same way as above, show a sequence of arc corresponding to the movement for summing the number on an ideal number line)), (0.4) I could +3 + 5 ((ibidem, emphasizing the different lengh of the arcs corresponding to sum different numbers)). All of that is a communication whether to self or whether to others. (0.5) I see it as <an enacted or a gestured form of communication>. (0.4) So, I'm not sure one needs to go to the whole enactivism in order to,>but I'm not saying that's a, that's a framework that one doesn't have to go to<. I mean, it is a powerful framework, just for me, (0.8) I've a kind of.. (0.7) Felt comfortable in that kind of.. (0.5) ehm.. (0.6) it's probably quite a bit of freedom >with that kind of being in a broadly socio-cultural Vygoskjian and then you can pull from what you want to pull from<, without being in a box of enactivism. But certainly (0.6) >enacting (0.7) and gesturing are seen as a key part of talking your way into r:easoning> and I think (0.6) the younger you are, (0.5) the younger the learner are, (0.4) the more we need to encourage and help them to do that enacting physically (0.4) because later, as you get older, and you become (0.8) able to then internalize and then just picture it. So, for example, if I say to you 27 + 8, you might instinctively ((snap her fingers)) and very quickly put them into the number line >without even known you doing that<, but for younger learner they're actually need to firstly <se:e that number line, dr:awing the number line, p:icturing the jump, maybe even sh:owing the jumps ((show the arcs in the air))>, because if we help them do that, (0.8) then..(0.4) that representation will become more..(0.5) ehm..(0.4) will have more movement in their thinking, which I think is key. 'Cause these representations, we see them as a static representation, (0.7) then, in fact, if we work with learners in a way where they <enact or they gesture along with their thinking>, if we encourage that, we make it much more powerful
20	I: I agree with you, thank you. And you said about some example for the primary school, or lower level, but (0.5) do you think that it could be also useful to present this activity to teachers of secondary school, with some example?
21	E6: Definitely. So, I mean, the reason why I said are so important for young learners is that for young learners it is actually the key for those kind of basic concepts and developing number sense, and

	developing fluency with number. I don't think you can do any of it without some kind of. (0.5) But..(0.5) but, for the (0.9) kids in the <high school>, the minute they come across a <new idea, or a new concept>, (0.5) once again they are going to need to be going through, the sense of that movement. (0.5) So, whether it's a.. (0.7) whethere it's that, you know, sin graph grow like this ((draw in the air with the right hand the trace of sin, starting from the upper right angle of the screen)), cos graph grow ((with both hands draw the cos graph in the air starting from the upper angle on the opposite sides)) where the sin drop.. (0.7) if we.. (0.6) do you know what I mean?
22	I: Yes, of course.
23	E6: they would be opportunities for (0.9) using that, especially at the start of concepts. So, I am not saying you mustn't use them as one goes along but I think in order to.. (0.4) in order to have those key representations or key visual images as your powerful conceptual resources, >like a bunny to do anything with a sin graph, I'm looking at the first graph< and I'm doing other things with that, having that movement flow of it (0.6) I think enriches the way we hold the concept, to a static image.
24	I: Of course. And do you believe that in Australia there are some standard examples of activites in which the body, the movement of students are really important? I think about- in Italy the Montessori materials are really known, for instance.
25	E6: Sure
26	I: There is the Dienes blocks in, the base-ten blocks, also, are really used. And in Australia there are some examples that are standard and easily accessible for teachers?
27	E6: (0.9) So, you know, I'm from South Africa. [I: yes] (0.5) So, at the moment I'm still working in South Africa even though I'm now in Autralia. >So, I'm know a little about the Australian curriculum and that<. Certainly, in terms of the curriculum and where they send the lear-(0.4) they send the teachers to the sportel Scootle, do you know about Scootle? [I:No] So, it's- it's kind of, if you go to look the curriculum you will see these low Scootle links, so then you can click on that [I: Ah, ok] , and it will take you to.. (0.7) yeah, kind of different resources where the kids can manipulate stuff. And so a lot of that movement stuff (0.4) is supported also with digital technology, >so where they can be building with shapes or whatever<, where usually they would say "do it on.. on a board or a geo-board" now they are doing it, you know, on the computer. So, certainly there is, there's a lot of emphasis on.. (0.5) on that kind of <physical manipulation> with kids or.. and so, guessed, the resources in the class would have things like the Dienes blocks of the whatever with the kids would be <physically manipulating>, in order to get the concept. (0.8) I think in <South Africa>, (1.2) there will be a mention of the Dienes blocks or the flight odds, or the number line, (0.4) but the focus on (0.9)- I don't think there will be as much movement envisaged or acted up by teachers. (0.4) I think the representations would like to be the <teachers showing> the representation and the movement as opposed to the kids doing it a lot, and that possibly because there's limited resources or basicly (0.9) the organisation of bigger classes to have each kid manipulating. (0.7) It would be least. So I think that is more of a carry out in Australia then in South Africa. But certainly in terms of the early childhood (0.7) stuff across the globe, there's a lot in the early childhood and in the foundation phase, even though math is often just lift off secret, other than in Montessori, the math (unsure: tends *16:25) to be. (0.9) But, certainly, all the other stuff is all about movement. (0.4) So we in fact enact project that works with early childhood grades reception year one and two, we bought a lot of <the movement staff in, explicitly into numeracy activities>, so that the teachers could see that the same arguments about the kids need to do the nursery rhytmes, (0.5) they need to act out, it is something you're also doing in maths, it's not that you do all of that in your curriculum and then now, (0.8) "now we are doing maths and now we just count the stones", are we? No. (0.7) So we're going to play "Wolfie Wolf what's the time", and the kids are going to count up the steps, (0.4) or we're going to re-enact the story or we're going to do that how many are-project, and we gonna have the physical, with the stones, for the combination ((put an hand behind the back and after show the palm in front of the camera, and than come back)). So, you know,

	how many are having the five finger puppets of the monkey story, and then I'll show you the five ((show the palm of the right hand to the camera)), is it the 5 monkeys? and then I say ((put the hands behind the back)) “Ok, behind my back, I shuffled and may I show you 3 ((show the palm of the right hands to the camera while the left hands is clenched)) , how many are hiding?”. All of.. (0.8) all of that physical the kids doing it, it is getting a more powerful understanding of the two part, >part part whole<, etcetera. (0.7) Do you know what I mean?
28	I: yeah yeah yeah. Of course
29	E6: And so we.. (0.9) You know, (0.8) In my work I was quite conscious of how important that kind of <movement and enaction and embodied kind of conceptualization is for those young learners>. And yet the math curriculum often just wasn't doing any in that way and so I've tried to work to bring those activities in order, you know, enacting the, you know, that is the camel with ten humps ((show to the camera the hands open)) that is the camel with nine humps ((put down the little finger and show hands with 9 fingers raised)) trying to get the (0.9) link with the action.
30	I: Of course. So, if you wanted to summarise, to recap: what are the main reasons why is important to promote and implement this kind of activity in school for learning mathematics?
31	E6: So, I think, I mean..(0.8)< for me> (1.5) >and I remember my mum always saying this<, if you put my hands behind my back I cannot communicate ((put the hands behind her back)). (1.5) If I have to communicate with you, you can get what I am saying if you look at the gestures constantly, ok. And..(0.9) what's his name, who was the president of.. (1.5) Ferdinando Arzarello, (0.8) I’m in the same committee with him, for 4 years, at ICMI
32	I: From Turin
33	E6: Yes, ok. He said to me he has never seen anybody who gestures as much as I do. So, (0.9) to me gesturing is..(0.5) is <how I communicate>. It's a key part of how I communicate. And I think that that it is an incredibly powerful part of how I'm able to communicate well with learners (0.9) or others in general, that kind of.. (1.4) yeah, allows me sometimes to save myself apart from others, in terms of >how quickly am I able to get the learner to get a concept<. And I remember talking, I think it was at a PME conference, about how I've been into classrooms where all of the learners are speaking Xhosa of the teacher is speaking Xhosa, I cannot speak Xhosa, and I’ve set down with the learners and I’ve help them. And it is all being through gesturing. (0.9) So, I’ve communicated with them, I’ve been speaking in English, they’ve been saying what they think I’m saying in Xhosa, we are assuming we are saying the same things because we're both gesturing and we're both <moving on paper and we're both pointing>. And so, I've always said, how may I able to that? Because we cannot speak in the same language, >very little words are overlap other than the numbers<. Ok, which overlap. And so, (1.5) to me, (2.1) the reason is it's a <key form of communication that we haven't exploited in fact sufficiently in education>. I don't think, I think (0.9) I think we all argue language is key, (0.4) and when we think language we think words, and then all people there were talking about gesturing, (0.8) like.. Ferdinando Arzarello and a whole lot of them are increasingly talking about gesturing (0.4) but I don't think we’ve done enough research on it, I think some of that is about how difficult that is.. (0.3) to transcribe. If you tried to now transcribed this interview without my gestures, that will be incredibly hard and time consuming. (2.3) And where I do my pointing matters incredibly is significant and how you capture that, because.. (0.4) So.. (1.8) so (2.3) yeah, I think it's a key and under recognized in terms of its <critical value> and that's not to say that you can't do all the learning without gesturing, (0.9) a lot of teachers gesture very little, and then show well on the board, a lot of people can communicate with their hands behind the back, no problem. Ok? (0.8) For me, (1.5) it's enhance very very powerfully and the process of teaching and learning, for me, happens <much quicker and more.. (1.8) more deeply>, I think, rather than speed. Happens <more deeply (0.7) with the movement and the gestures and enacting>. And I think we to almost reclaim this word enact, without having to use enactivism, as a theory. Because it's a keyword of what we are doing, we are enacting or re-enacting or..(0.8) you know? Ya

34	I: yeah, it could be a right word to be used, yeah. Thank you. But, I want to know- you believe that gestures, well, they are not so much studied and we are not so aware of these aspects in all the education. But this is something special in mathematics education that request the use of body and movement, from teachers but also from students? Particularly for mathematics education? What do you believe about this fact?
35	E6: yes, for sure. I mean, I would think that (0.9) for math education it is. (2.3) Probably more important than say in <history education> or.. (0.9) Because <the concepts move>, so the concept of part part whole has inner movement, (0.8) the concept of a number line, or an empty number line has inner movement, (0.7) the Dienes blocks have movement. (1.4) The <mathematical concepts move>, they.. (0.8) yeah. They not..(0.5) I mean, an image may be static at some point but.. like I have always used to say the teachers "I don't like overhead projector and pre-prepared exercise" and I think one of the risks of technology education is that some teachers are starting to use PowerPoint presentations to..(0.9) to show learners or to teach something, (0.8) ok? And in fact we used that (unclear *25:50) down some national training in South Africa, where we are doing, you know, we trying to move kids on from this one to one unit correspondence of counting when we say 27 + 36 and they start doing that. So we are showing teachers to use the number line, (0.9) but we insisted in those slides because we had these slides, (0.6) because we will working with, you know, educators across the country and we kind of needed it to be relatively polished, or not scribbling on a thing. We make< sure that everything came up as a movement, not as a lock>: there it is and you can see that there was a jump, >and then there was the jump at the study ((draw an arc in the air)), and then there was the bridging treatment ((draw an arc in the air)), and then there was..((draw an arc in the air)) < No. <"Here i:s the number line">((trace an imaginary line between her hands)), <"we stop and d:oing this">((put the right hand vertically in the middle of the imaginary number line)). Then "where's the nearest ten?"((show with the left hand and arc starting from the vertical right hand)), so to get to that and then where we could jump to thirty ((show bigger and bigger arcs starting from the vertical right hands)), "ok jump." So, where people have had these kind of pre-presented slide shows I've always said "it's so dangerous for learners, because they only see the end product, <they don't see the movement, they don't see the thinking process with the movement, of how each bit of that representation ((show little arcs in the airs)) moves ((rotate the hands backwards)) as the concept developing". (1.3) Whereas you possibly could up.. (0.7) probably science needs the movement as well, but I would.. (0.3) I would expect that you might be able to put up a whole (unclear *27:38), you know, some kind of.. I don't know, I don't' know, I can't really, I'm not experted in other subjects, so I can't claim more or least than in other subjects but, certainly, in relation to the conceptual understanding of mathematical concepts, a movement understanding is critical, and an understanding that goes with the process and movement. And I mean the idea of the processes, you know, widely accepted, and so that's where I see the movement as, (1.5) or a gesturing or (0.9) enacting as key.
36	I: Of course, the movement is embedded in mathematics concepts, so. (0.9) I also think that this is (1.4) a key point. So, another question: what do you believe are the beliefs that should guide teachers when they implement activities in which students are engaged? Are there (0.6) something in particular they have to be aware of, or some particular knowledge that they have to have got, (0.5) or some considerations, or particular belief that it's important that comes with the implementation of these kind of activities in classroom?
37	E6: I mean, I think that they would need to have an understanding, a kind of <general (1.5) constructivist, (1.0) social-constructivist understanding of learners needing to actively construct the knowledge themselves>. I think that will be key, and I think <a br:oad kind of view of that kind of theory of the language> and we talk away into reasoning. Those kind of beliefs of language and then <a br:oader view of what it means to communicate with language>. I would think that those beliefs would be important. So if I am selling something with a kind of behaviourist droven practic "I can just show, I can put up that over head and I can say: Look this is a number line, can you see that is how it worked.

	Ok, now do". Ok, yeah, (0.8) I think then is gonna collapse (0.8) or it's not gonna be, (1.8) yeah.. (1.9)not gonna, yeah. So I would think that those kind of of broad, broad beliefs within they can't.
38	I: Ok, yeah. Of course. And about the characteristics that concern the implementation of these activities that are particularly important to the effectiveness of these activities, (0.9) do you believe there are some characteristics in particular, or broad characteristics that are important, for implementing in school?
39	E6: I'm not sure, but probably.. (1.5) probably developing some kind of understanding of.. (3.0) of <h:ands has been key>. Ehm.. (0.9) largely because these are the most available, and also because they are the easiest to enact <the wh:ole class>, and in their chairs etcetera. So, I think if we got.. I think I've seen sessions where it's like " Ok, movement is important. I need to get the kids moving, now we are going to go outside, now we are going to enact" and everybody moves and.. and maybe they jump, jump in the number line, and then jump up on the ground.. I'm not saying that they not use less activity, ok? Absolutely useful. To organise that activities and <logistical enacting>, the teachers aren't gonna do too often. So today they feeling like >"Ok, I've energy for many gymming kids going to running around, going crazy, screaming, shouting, jumping around, jumping the number line, on the ground, yehy!"< They can do it, ok? Now, >I have one of my masters and my PhD students did it recently where these animals jumps across the river ((draw in the air the jump with the left hands))<, she's integrating music and mathematics and she's got them jumping on a number line and the videos are beautiful. So ok, (0.9) great. (0.9) But I think we need to get the teachers to understand that they don't need to do that. They can do it? Lov:ely. They want do it? Lovely, but in fact the simple things of getting the kids to say "Ok, show me. Yes, show the number line. ((With the fixed index fingers pointing up, show a distance in between)) Ok. How is the animal.. how's the giraffe jumping? The giraffe jumping wooooooooow! ((the right index fingers is fixed and the left index finger show a big arc starting from the right index to the extreme left)) Ok, let's see. Now the monkey: wo wo wo wo wo. ((the right index fingers is fixed and the left index finger show a sequence of little arcs moving horizontally from the right index to the extreme left)) Now the elephant: woooo woooo.((the right index fingers is fixed and the left index finger show a sequence of middle size arcs moving horizontally from the right index to the extreme left))" Just this is powerful, ok. (0.9) So, I think what we need to do is we need to keep it simple, because if you start to.. (0.7) if you start it integrated in such a way, then it becomes a your whole class needs to be <moving around physically, running around, etcetera etcetera> teachers just are not gonna do it. Or they're going to do it on a <Fr:iday>, or they can do it on <the l:ast day of term>, when the kids are manic anyway and near finished their curricula. (0.7) Ok, I think we need to build it into where, we can sit and we can say to all the kids there, "all of you now do the jump". (1.2) And I also think that if we use the <hands, everybody can be involved>, in a way that in fact you can't be sometimes with resources. So, I mean, like the simple thing we use this thing, where the kids say.. say you asked him you know, 26 + 35, and then we said at them "Ok, don't you do those, 'cause that distracting, don't shout: I've got it, I've got it, I've got it, shout up your answer. Just do this" and I know you've got it and through this, it isn't distracting anybody else, but it's communicating. It's very simple
40	I: Nice
41	E6: but it became very very powerful, because <they're in this space> ((move her arms horizontally)). And so, I think a trick will be keep it.. keep it relatively simple and focused on what all learners have in their sitting space, as opposed to we need to be having the space in the classroom where all the kids can be<j:umping>, or all the kids can be <d:ancing> or all the kids can be..(0.8) Do that, absolutely, but that is not the focus.
42	I: Yes, we could do with simpler movement, with simple environment, it is beautiful, it could be great and super but it's also good if it could be the simple thing that you have to do, but the point is that you have to move, it is not the perfect world where we can do all the things we want.

43	E6: And I think the other thing you said, we need to try to get all learners in the class moving, so just like with language, when you are doing whole class teaching and you're asking and one learner is answering at the time, it can be very ((move the left arm up and down)) It can be quite limiting for all the other learners who are just listening. Ok, I need to think, need to find a movement with the kids are enacting themselves ((move hands and fingers)) and all are acting ((open and close hands with the palm in her direction)), all are moving their fingers ((streatch the hands with the palms in the direction of the cam)), as opposed to one is communicating and the others are watching ((Move the index finger of her right hand between the webcam and herself)). So, (1.6) yeah. And so would be kind of managing, enacting that we need to be thought about pedagogically.
44	I: yes, of course. (1.4) And do you think that are.. there any limitations to the implementation of this activity, to the use of the movement? That could be some.. (0.7) something that you have to be aware of (0.7) as a limitation of this kind of approach?
45	E6: I can't see any limitations. (1.2) I think it would be <dangerous, if messages are mis-interpreted>. I will give you an example: when we had our first post to partake curriculum and it was <all outcomes based education, all about learners have c:oncr:etely discover every concept for themselves> ((knock on the table to accompany her words)), and they must do that at their own pace, and so learners just had hundreds of blocks and would just be counting them, when one moving the blocks around ((the left hand is fixed and the right hand from the left one draw direction towards the right side) then and.. (0.7) and, suddenly, that became fun, because the learners are touching the blocks, and they were moving the blocks ((ibidem)), and the fact that, by grade three that was still counting 97 blocks like those, instead of going 10, 20, 30 or 20, 40, 60, 80 and another 3 ((move up and down their hands, one for time)). (0.6)The fact that they never moved on to that didn't matter, (0.5) because the learners had to do it <con-cre-te-ly> and show they are working <con-cre-te-ly> and s:o (1.2), in fact our mathematical numbers is going backwards, because in fact a message was so badly communicated. (0.4) And so, there is a danger that if one communicate that, (0.3) you know, <movement and enacting is key>, and teacher see that as <enacting a story> way each learner has to represent number or we have to have the number line on the floor and the learners have to actually <move and j:ump on the number line> as opposed to they can just say "Jump, jump" when showing on it ((repeat the movement of little arcs drawing in the air)), I think that we run the risk of..(1.9) yeah- people eventually said "ok, but let them work". Because, in fact, in the case of an activity like that, learners are taking much more aware from the activity then, (0.9) well, simple cutting line and simple stood on my toe, and >when he jumped, he bumped me over< and, you know, when Mark is told to jump, "that's not fair", "I haven't jumped yet", "why did he get three jumps and I've only got one jump" and it's going to be all about something else. So, (1.4) yeah, so I think there's a danger there, (0.7) but just..(1.6) just like, you know, just like there's no downside to our understanding of <language being the key conceptual resource> and that, we talk our way to reasoning, language is the key to our reasoning, both to a ourselves and inter-thinking, inter-communication. It is not d:angerous, to that. I can't see there being any d:angers to the.. (1.3) to the ideas that does needs to be brought into stage but there would definitely be dangers in.. (0.4) in the way in which curriculum activities, or even textbook activities might interpret and take it up, and then it becomes something else.
46	I: Of course, and the last question is about the possible hinder or foster factors that could promote the use of these activities in schools. Do you believe that there are specific hinder factors that limit the use at school, (1.2) or something that foster the use of it at school?
47	E6: Ya
48	I: About students, about teachers, about the structure, the environment, the curriculum.. I don't know.
49	E6: I mean, in terms of curriculum and key resources and key representations and stuff like that, certainly your kind of teacher knowledge or access to Dienes blocks, so access to >teaching knowledge about the number line, teaching knowledge about empty number line<. And I say those because

	teachers in South Africa often use the empty number line, you know, most students find it normal resistence to the empty number line, because number lines are things where you do everything in once ((show sequence of little arcs on the imaginary number line)), and you do all those little things, you know, and so, you know, <teacher knowledge and pedagogical content knowledge is going to be key ((knock on the table to emphasize the discourse)) in terms of enacting things in a meaningful way. If you don't have that, you know, conceptual knowledge, teachers don't have, they aren't gonna enact it. So, yeah, you know, so, if we want them to be doing <enacting on physical resources>, we gonna need to have those physical resources, that Dienes blocks etcetera, and we gonna need to have per [each] student. So <limited physical resources> will limit that, and teacher knowledge would limit the way in which they could bring <appropriate actions into the teaching space>. But I think, in terms of the power of these arms ((move the arms)), these hands ((shake hands)) and these fingers having 10 (move the fingers)), I think is.. I think is little limitations. I think the possibilities and the potentials of handless, in terms of what we can do with just..((great movement of the arms))
50	I: the bodies
51	E6: ..these, just these. Sitting on the chairs and stalling, 'cause so many teachers do feel they need to maintain their <classro:om order>. When kids start running around out of their chairs they do that, they bump each other, becomes about who's bumping into each other and, you know, >in many South African classroom you're not going to be able to get up and walk, in fact, you know, kids need to move the best in order to be able to get out the class, because they're so jam-packed<, ok. So, I think the potential, in terms of just using the space ((move the harms around herslef)) is enormous.
52	I: Ok, perfect.
53	E6: Thank you.
54	I: It's a pleasure to speak with you about this topic that it's something really important for me, and I am really happy to catch you're insights that are really interesting for me and something that is quite different from my point of view, (0.7) in my environment, that is culturally different. (0.8) In Italy we use a lot of gestures, for instance, but (0.8) not in mathematics.
55	E6: Interesting, (0.5) very interesting. (1.4) That is not in mathematics is an interesting thing, because it is exactly what I had with early grades, so all of the teachers are >"Oh, we use movement, we use movement."< Not in mathematics. >"Oh we use sign, we sing,.."< Not in mathematics. >" Lalalalla"< Not in mathematics.
56	I: Yeah, of course.
57	E6: And so that, I mean, that would be a nice title, even for a paper. You know?! Not in mathematics
58	I: [Laugh] Yes
59	E6: That, yes, yes: but not in mathematics. Very nice, very nice topic. And I was thinking as we are talking, and you must think about with getting.. (0.7) You going to be interviewing other so-called experts, or whatever, in the field, it would make very nice if I read in a paper. The basis of these interviews would make a very nice conversational piece for a FLM in paper. So I was one of the Editors of FLM, I'm now an editoral board of whatever, but if the underline your keen, we could look to doing, we could look to put inside some of the of the conversational interview stuff as an FLM conversation, and I actually think it would work very nice, because FLM is all about, you know, enturing dialog and conversation. It's very different from other journals, so it could be something that you could publish as you going along now, (0.6) in terms of speaking to the different people, and we could have a little.. Yeah, I mean make very nice conversation. So, think about it when you've got your others, and come back to me, and I put them to the.. to the editors
60	I: Oh, thank you so much

61	E6: Yeah
62	I: You are so kind.
63	E6: It’s a pleasure, I look forward to, yeah, follow-up your research and come back to me and let me know how it is going.
64	I: I will inform you of the discoveries and other steps.
65	E6: yeah. And write to me if there is anything you need.
66	I: Thank you so much, having a good day and again, thank you.
67	E6: Thank you, it is an absolute pleasure. Ok, thanks, bye.
68	I: Bye.

TRANSCRIPTS OF TEACHERS'INTERVIEWS

Teacher G

12/04/2022

[...]

G: Well I'm in Canberra, in Australia, and, um the school I'm at is a Senior Secondary College which means only the last two years of school. [I: yeah] So I don't, so I haven't taught the younger students for a long time, because I've been at the school for 12 years (0.8) and um, yeah, so so Year 11 and 12 is the last 2 years of school here. (0.9) [I: and] And I can't remember the other question?

I: ((laugh)) What, what, what kind of school context is (0.5) [like]

G: [It's a Government], a government, a government school. Or a public school they're called here.

I: [And..]

G: [So we] have students from everywhere. We don't are not selective.

I: No, no, no, no, no. Perfect. And (0.6) umm (0.6) A question to break the ice. What is in a sentence, or in a word, Mathematics for you?

G: (1.4) It's umm, (2) difficult to say actually. [I: mmhm] It's just a way of explaining, a way of explaining or describing the world. The physical world.

((laugh)) [both]

I: Yeah, yeah, yeah – the real world

G: Not the psychological world

I: Thank you. So umm now I want to ask you some feelings about the questionnaire. In particular (0.3) the questionnaire is about the active, bodily experience learning activities. And what do you think about this topic of the questionnaire: seems familiar or far removed from your context?

G: I think it's umm, in Australia anyway, I think it gets used a lot ((laugh)), particularly in the (0.5) younger age groups. I mean, for example, I can remember when I was teaching the younger age groups, that when we have, aah, we have a horse race in Australia, the <Melbourne Cup>, where umm it gets Australia wide interest and so I used to always try and do probability around that time, and teach students about the odds in horse racing. And I would get them to bet using Smarties for mon-… like ah ah like small lolli-…, small sweets for money. And I would supply the sweets, and then they could then either win or lose more by <betting on the race>. And, ah, that, and so that was one thing. We also used to do things like measure up the right angle with a, with a rope, umm, look at fractions with chocolate bars [I: yes] ahh things like that. That was with the younger age groups. So it's been, it's been part of umm edu… Mathematics in Australia for a long time. Because I wasn't the only teacher who did that sort of thing.

I: And it involves also, mmm, digital technology or something like this?

G: Umm. Not when I started it didn't involve, it … because digital tech … because I've been teaching for, umm, let's see, umm <38 years>. So there wasn't much digital technology at the start. [[laugh]]

I: Yeah, of course.

G: But now there's much more digital technology, so, especially online. Online tools like Desmos – have you used Desmos as a graphic tool?

I: No.

G: It also does, umm, probability [I: for geometric..] and… and a whole range of things

I: Is it for Geometry?

G: No, no, no, it drives functions.

I: aah

G: It will also umm, umm, do probability, aah you can program it if you – I'm not, >I'm not programming, I'm not a programmer<, but you can programme it to do, to have umm, umm, activities which are sort of preprogrammed and the students just have to either watch or change a variable to see what happens. Animations. It does animations.

I: Yeah (1.4). Fine (1.5). And, so (1.8). Asking in particular on the questions that are in the, in the, in the questionnaire. Did you find [G: mhmm] them relevant or you notice some inconsistencies or something that you do not expect to find in it?

G: Umm, aah, I don't really remember all of the questions but, umm, [I: (unclear *4.47*)] I think umm, umm, what I was, >what I was wondering about was the< way the (1.0) the description of the project is about. (1.0) A sort of involvement of the body but it seemed like umm, it was, it seemed like it encompassed more than (1.2) – I was picturing that it would be umm (1.0) activities with the, like the whole body, but it seems like, it seems like it encompasses all sorts of activities where you are using something other than <just pencil and paper>.

I: (1.5) Of course. And (1.0) do you believe that some important aspects here are not taken into consideration? What is your feeling about it?

G: Umm – I think the umm the use of physical activities can help with understanding (1.0) of concepts. Last year we did a umm experiment where >students were given a recipe to bake< small cakes (2.0) and then, umm, we weighed all of the cakes, and looked at the average weight and, ah ,standard deviation ((laugh)) – sorry, we looked at – every student weighed their own cakes first. So we had sort of a whole lot of means. So then we could look at the <central limit theorem> for that, for the mean of all the cakes because they all followed the same recipe, used the same, made the same sized cakes or close to the same size.

I: Nice

G: And I think that helped with understanding the idea of the central limit theorem a bit more.

I: And why do you believe that is particularly important for learning mathematics to involve the body and the movement of students?

G: Well, for that particular experiment, umm, it's a very umm theoretical concept – the central limit theorem – the idea of taking samples and (1.0) and, umm, finding that the means of the samples are umm, umm, like cluster around the mean of the population. And umm, we've done electronic versions of that before with spreadsheets, and I don't think just working with the spreadsheet and taking samples from a column of data is the same as having the physical objects in front of you and using a weighing pan umm to to to get the mass in in in <tenths of a gram> and so on has the same, has the same impact on the students, yeah.

I: It's like something that is (1.0) memorable? For instance, [G: yeah], or it's simply a thing of engagement?

G: I think it's, aah, both of those things. I think it, it does engage the students because, umm almost all of the students participated. I mean some, there's always some students where if you ask them to do something at home and bring it to school, that won't participate. But almost all of the students in the class that I'm thinking of participated. So, I think it did engage them and they had a curiosity about what they were going to get from it.

I: Mm. (2.0) Yes.

G: And I think they will remember it as well. They'll remember it when they leave school that they did those sorts of things.

I: And (2.0) Do you think ah they they – you could reach aah mmm a better results also in the formative outcomes?

G: Uum. I don't, we didn't do the – we don't have the statistics – it was like for that particular experiment, or for any of the ones we've done, we've never really looked at it as a research aah idea, so we never have umm, a umm, umm, like a control and another group to compare.

I: Of course. But what's your feeling about it ((laugh))?

G: Ah, oh, my feeling about it was that it does make a difference to the students' understanding of things. That, umm, that umm – that, umm, there's not so many stud-, like, you have the big group of students and I think, if I can try and get my hands in the picture, and I think maybe only this many can do it from an abstract point of view, but many more can do it from, if you have the concrete illustrations as well.

I: Yeah, yeah, yeah. A concrete experience of it. [G: mmm] And what about the, umm, the difficulties that you. did you experience when carry out this kind of activities?

G: Umm mostly it's about preparation. I mean if you, if you just come in and say "we're going to do an activity" and there's no preparation in advance, then the students umm take a while to, to work out what's happening. So, it's important to make it part of (1.2) a series of lessons, not just the, not just the one lesson where it's a surprise. Umm so that they know what's happ-, they know what's coming out and they have an idea of what their, what their going to look like, what they're going to be looking at, so that they have some – >even if they don't understand exactly what's going to happen they have some< mental preparation for what's gonna occur.

I: Yeah, of course. And, and, do you, umm, encounter (.9) some particular difficulties experienced by students during this activity?

G: Umm (3.0). Well, some students umm are more efficient than other ones. When you involve, aah, something other than the math, the text book and the, and the paper, umm, some students are not very practical [I & G: laugh] so anything that involves having to do something practical is, umm, is for some students, not easy for them to come to. But most of them find it interesting enough to participate. There's very – I've never found people who really want to sit out and say "<this doesn't help me.> (1.0) So I don't want to be part of it."

I: And do you, do <you> find some strategies to overcome these difficulties, this [2.0] aah, initial, umm, practical difficulties of some students?

G: Well, only, only the same sorts of strategies that we normally use. I mean, we're not, (1.4) at the school I'm at, we're not "sit in the front" and the students do the work and they come out if they have a problem. We, umm, we get arou-, like the students are in groups, normally, and we get around to every group, and, and ah assess how umm, what difficulties they're having and offer, and offer help. So we try and be proactive in that area.

I: And do you scaffold during <the>, <the> the activity, when they are carrying out the activity?

G: Yeah, (although *11.52*). Yeah, if there's not an existing worksheet we'll construct a worksheet which has, like, the steps involved. So students, umm, can, can refer back if they've not listened ((laugh)), or, umm, or don't know what the next step is and don't want to ask right away, because I'm busy somewhere else. So, umm, umm, it involves a bit of preparation, but umm you have to prepare for all of your classes really, so – because every class, even if you're teaching the same, like in – we have the same Mathematics course in my school that we've had for (1.0) 9 years. So, even though we teach the same course every year, ah, people still alter their preparation every year because they, they're constantly looking at ways to make things better the next time through.

I: Yeah, [G: so um] to adapt to the different group you …

G: And the groups are different each year as well, so what worked last year maybe doesn't work so well this year.

I: Yeah, of course.

G: Or needs to work a little differently ((laugh)) this year.

I: Of course. And umm, some, some teachers could could could feel umm they fail the first time that try to implement this kind of activity, but..

G: Yeah

I: But what do you believe could be the main reason of a failure when you implement this kind of activity?

G: Umm – I think it's mostly come, like (1.0) it's not to do with the activity, it comes back to <the teacher and the students>. I mean, if you had difficulty, umm, in an ordinary lesson with the students, then you'll have difficulty, maybe more difficulty, with the lesson which involves umm, umm movement and a little bit <less control> of exactly what's, what's happening. So, I mean, the number one thing always is the relationship of the teacher with the student to make things work the best.

I: Of course. And do you believe that are some important things that the teacher have to observe or to do during this kind of activity. Something that …

G: Well, umm (2.0), well first thing is that we don't – these sorts of activities are not, umm, for assessment usually. I mean, we don't, we don't usually use those sorts of activities for assessment tasks. Because we have to be sure in an assessment task that <we're> assessing <the> the goals, the unit goals that we want to assess and not, not assessing people's practical ability, because it's not part of the course. So, umm, so we don't have, so, so there's not that, umm, layer to look at. But, umm, what we do want is we want it to be successful ((laugh)) so the main thing we look at is umm, is whether people are engaged or not. So, I mean like we, like what we would do normally in a class when we've set work for people to do. We want to see that they're engaged, we want to see that they're making a success of what of what they've been set.

I: Nothing different? ((laugh))

G: No. Not really, I think it's it would be the same in Italy.

I: Yeah, yeah. And how, how, how are you umm fit this activity into the curriculum? You, if …

G: Well, we umm, we have a curriculum, but then with the curriculum we write what's called a program of learning. And the program of learning is really just what we're going to do every week for the whole seme-, for a semester. And so these things are planned in advance. They're not ad hoc ideas that we just think "that's a good idea" ((laugh)) because I read it yesterday ((both laugh)). We plan these things in advance and we use things that we know have been successful before, and if we have a new idea, we get someone to try it out first before we write it into a program of learning. So we try and do, umm, we try and do what would be called in business ah, "due diligence", before we include something like that.

I: Yeah. And what convinced you to propose this activity in your classroom?

G: Well, umm, often it would be, umm, professional learning ah, that we go to. So, in Australia we have, umm, and I think Vince is part of this, is a member of the <Australian Association of Mathematics Teachers> and, [I: yeah] and, umm, they have an annual conference, and they also publish a newsletter, and they also have local chapters or branches in the different states. I'm a member of the Canberra branch (1.0) of the Maths Association and umm I go along to their professional learning, so I get ideas, I get ideas from there, and other people get them from, umm, from just from their friends at other schools because we, ah, umm – I mean we're not isolated, we do, we do, like Maths teachers do have sort of groups that meet together, and share ideas, so umm, it umm. We have a, it's a fairly, it's not a specific source, it's a very wide range of sources that we look at.

I: And there are mmm also some colleagues in your school that do these kind of activities and that you meet, and you explain your, your way of doing maths or it's something that happens only "extra school" in a certain sense?

G: No, we have, umm, umm. (1.0) Like the Maths teachers have a <single staff room>. So, they're always able to talk to each other when they have, umm, when they have preparation time and, at least in our school we've got a a stable staff so they have a lot of prior experience, so they, they're used to talking to each other and sharing ideas and umm proposing new ideas and seeing how they might work. They're umm. I mean, I, I think that in my experience that's how the best staff rooms work because you have a – >even if you're not everybody's best friend<, you're everybody's professional best friend and you're able to speak to each other truthfully about how you think things will work and not work and help, umm to come up with new i-, with ideas to improve things and make them work better. And ahh – that that's my experience of maths staff rooms, anyway. That they are very collaborative.

I: Yeah (2.0) Yeah. And you, are you supported in proposing and implementing these activities by the staff members in your school or the organisation of the school you are in.

G: Yeah, our umm, well our [both talking] our school has, umm, they're not really values. I don't how it is in Italy, but in Australia there's a trend for, umm, where schools used to state their values, now they tend to have a set of three or four words that are the things that they want to represent them. So, our, our three words are <"connect, innovate and impact."> So, innova-, innovation is one of the things that we're aspiring to. So, umm, so the organisation does support, ah, doing things differently.

I: OK. Fantastic. And, umm, do you believe that there are any constraints or limit to implement this kind of activity, but also theoretical limits, in a certain sense, or something that it's umm "outside" of this kind of activity?

G: Umm. Well, the theoretical limit is you still have a certain amount of curriculum to cover in the time. And some of these activities take more <time> than traditional teaching, so there's a limit on how many of these activities you could fit into a term or a semester. So, umm, we tend to use them for, umm, where they're – where we think they're something the students may have experienced before, and where we think it will have an impact on their ability to gain something. Like to improve their understanding of the concept. And the other limitation is cost, because you can propose lots of activities that, that umm, require costly materials or costly equipment to implement, and so, we're, we're restricted by budget to some degree as to how far we can go with, ah, activities, but, umm, umm we can do a lot with what we've got. We have a lot of manipulables, umm. So one of the activities I do, if you're familiar with Pascal's triangle?

I: Yeah.

G: It's laying out a row of 5 hula hoops, 4 hula hoops, 3, 2, 1. We stand in the 1, you roll a big die, big fluffy die, ((I: laugh)) and you get paid money if you can stay on the outside! ((I: laugh)) Which is (I: Fun) – I don't have to pay too many people.

I: ((laugh)) It's a funny idea to me.

G: Yeah, so it's just about reinforcing the probabilities of which way you're gonna – where you're gonna to end up if you umm, if you're part of Pascal's triangle.

I: Yeah.

G: It's a little bit, little bit different to the umm, aah I've forgotten the name of it, the one that where you drop the balls down and they (2.0) there's a name for the apparatus where you drop balls down and they just distribute themselves, as they collide on the way down..

I: Yeah, yeah, yeah (*22.13*)

G: I did know the name of it, but I can't remember. (3.0) We have one of those as well ((laugh)), but it's not as much fun ((laugh)).

I: So, I, mmm believe to have asked you what I want to ask you.

[...]

Teacher J

05/05/2022

[…]

J: OK. So, I've been working as a teacher now since, oh, (2.2) 20 years or 21 years. So I graduated in the UK. I have a degree in Mathematics and then I have a post graduate certificate in Education. I did one a half years in ahh the UK and then I came to Australia, umm, >I did a little bit of supply work<. So that's when you go in and, if a teacher's sick and, but this has been my only place of work, it's a permanent job and I've been at the school for 16 years.

I: OK

J: 17 years I think this year. Umm, so, yes I started off, and I was only 28 I think when I started here, something like that, 27. And, (1.2) as a normal classroom teacher and then I was assistant head of faculty and I've been head of faculty for 5 years at the school. And (1.0) [I: and] so yes. And it's - I might just go into another room, because I've got lots of people in here. [I: ah] right hang on, just a second. Oops. (6.5)

I: No problem, no problem ((laugh)).

J: I'm not doing (unclear *1:13*) they're scared I'm doing a job interview. No I'm taking part <in> a survey with a young lady, who's in Italy who's doing research in mathematics teaching. (unclear response between others and J) ((laughter)).

I: Bye bye ((laugh))

J: We have, umm, it's a private school, so in Australia, umm, (1.3) it's quite different to the UK. I think on the Gold Coast, where we are, there's umm, 30% of students go to private schools. But we get more funding that we do in, umm (2.2) I know, in the UK private schools are very expensive. So, and, the children, yeah they pay to come here. It's a prep to 12 school, so we have from 5 year olds to 18 years old. And - which I quite like - I teach Years 5 at the moment, a Year 12 class and a Year 10 so that's 18 year olds, (3.0) 13 year olds and there's 10 year olds, so it's a big, a big difference and it's nice, umm, to be able to see them progress throughout the years and – (3.5) usually you don't get to communicate with the primar-, the senior schools, where, we can just walk down there and have a look in the classroom, so, that's a a huge advantage for the school. And, I see we are working with the Australian Catholic University?

I: Yes, all right [J: right as well *2.41*] the ACU.

J: Yes. [J: (unclear *2.43)] The school here used to work a lot with the ACU umm when I first started. The ex-head of department did a lot with, ((sigh)), I forget all the names now: Vince Geiger (2.0), and ((sigh)) I forget. There's quite a few, there was quite a few ahh lecturers that would come up to the school and we used to run a program called umm STEM where umm they would go to a local university and do activities. (2.8) But we haven't done that now for (2.0). So we used to do a lot of movement in Mathematics, ahh now it's more - we don't do as much, and we don't do that program. Which is a shame, but I think it was in terms of the administration and costs, umm, they stopped it. So, yeah.

I: And where, where is, exactly, your, your mm, your school (3.5) in, in, in, in a city or in a … ?

J: Umm, no, so where we live, umm, it is a city but it's not like a city in Europe's size. So we are 1 hour south of Brisbane, [I: OK] umm in Queensland, so, we are (2.0) maybe 15 kilometres from the coast. Umm (indistinct *3.4*). I think a few people would commute into Brisbane, in terms of the parents that

we would get here. Umm, it's a huge campus. I'll show you, quickly. I'm on the top floor, so. We have a purpose built Maths umm facility, which is amazing, so we have (2.2) oh this is one of the classrooms, behind me, [I: wow (gasp)] with an electronic board. And then [I: a big, a big classroom]. (2.3) Oh very, yeah, very big and not huge classes. And then all of - this is the Maths room and all of the all of the classrooms go off this room. Then all of the Maths teachers get to talk to each other, umm, on a regular basis. (1.2) And then (2.5), I'll just (1.5) ((opening a door)). So this is our campus.

(4.8)

I: Oh yeah!

J: (unclear *4.56*) stunning

(4.4)

I: Wow! (3.3)

J: So, it's a big campus. We have 1500 students, from Prep to Year 12. So in each year level we usually have, (1.3) umm, about 6 classes (8.2). ((Walking around the campus)) (4.2). Every Year 7 class starts at the same time on the same day. (1.5) Which is good if we wanted to get a year group together, we could, or if we've got an exam that's what we do. Umm. Yeah.

I: Thank you, thank you, thank you also for the visit of the school ((laugh)) - great ((laugh))! I haven't been in Australia for the pandemic emergency, so I'm really curious about the... (2.1) also the place (0.5) the, the real context. Thank you so much. So, umm, [J: Yeah, ok], to, to break the ice, I want to umm to ask you what is mathematics for you? If you can summarise in a sentence, or in a word (6.2)? Aah, it's quite difficult ((both laugh)).

J: I'm, I'm really passionate about mathematics. I think mathematics is the core of, umm, all of the sciences <and> (1.2) aah, it's a beautiful subject. (1.5) Umm, it links, it links everything together (3.0).

I: Great!

J: And.. these couple of things.

I: Thank you, thank you. And now I ask you something about the questionnaire. In particular, what do you think about the topic of the questionnaire? If, aah, did it seem familiar or something far removed from school - your school reality, aah, when you, when you complete the question?

J: (6.0). Oh, on the questionnaire? umm (2.0) I think we don't do <enough movement>. I can't remember what I put in all of my answers, now. Occasionally we'll do something with movement in the school, but (0.6) Yeah, I could relate to, because we have done umm things in the past. (4.5) But, yeah, I can't remember all of the questions now.

I: ((laugh)) no, no. eh, (1.2) I, I know that you complete (1.2) mm many, many days ago, but aah, if you can remember, there are some questions that you notice as unexpected- >particularly unexpected< or something, (2.1) some important aspects that you think, ah umm, (1.2) that is not covered in the questionnaire, or something that is inconsistent (1.3)? Do you remember something in particular that catch your attention in this way?

J: No, I (1.0) I think I was quite thorough with the questionnaire <and> (3.2), I just, I can remember >reading it and thinking "oh, we really need to do more of this"< of what (unclear: *8:10*) you could see what you were asking in the questions and I was thinking "yeah, we don't do enough (1.8) movement," but, yep, > I think it was thorough, but I can't remember all the individual ones<, I'm sorry.

I: Oh no, it's good. And (0.5) mmm, now I want to ask, even if you, you, you're not really familiar, mmm, could you think about an example that you have experienced or implemented it in your classroom or

seen from your colleagues, uh, in which (3.3) students are engaged physically to (3.5) experience mathematics?

J: Yep. Umm, just the other day, in this classroom, I walked in and the teacher had, oh, lots of boxes, and I thought "oh, what's she doing?". And, umm, she had (1.2) they were Pythagoras in three dimensions. So she had (2.2) boxes and string and rulers and she was actually (sound of chime playing over the voice *09:17*) measure out all of the distances, and then I'm guessing that she checked them. Umm, (0.7) one I, I always do every year when we do umm statistics, and we do mean media at the upper quartile median and the lower quartile, I like to get the students out the front and we put them in height, height order and we talk about which (0.8) 25 per cent and 25 per cent... I usually do that. Aah - I've only done this a couple of times, where we've gone out for umm (2.5) (unclear *9.51*) with - in trigonometry and we <look at> how we can measure the height, where we're using ratios with their shadows. Or with a, umm, clinometer, and they're measuring the angle [I: good] and then [I: great!] they've been able to verify it with a, umm (2.5) umm, we have flags - all the Australian schools have flags, we don't have them in England. We have flags and they can put the tape measure up the, up the pole [I: laugh] to check their measurements, to see if they, if they calculate it correctly. So that a was nice activity. Umm, (3.2) what we're <about> to do in Year 10 is an assignment where, (3.2) umm, they take a photo or a video, (2.4) and they put it in a program called Logger Pro. They put the photo in and then they collect data points: quadratics. So, some of the students might do basketball, and they'll film themselves throwing the basketball, and then they can come back and, and create a, a scatterplot. Umm, (1.3) and like I said, we used to do so much more. I, umm, for low abilities, umm, I have a teacher who uses a lot of hands-on material. So, if they do volume, she brings liquid in and they get to measure out, and she has, we have some clear shapes, umm, so that they put in a cylinder, and they can tip it into their cones and see that only a third, umm (4.2) - but generally, I'll say that, (3.3) ah being honest, maybe two lessons out of the 50 are hands on and the rest is, (1.2) you know, (2.0) here it is, (2.0) here's how we do it, now you have a go. [I: traditional transmissive / J: So / I: aah education]. Yeah. Another thing, I think it's (3.5) I don't know, in terms of preparation or resources can stop that, or imagination, umm, coming up with ideas …

I: But, [J: so] but, do you think that carry out these activities in which students' bodies and movement are involved are important for learning mathematics in particular?

J: I think they give them a (unclear: *12.03*) lesson that they will remember for ever. Umm, in terms of then making sure they've got the time to consolidate, as well, on practice questions is also important, so it's hard t-, it's hard to measure, isn't it, how, how much better or, (1.5) you know, how much they can, they can take in from the activity? I think it certainly makes it more enjoyable, umm, to, and they can see the real world - you know, like why they're doing something. So, I think that's important, for students, to understand that, yeah, it's not just pen and paper. Umm (2.5),

I: And do you believe ...

J: Hopefully I think [I: yeah, yeah] [J: go on] [I: no, no, no, go, go]. I think it is just well as practice, practice, practice of the skills becomes umm fluent with the children, it's also important.

I: Yeah. But about the, the formative outcomes that you can ummm obtain with this kind of activity, do you think that they could have better outcomes implementing some, some, some teaching strategies that is consistent with this, this umm, this framework?

J: Yes. I, I think so. I think for some students it, umm, particularly digital learners or the kinaesthetic learners are very - (2.3), for example that 3D test with the Pythagoras in the box - some students, if you draw that on a board, they can't, they can't work out what's happening. They can't see where - so it makes it very clear, and, so I think in terms of, (1.5) particularly spatial activities, umm, (2.5) it is much better. Umm, and like I said, with the measurements, I think that it's much better than - and even just

reading off the cylinder, off the measuring cup rather than on a piece of paper, and it's just lines on the paper, they can see (3.0) these are relevant activities I do think it probably leads to better outcomes, but...

I: Thank you, thank you. And, and, when you experienced these, these great activities- I think you mentioned some interesting activities - what, what difficulties do you experience when you carry out this kind of activities in classroom? What are the difficulties you experience, and also students experience, during these activities, in your opinion?

J: Umm, I think, if it's done - like an outside activity it's just monitoring when you've got 27 students. That everybody's on track. Umm, (1.3) being, making sure the instructions are very clear when you've got a practical. <If> the instructions aren't clear and then they're all just left (2.8) and, and asking, that many times before (1.8) they don't know what to do, they come to us here and then they're asking their friends and it, it, it can be a little bit chaotic. So, I think that's one of the difficulties. And then having enough equipment to carry out the activities, it's umm, depending on the class size, or if you've got rotations happening, so, umm. And then also, in terms of the age of the students - makes a difference in their maturity, and depending on the activity time, thinking at one - they love it, there's one what we used to do, haven't done it for quite a few years, where they do their rubber band (2.3) and then they put a weight and they, they see the relationship between the number of rubber bands and how far it goes. And then with, with, they try and predict, and we put it over the balcony, till it stops, to see if they can get it close to the ground but not ((single clap)) smashed. And if you give 13 year-old boys rubber bands [I: yeah, of course] they have a lot of fun!

I: And ((both laughing)) [unclear: both talking *16:06*]. Yes. Of course. And what strategies did you carry out to overcome the difficulties you encounter? Mmm, you <you>, (2.4) you remember some [J: umm] particular moment that you think about a strategy to overcome some difficulties that you have encountered?

J: I (0.2)... <well>, what we've started to do, which wasn't something we could do in the past is, and this is due to Covid, is making another video. So, you can do an explanation video so you can play it first, so you can demonstrate. One, you can demonstrate it in front of the class but also you can, you know, they, umm, play it back any time. So, umm, that's one, and then instruction sheets that are nice and guiding. Now do this, now do this, now do this, umm (unclear: *16.56*). Or if you've had, umm before we might have a couple of teachers together, so, (2.2) umm, you've got one pers- one teacher doing one thing and one teacher doing another. So, we're very fortunate in this - this room is just a single room, but, at this side, we've got two more rooms on one side and so there's three on each side. Those two open up so we can do, umm (2.6), class - two class activities with the benefit of the big space. So, being able to get two teachers in (2.8) [I: yeah]. Umm. And, having, having the software, also, to (3.2) to analyse data if you – like I say, if you do a video. I think that now, now it's so much easier.

[…]

J: Umm. So, I think technology's made things much, much easier.

I: Of course. And, ah, umm do you believe that exists also some downsides to bring the, to bringing this activity in, in the classroom?

J: (5.9) Yes. I think the biggest downside is the time it takes. So, (1.6) where you might be teaching one concept, some students might get that quite quickly if you just demonstrate it on the board in 10 minutes, where it might take an 80-minute lesson to get through, and then you don't know how many more of them were able to study because of the activity they've had a lot of fun. Umm, so, I would say that time would probably be (1.2) umm (1.2), the biggest negative to it. To doing the activities. I'm, (2.0) I'm umm, I don't know – it's imagination, <thinking of good activities>, (2.2) really. [I: yeah] But I would

say mainly just time taken away (2.6) from (1.2) the classroom. We don't have a lot of time to get through a lot of content. So, that would be the biggie.

I: Mmm. Often there is, the um, some teachers try to implement this kind of activity. And then (1.1) feel (1.4) a sense of failure (2.1) for the implementation, <and> (2.3) in your opinion, what could be the main reason of a failure when implementing these activity in classroom?

J: Umm, I would say (3.7), and there's a few things. It could be the behaviour of the students, that could be frustrating. It's - we're really fortunate. We have good - well behaved school. But that would put people off trying activities, definitely. I reckon that would probably be number one. But, if, if I can feel like something hadn't gone well - and another reason could be that (3.4) in terms of organising the activity that you hadn't thought about umm - which we don't, until afterwards in retrospect you go "oh, I should have done – a worksheet, I should have made a video first." So having clear, detailed explanation, not having, having that at the outset, and then students wasting a lot of time, <getting people on task>. Uumm. (4.2) <Or> like I said they might think "ah, they could have learnt that in 10 minutes on the board" rather than 80 minutes in class. (3.3) I don't see why else they would think so. It depends on the people that are doing it as well. [I: yes]. So, some people will have actions for it and then if you ask people to say "right, this is what the activity we are doing with Year A" and they strongly disbelieve in any, any different activities in their classroom, then they're going to have a negative outset. They're not going to enjoy it, and the students aren't, so … And that's something difficult to get across to people.

I: Yes, yes, yes. I agree. And, and, ah, do you think that are some important things that a teacher has to observe or to do during this activity, for the effectiveness of the activity?

J: (3.2) Umm. They've got to explain why they're doing it in the first place. And then a nice demonstration. Umm. (2.0) If it's a competition, with the students, that always works well, if they, you know, if they, (unclear: *21:28*) goal, like (unclear: *21:32) how close can we get it. (unclear: ? "Is it" *21:34*)

I: They are engaged [J: unclear:*21.34*] Engaged in the competition. ((laugh))

J: Yes. Not just "oh why are we doing this?" So …

I: And, ah, what convinced you to propose this kind of activity in, umm, (1.2), in your classroom? Do you implement something that you have already experienced as a student, or you've seen something from your colleagues, or you read something, ah, on a journal or on the internet?

J: <Usually> it is something that I've <seen> before. Occasionally, I've made a few up, but I think it's mainly things that I've seen a colleague do or we've <done at school> before. Not very imaginative! I haven't read much on movement in the classroom, so finding resources (0.8) umm.. you could suggest some would be good!

I: Ah, yes, of course! And err, the.., are you supported in proposing and implementing these activities in your ah school context, or you encounter some limitation or constraints ah …?

J: (1.5) No, we're really lucky and (1.2) we can (2.0) as head of Mathematics, we can, we can, I can choose what we do, and I don't, I don't tell my teachers what they can and can't do. We might suggest activities. So, we are very lucky in terms of the school. But there's no reason why – we have, we have a big ground, we have good facilities. There's no significant- nothing stopping us at school to do activities.

I: Great. And, umm.. What kind of collaboration or support would you need to umm, to implement those kinds of activity in your class in an easy way? You said that have two, two teachers in the same time it's a great thing, I also agree with you in this particular feature. But do you.. do you believe you need something else (1.3) that could support you?

J: Umm. (4.2) No, I think it's mainly the time to talk about ideas and map them into the curriculum, into lessons. So, <having time to share best practice>, because sometimes things go on in the classroom, and I (0.9) and people are doing wonderful things but they don't always tell you. So, we do (2.1) we're fortunate that we have a classroom, a staff room, like I showed you, where we're all in together. So quite often, we will share. But you don't see everything. So I think that would be one of the biggest barriers is just communication with each other and time to be able to collaborate and come up with ideas. Umm, probably be the biggest thing. And I, even though we're in there, umm, together a lot, we don't have, (1.3), umm, usually we do but this year we've not had that much, umm, a lot of faculty time, where we spend time as a team, discussing [I: with colleagues?] new ideas. Yes. Because people have wonderful ideas, but it's usually it's got to be (unclear: *24.64*) "right, we've got this to do, what could we do?" And then it builds very easily.

I: Yes, and can you seen, in, in, in the classroom of your colleagues what are they practice? This kind of practice in your school, that you can come in another classroom, and seen the implementation of some, something that you would like to implement.

J: Umm, yeah. I'll be honest and we don't do that much here, and, I have a couple of teachers that do more than other teachers, because naturally they enjoy that type of teaching. But (3.0) if I saw something I would share and go "oh, Michaela's done an excellent lesson on … this is what she was doing". Umm. We have, umm, (1.8) I have one person in charge of each year level. So, if, say, Michaela, who is very good at it, is in charge of a year level, she might say "oh, we're doing this this week – >you might want to do this<." And they, they, err, hand out ideas.

I: Of course. Also in Italy we don't have this kind of- this practice really much, but I, I think could be, could be precious ((laugh)) because you have some, some insights not only from, from, from the work, the experience aah (0.7), that the teacher (0.7) could explain you, but also to observing the other students for their context, and it's great.

J: Yes.

I: So, I believe that I ask you all the question I want to ask you.

[...]

Teacher K

20/04/2022

K: Sure, OK. So, umm, so, I'm currently working in a private school, and I teach secondary Maths, and that's been (0.3) ah, the main part of my job for, umm, for on and off, umm (2.3) 30 years, around having children, umm, so I umm (4.0). I've worked full time in government schools. I've taught from Year 7 to Year 12, (1.6) all levels, quite a few syllabus changes. Can I, can you pause me for a minute - I've got someone knocking on the door?

I: Yeah, yeah, yeah, yeah. Of course [both talking] [K: I'm really sorry.] It is no problem ((laugh)) - go, go.

K: Just go and see what it is.

I: Yeah, yeah.

(approx 30.6 pause)

K: I apologise. Some friends just dropped in unexpectedly, but umm. [I: no, no, no, no no.

K: Yes, so I have (0.2) a long umm (0.2) history of trying different things, of seeing some changes in the syllabus. I've worked in the state and private sector, including the Catholic school sector in Australia. And at times I've done casual teaching and even in primary school down to kindergarten and prep. But the majority of my experience is high school maths. Umm, (2.7) with the New South Wales curriculum and syllabus, yeah.

I: And, in particular, now, where you are working in? It's a Catholic school, where?

K: So, it's a Christian school, umm in rural New South Wales, [I: aah] in Gunnedah [I: yeah, yeah]. Umm, it's umm, only goes up to Year 10 at this point, so I teach, currently teach Year 7, 8, 9, 10 maths, and (0.8) umm, yeah, that, that's where I am now, yeah.

I: Yeah, yeah, yeah, yeah. Thank you. So, ummm, a short question to break the ice [laugh]. If you have to summarise in a word or in a sentence, what is Mathematics for you?

K. <mmmm> (7.2) I don't think I can do it in <one> word, (2.0) but in a sentence, it would <be> (5.0) umm (6.0), it would, (6.0) it would be about order, in our world, it would be making meaning of our world with, with (3.0), you know, numbers, geometry, umm (3.0). Yeah, it would be about that, I suppose. If I, I mean it's so much more than that but, yeah, it would be about …

I: This is the first thing [laugh].

K: Yeah, yeah. It's hard to condense it, because it [I: yeah] at times different things, yeah …

I: Thank you. And, ah, secondly I want to ask you some feelings about the questionnaire. And the questionnaire is about the active body experience learning activities in mathematics. And uh I want to ask you what did you think about the topic of the questionnaire? Did it seem familiar, or something far removed from your school reality?

K: I think, for me, it's a little familiar because when I first started teaching there was a lot of training around learning styles? Then later, when we were trying to include more recent years, umm, an indigenous perspective in our teaching, again this learning styles and being able to do things in >new ways and different ways and more ways than just paper and pen, sitting at a chair and a table< or standing at a table, umm, that's been with me all along. Like, that consciousness that, umm, ah (0.5) not just in maths, but any learning. Aah, kids from little to, to adolescents, you know, older, umm. It's important to cater

for everyone, it's increasingly important that we don't sit still and sit down all day, umm. I guess it plays into my thinking that (1.5) learning should be, aah, engage you, >should be interesting, should be fun< and the more senses that you can use, the more, (0.2) umm (0.2), you involve the student in any learning, the better they will learn. Yeah.

I: Of course. <And> ummm (2.0) asking you about some observation about the topic covered in the question. Umm. Did you find the question relevant, or did you notice any inconsistencies that you remember – something in particular [K: yes, I: or, aah …]

K: Yeah, it is, (1.0) it is a little while since, aah, I think it is an over a week, two weeks ago that I did it? [I: mhm]. Umm. I remember it made me think again, because (1.5) it's something I try and use and I did just do a couple of quite, umm, quite [2.1] body involved, movement involving activities with my Year 7 class before we broke up at the end of this term. <But> your questions also led me to that idea that we don't just (2.0) target it. It can be explorationary as well and that made me remember that I'm trying to do that as well. Umm. I am interested in the whole topic so it did, it did tie in with some things that I already think and would like to do more of. But I often have this tension between <time and the curriculum content> and making up new activities and engaging activities that might take us even off track (1.5) from that content. So I am, I think most Maths teachers would say that there is some kind of tension there with (1.2) teaching to the tests that we know children are going to (1.1) encounter, but trying to engage them in thinking and learning, and being involved in their learning. That's a bit more open ended. (1.3) Does that make sense?

I: Difficult to balance these [K: yes] two [K: yes] parts. Of course. And, and mmm, (1.5) About your experience, can you give me examples in [K: yes] reference of an active bodily experience aah [K: yes] Mathematics learning activity that you have presented or that you have seen? [K: yes]

K: (0.8) So, I've got, I brought a resource with me that umm I was introduced to - it's probably - is that back to front to you? ((Show the book the MCTP Activity Banks - Volume I, II (1988)))

I: Yeah, yeah, yeah - I know, I know.

K: You know this one?

I: Yeah.

K: So, what I like about it, because it does go through primary to secondary, is that, umm, and some of my favourite activities that have lasted the years have come from here. Umm. I'll try and find you a couple of those, umm - And you'll see even on the cover - they are standing in the playground [I: yeah] you know [I: yeah]. So, I - one of the things I try and do is think "what if what we were doing was big?" So, we're going to do angles: "What if the angles weren't on the page? What if they were on the ground in the playground or what if their xy number plane, the cartesian number plane, wasn't on your page or on the board, it was on the basketball court? Or on the fence?" Like I try and think: "what if we made this big?" So, we have to go outside, or we have to- (0.3) you know?

I: yeah

K: And so, one of my favourite, and I really like it is teaching linear functions. We draw a <life size> xy number plane, and I make a rule and I stand them all on the x axis and I say "you are, you are the point. You are going to be the point that follows this rule. Whatever ever your x factor is, for example, you have to now double it and go to where that (0.3) just walk in a straight, up or down to where the y value is." And they go, and then they look and go "((gasp)) - we're all in a line!!" Like, you can't get that "ahah", really! Even GeoGebra, which is a <great tool>, graphing calculator, you can't get that "ahah" you know. [I: <yeah>] And after, after I do a couple of those, then that activity comes directly from here, after I do a couple of those, they start to go "you're not in a line! You must have got it wrong!" ((both laugh)) You know. Like, they can see it, straight away, even if they're not very good at Maths.

And it helps with those negative numbers that they can't double, or they double and they get it wrong, and then they go "you're in the wrong place, move down there". Like, I can see them telling each other (2.0) this "you haven't got it right" because their body (1.5), because their body sh- yeah, where they are standing shows that. So sometimes we use a rope, sometimes we just stand, umm stand and they can tell. So that's one of my favourites, (1.5) but it's (0.5) directed by me, it's not so open ended. I could probably even make it more explorationary, if you get what I'm saying. Umm. Another one is (4.5) umm, when they're first learning negative numbers. Again, from this resource there's a "walk the plank" activity, where you have a boat and a shark, (0.8) and you have dice that tell them to go towards the boat, back two steps, or face the shark, walk forward one, and they're trying not to get eaten by the shark, and they're trying to get safety in the boat. And then <we change (0.7) those (1.4) ideas> of the boat and the shark to the positive and negative [I: yeah] directions of the number line. And, of course, making it safely to the boat is positive and getting eaten by a shark would be quite negative, even though those terms are really, you know, they don't have that meaning in maths, but, umm. (2.0) And that helps them forever with adding and subtracting positive and negative numbers. I have, (1.5) this year I asked some of my Year 9 advanced students to come and help with this activity with Year 7. And I heard one of them say to the Year 7s "I still use this all the time in maths." [I: aah] like. So they were quite excited to come and [1.2] run the little groups, playing this game, because they remembered doing it with me in Year 7. You know?

I: It's [K: so I…] memorable for them.

K: Yes, yes! They get that continuity and, um, (2.2) yeah. So, there's a couple of examples, is that … ?

I: (2.8) Yeah, yeah, yeah, of course. You have a long experience, I ((laugh)) I notice ((laugh)). Great. So, mmm, about the mmm (1.4), the.. (2.1) the role of this activity in particular. Do you think - why do you think that carrying out activities involving students' body and movement and movement is important for learning mathematics? You, you have a, you have umm just said [K: yeah] that it's important for learning in general. But why, in particular [K: yeah] for mathematics?

K: OK. Well (1.3), a couple of my reasons are, of course, that I think that <moving from concrete to abstract thinking can be quite variable> at different ages. So I feel like, if we're going to do something with a pen and paper it makes so much more sense if they've already walked it and seen it, like the number line, the number plane. Then, they like playing a small game version of it, of the real life thing. Like having a plan of a house when you've been in the house. Or having, you know, a map, when you've walked around the town. Like, it's like we're (1.2), I'm trying to make meaning that's connected to their experience on the page. So rather than just start with the page and this is a number plane and we, yeah, we we start walking around on it, on the ground first. Umm. So I think it helps them with their abstract, you know, and the <small>, you know, it's quite small for some of them to, umm (.8) - It also, it also helps them see that Maths is connected to life, to the world. Like, (0.9) if you imagine (0.5) a grid on our town, you know, we start with grid positions and maps, and then the xy number plane is an axis, which, of course, we don't draw that axis, but if we did draw it here, this would be this position. It helps you (unclear *14:28*), you know, I guess [I: yes] it's euclidean geometry in a real life setting. You're seeing that a point is a place, a real place. Even though we often talk so abstractly about these things. I'm trying to connect, (1.5) because I think our curriculum is quite abstract, quite early (2.1) and so I'm trying to connect for those learners that are still very concrete. And so touching, doing, you know. Umm. So I think it's very important for that. I also just think (1.3) that the more senses that are involved in your learning, umm, which, you know, <moving is as, you know, involves your feelings> and umm (1.2) stepping out something. I just think you are involving more of your brain, more, it's more memorable that we talked about. The kids that did that activity two years later - clearly remembered learning this activity two years before. And I've even had private students that I've, you know, helped out, say to me years later "this is still how I add and subtract negative numbers. I remember the shark

and the boat." You know, they remember it fifteen years later. So it's more memorable, you know, it stays (1.5) deeper in their consciousness I think. Umm (2.0), <and>, I just think those kinaesthenic learners that (2.0), you know, maybe it's more children, because children are more sedentary these days, sometimes? Umm, just that more of a <need> to be moving (0.3) and not, (1.5) kind of shut down, switched off. I don't know …

I: Be actively involved with the [K: yeah] with the, with their body [both: yes] (both: laugh)

K: And I, and I think it's more probably research that I don't know, but (1.6) instinctively this makes sense to me every time I've seen it come from this angle or this angle and my own experience of teaching (1.2), is that these activities are stronger. I'll tell you about one more. Umm, there's a <game> (0.6) it um, it must be a kind of a copy of an actual game where (0.9) kids have to dance to different moves, they get told moves. And this is a game we play with, umm the angles that go with parallel lines. It's called "dance, dance, transversal." I don't know if you've heard of it. [I: No] Umm. But these songs (0.8) start playing, so there's music and there's moving - and they really like that. And then, on the <screen> (1.4), is (1.5), umm. Can I share my screen with you? Would you.. [I: Yeah, of course]. So I'll see if I can - first of all I'll just (1:8) get that up (1.4), umm, ((click on the computer) if you'll give me a second (3.2) [I: Of course, thank you]. Umm, because I've only just done this recently with my (1.2) ((digit somethings)) umm (8:4) aah, where is it? (11.3) - sorry, I should have been more prepared. But this is one of them. (4.3) Umm. (2.4) <Now, how do I make sure I'm sharing that?>

I: OK, I, I - [music starts]

K: Can you see it?

I: No. (7.0) No, I can't see it. OK now yes, I see.

K: And their feet have to go with the … [music now with lyrics/instructions]

I: <Okay> [music] (approx. 10:0)

K: [music stopped] So they (0.5). I'll, I'll try and show you a [0.2], I think I've got a photo of them doing it (0.3). And they all, after a while they're all in time, going, you know <corresponding angle, co interior>. Like they're (0.2), and they actually, yeah …

I: They are divide - Are they divided in (0.5) groups, for instance?

K: Umm, so I put, I used masking tape and made the parallel lines on the floor. [I: yeah] And used the carpet lines, and they (0.5) stand on one of those. So I'll try and show you a <photo of it. (0.6) Aah. Have I got a photo of it. If you give me a second (0.7).> ((click on the computer))

I: Yeah, yeah, yeah, of course.

K: Umm. (15:3]. <umm>, sorry I should have been more prepared for this, too. (3.0) Aah. [I: no problem] Hmm. (6.0) Because I'm at home, I'm not connected to the school drive, so, umm, (2.3). I might be able to (1.6), sorry, I'll go back to (5.2), I'll go back to you. I'll see if I've got something on my phone here. ((search in the smartphone)) Because they did take (2.2) yeah, we do have to be so careful. We're not supposed to take photos of children blah, blah, blah. (1.2) But umm

I: [both talking, indistinct *19:57.5 - 20:01.5*] If you want you can send me after by mail.

K: <Yeah> maybe I could do that, umm, because they're, umm, we have a newsletter, you know, and we put umm, (3.3) we put some (1.2) umm some shots of the children doing - see!, no, I do have some! So I'll try and show you <that> (2.5).

I: <AAH, Okay! fantastic!> So. Every students have the parallel line [K: yes] and have to move on it? OK. fant-, that's fantasic [K: yeah] I understand now. [K: it's difficult to explain that] Yeah, yeah, yeah, yeah, yeah.

K: <So we have this projecting and they're watching the next one come up and they have to jump to that spot>. And I'm trying reinforce, I guess, the words and the making again, it's, to me it comes down to "can you make this big? Can you make it big enough to walk on, stand on, jump around on?" Like, like I just, yeah, so. So when I do area, umm, I had a Year 6 class a couple of years ago. We made a big newspaper square meter and we took it outside and we tried it out. How many of these connected on the ping pong table, or how many? So that's a simple thing, but, again (3.2), you've got to pick it up. You feel how big it is, you feel how wide it is, and long it is, and then you've got to try it out on the shape you're measuring and see, and I got them to estimate this, of course, and then. But, umm, a lot of this is very targeted, very directed, and it's not as open ended as I would <like>. It's usually about a specific curriculum. But my first thought is: can I make it big, can I make it outside, can we get out of the classroom, or at the very least, can we be standing up, moving? Yeah.

I: Of course, and, and what, what, do, do you believe that you could reach some formative outcomes with those activities?

K: Umm.

I: Do you notice err, some …

K: Yeah, I haven't, I haven't done it that way. It's more about the, the learning along the way. Umm, yeah, I would have to give that some thought, because we, we seem to be very locked in to pen and paper formative testing. Umm, and of course, that always disadvantages some students, yes. Umm, yeah, I could think about that a bit more, yeah. Yeah.

I: And, and do you believe that - what are the, the, the main difficulties that you experience during these activities?

J: <So> (5.2), one of them is just <running them>, getting, getting the kids to listen enough to know the instructions and do it. Umm that's why I borrowed Year 9 to help with Year 7. So they could just keep explaining, (1.4) so I … that was really helpful but I can't do that all the time, because they have their own lessons to go to. Umm. So just having enough adult, or or direct (0.9) like, you know - just running it so there's not kids just going off because we're outside. Umm. But obviously, the more you do it, the more they're used to this is what is expected. Umm (4.2). I think, like everything, so, for this and for other - like I'd like to do more open ended questioning and I'd like to do more problem solving, I would like to do more exactly what we're talking about. I'm always under time pressure <to get through the content>. It's, it's really hard <to cover the content and not rush kids on when they're just getting learning and exploring>, yeah.

I: And do you implement some strategies to overcome these difficulties? And to include these activities?

J: Well, I obviously do include them, because I think they are important. So I, I make time where I've seen that they add value to their learning, and create interest and excitement around something new. Umm. They're often, they're often either <introducing an idea or topic or consolidating it>. Umm (3.1). I, I would like there to be more exploration and like we talked about, more open endedness, but I haven't managed to fit that in. I'd, I'd love to collaborate with more teachers about what they're doing. Umm, I'm the only - mainly for the last year's been the only Maths teacher, our school's quite small. Umm, we've just got another person this year, and so, but again, there doesn't seem time to collaborate enough, yeah.

I: Of course. [J: yeah] And about, (2.5) the, the, the, your teaching strategies, what, what do you think it's the kind of instructional guidance that ensure the effectiveness of these activities? There are some strategies in particularly that are important to ensure the effectiveness of this implementation in your experience?

K: I guess, yes. I guess, umm each time I run an activity I learn from it. Like, I did a circumference activity that I thought they would really like, and it really didn't work well. But every time I do that I have to think "well, why didn't it? And would I use that again, or is there something better?". So, again, it was out of MCTP. It was one where they paced out the radius, then on a, holding on to a rope with someone at the middle. Then paced the (2.2) circumference, and then compared them. But I found that they weren't very good at pacing. Like, they made different sized steps, they didn't hold the rope taut. There was so much about just, ma- like, just like, we were like a big compass, right? [I: yes] And there was so much about that that they didn't get that I thought "I actually have to set up, I have to scaffold before this activity better" for it to work. So, umm, and the more I get to do something, the better I get at running it smoothly and explaining in - not too much explaining, but enough so it works out. But also letting them, (0.5) like that discovery where I say "we're going to go out and stand on the xy number plane, and I don't tell them that we're studying straight lines." I let them find out all these rules make straight lines. That's lovely, when they can discover something for themselves. I know that that's what they're going to notice, one of the things they're going to notice, but I don't say that. Whereas probably before I'd say, before when I first started using: we're doing this activity, this is what they look like, and then we're going … . Now I just try and (0.6) and the same with the parabola. Like "here's a post, here's a fence, everyone go to somewhere where you're half way between the post and the fence. It will be the same distance from the post to the fence." And they think about that for a while, and then they - this is Year 11 and 12 with the directrix and the focus, you know, of the parabola. And they think about it, and someone goes and >stands exactly between the post and the fence<. But then the others have nowhere else to stand. So, then they think, "I'm going where, where else would you be the same distance? Am I the same distance? I'm closer to the post. Where could I stand where I'd be the same distance?" And after a while they form a parabola and then they go "aha" again. Like, you know, that's the introduction to, you know focus and directrix of the parabola like …

I: Yeah, yeah, yeah

K: Yeah.

I: That's great. [K: yeah] Great. And, ah, what convinced you to propose these activity in the classroom? You, have ever proposed it, or, or, or there is something that convince you that is a good …

K: Usually, it's umm, usually it's umm talking with other teachers and being exposed to professional development that, that gives me <ideas and inspiration> and then tr-going away and >trying it out myself and going "wow that worked" or that didn't work. How could I do that again? How could we do that better?< So usually it umm it comes off the back of something I've encountered from, (1.2) you know, <just my own, umm reading or um, looking or go-, attending somewhere, yeah.>

I: And your school supports you in this umm …?

K: Umm, over the years yes. Not so much when I was a casual teacher, like you miss out on a lot of professional development. I had to find it for myself then, umm, but at various times, like when I first started teaching I was in a government system and I was at a Sydney school, and there was lots of access to professional development and I took a lot of opportunities to attend and I really valued that. Because that was my formative teaching years and I, I had a very encouraging head teacher, umm, we collaborated well as a staff, and, yeah. And this really (2.2), I guess maybe not everyone took to it like I did, some of these things. But I just loved it. Because I could, I guess I could see straight away it would have value, even if it wasn't everyone's favourite. I could see it had value, (2.3) like, straight away. Yeah.

I: Of course. So, I asked you all I want to ask you, and so [K: okay] And so I want to really thank you for, for your time and precious insights. I will contact you with the report of the result of the research if you are interested in. I have the email, so I

K: I would, I would like to see it, yes! It's, because I'm sort of curious how many teachers - I think, I think that a lot of the Math teachers I've meet are quite keen for the subject to be more accessible. We have quite a (4.2) high level of curriculum and, and, sometimes it's not everyone's favourite subject. So I think, especially, like since I've been teaching, umm making it understandable, making it accessible, most, (2.3) most teachers are quite keen to give something a go. I think if you have a bad experience, though, it puts you off, like if the class goes silly and crazy and you feel like - well, we just wasted a lesson and no-one learned anything, it would put you off. Umm. I've probably tend to think "well how could I have run that better" or I probably believed in it enough to persevere till I can make it work, yeah.

[…]

Teacher O

31/05/2022

O: OK. (pause) All right, umm, so I work in Melbourne, at a Catholic school (4.0) umm, sorry, I'm just going to move the heaters, it's very cold here.

I: ((laugh))

O: Umm, and the heater's too loud. So, yeah, I work in a Catholic school. And, umm, (2.3) and I've been teaching for maybe <20 ff- 5> years? I think. Umm, and I teach just mathematics, so from Year 7 to Year 12. But this year I'm just teaching the VCE Year 11 and 12.

I: OK. [O: yeah, yeah]. Thank you. <And>, a first question to break the ice ((laugh)). Can you define what is mathematics for you, in a single word or in a sentence? ((laugh))

O: Oh! (1.2) Umm, (4.2) mathematics for <me> is a, (2.2) a language and a way of thinking. That's for me, but I don't think that's what my students think mathematics is ((I: laugh)). Yeah. So, to me I see a lot of beauty in mathematics, but, umm, (2.3) yeah. ((O: laugh))

I: It could be, it could be... ((laughing))

O: So, for me, it's a language that we can all speak, and it's a way of thinking about things … [I: Yes] ((4.2) and finding patterns and things like that.

I: Thank you. So, (3.0) ummm, mm, if you, if you, can remember the completion of the questionnaire, <and>.. It's about, mmm, active bodily experience activities. (O: mhmm) And, err, I, in particular I want to know – what do you think about this topic of the questionnaire? Did it seem familiar, or something that you, that is far removed from your school cont- reality as to school experience?

O: Umm. (2.2) Look, I've also taught in younger year levels, and in younger year levels you can do more, aah, physical things with students. Umm, (2.2), I have done ...(1.2) When I can, I always try and do physical things with the students, but I'm limited in the school that I work at, because we, umm, (1.0) I only see my students 3 times a week. So, (1.3), umm, (1.0) it, the time is limited that I see them, and I do find physic-, when I try to involve their bodies it does take <longer> (2.2). <Longer to set up, longer to, umm, (5.1) ohh, longer to c- longer to conduct the ex-, like an experiment>, umm, and it does rely on, aah, you need good behaviour from the students. (1.2) So, I'm limited by those things.

I: Of course. (O: mm) And, eh, about, <emm>, any observation, aah, about the topic covered in the questionnaire, did you find- if you can remember, did you find the questionnaire relevant, you notice something that is inconsistent, or something that you not expect to find in this questionnaire? Or some important aspects, for example, that you feel are not taken into consideration in the questionnaire?

O: (4.2) Is, is this in the survey, that …?

I: Yeah

O: ..the quest- Umm. (1.2) <No>, my, hmm, (3.0), umm, (1.2) no I, I suspect that if kids, students, are using their <body>, when we are learning about maths, that they will understand it more? So to me that's not surprising. But, umm, I don't think we do enough, we do much … err, many teachers, umm, do that, so …

I: Yeah.

O: Yeah. [I:And..] And I, I think … Wouldn't it be, umm, (3.0) that if you're using your body as well as your mind, that sort of reinforces again what you're trying to learn? Especially with some topics, like,

umm, geometry, where students don't really understand angles very well. So if you, you try and (1.2) they think like (1.2) if the lines are really big, then the angles are bigger in between – but they don't understand the angle, the <term>. Umm, when you're learning trigonometry, sine, cos, tan – all those ideas – if you use, if you do a physical activity with them they'll be (1.5) much more- they'll understand it more better. Umm, what else? With, ahh, when we're learning about the earth, and <latitude, longitude> (1.1). Umm, usually I bring a ball into class, and we draw on the ball, umm. (2.0) Aah, I've brought Play-Doh to, umm. Do you have Play-Doh in Italy? It's like …

I: No.

O: Yeah, so, just – so then they can cut it out and see what's inside the earth, and try and look at the angles inside, but, yeah – it's, it's not easy.

I: Looking at 3D angles, in this way?

O: Yes

I: Yeah. Great. [O: mmm]. And (0.5) so, mmm, you have implemented this kind of, umm, activities, in, aah, in your school classroom?

O: I have, yeah.

I: (3.0) Great. And …

O: But, I d-, umm, I no, I (3.2) umm, (6.0) I don't find these, (2.2) umm, manipulatives or things to help me, umm. I find that they are hard to, umm, access. They might be expensive, umm, (0.6) for the school, umm. And sometimes there isn't one. Like I was looking for a, an earth, a globe, where you can cut it out, and look inside the angles. And I couldn't find one. I bought something where you could make the globe, and, ah, and you can cut it but you … It was (0.6), this, I find it, aah, not accessible. The …

I: Yeah, yeah, yeah. [O: yeah]. Affordable and accessible ((laugh)) [O: mhmm] at the same time [yeah]. (1.2) OK. And, and, and have you ever, for example, used technologies <to>, umm, to include some perceptual-motor aspects with the.. [Some..]

O: Yes, I <have>, umm, again, I don't find it very accessible. It would be very, (1.0) it would be lovely if we could have a, umm (5.5) – I'm not sure, like, some kind of (0.5), – you know, they have the concert, they have, umm, the person, the singer's died and they have like an image, (1.5) in, and, and … So I would love to have that, in the classroom. Umm, (2.0). Yeah, so, (0.3) I have access-, accessed technology, but (1.5), umm, it's, you know, it might, might take me one hour to find something good, (0.6) and then I only use it for 5 minute:s. Yeah. Err, and then sometimes, - err, I was using, umm, (1.0) one year, for bearings, umm, (1.5) an aeroplane, the most - and they were working out, umm, if the bearings don't, err, like if the aeroplane's going to crash, together, and it was a really good website but then, and I bookmarked it, but then, um, and, the year later it was gone. (2.0) So, umm, you know, I didn't have access to it (sound of bell ringing). Sorry.

I: No no, no problem.

O: (8.2) Sorry about that.

I: No, no, no, no (laugh). It, it's quite difficult to find some material that you can use, you can, umm, yes, access.

O: Mm. Mhm.

I: Do you think that carrying out the activities involving students' bodies and movement is important for learning mathematics in particular?

O: Yes, definitely …

I: And why?

O: So they get a, they get a sense of, umm, either number, measurement, (2.0) umm, (0.3) what these abstract things are – yes, I do.

I: Of course, thank you. And what kind of outcomes would you expect to obtain from such activities?

O: (3.0) Umm. (7.0) Well, I would hope they would understand the concepts <better>. So, ii- if they, for example, drew an angle and they, they turn, (1.0) you know, and they, they realise that the angle is a turn, it's not a (0.5)- it's the size of the turn, it's not being anything to do with the, huh, [I: yes] the, umm (0.5) the lines. They always think about the lines – as the lines are big and all that. So, I, I, hope that it gives them an understanding of the concept. <Initial (2.0) concept>, yeah.

I: Of course. And do you have some formative outcomes that, ah, umm, come ups when you implement that confirm that?

O: No, look I just get, umm, comments from students like (0.4), "Oh, Miss, I'll always remember that lesson." So, this, I, it's just- umm, what's it called? <Anecdotal comments>, you know. Just "I always remember that lesson, Miss!" Umm, <and> so I get a lot of positive things about that, or I get a lot of "Ohhh, is that what it is?!" You know, and I get "Oh, OK". So I think it's working, but you're right, I haven't (0.2), umm, (0.2) checked like one class, maybe, I do physical movement and another class I don't do it and see if there's any difference. That would be nice if we could do that. (3.5) But (1.0), anyway …

I: Yeah, of course, but you have a feedback in a certain sense, so, it's, it's all, it's OK. ((laugh))

O: Mmhm

I: And about limitation and difficulties, aah, you, you have (1.2) already said, ah, something a bit about this, aah, this downsides. And, ah, what difficulties do you experience when carrying out these activities? Then, (2.5) al-, also the difficulties experienced by students in, (0.5) in the implementation?

O: Umm. (6.0) One, aah, it's beca:use you're- it's not a structured, as structured a lesson as normal. Or it's not a common (2.0) way of learning. Some students get too excited, and, umm, they can misbeh:ave. And, you know, umm, (2.0), they (4.0) … yeah, that can be a problem. Like, at the school I'm at, there's a lot of difficult students, so, ah, their safety's an issue, like if we're outside (0.3) doing something. Umm, for some students, that already understand the concept, it's kind of a bit boring, maybe? [I: mm] if I'm doing this activity, because, you know, "I already know", you know? (0.5) Umm, but, the, the main problem is the access to the, umm, (1.2) I don't know – the limited time to look for the activities, they're not readily (1.0) available. And because Internet keeps changing, and, so maybe something will come and, and I don't know about it. So, that's (0.5) my problem. Ah, and, the cost is a problem, (2.0) yeah.

I: Of course. And that [O: mm]. Umm, what (3.0) are the, the strategies that you, (1.5) did you carry out (1.2) when you, aah, (2.5) want to overcome the difficulties of implementation (5.0)- the problems with implementation in your classroom? [O: mm]. Did, do you find some, some strategy that could help you in, umm (2.0) implementing them?

O: Umm. (16.0) aahh ((laugh))

I: Just think about an experience that you have that demonstrates someone who misbehave or be bored, that you, <you> mmm think about some strategy to overcome this difficulty during the activity.

O: Um, ((laugh)). I (10.0) ohh, I, maybe I do-, I can't, I haven't come … I remember one time we were doing Pythagoras, and I took them outside, and I said "it's easier to walk across, (1.1) diagonally across

the oval than around the oval, err, aro:und the (2.5) the rectangle", <and> we did that, and we measured it and everything, and they said "but I already knew that Miss" ((laugh)) and I was just – it's, and they got bored and some ran away, and … But, umm, <I>, I probably only do it for a class that I can, I know will <be> (2.0) aah OK, they will be OK, not too (1.0) bad, yeah.

I: Of course

O: [Anyway] But yeah, I probably haven't got a strategy. Maybe.

I: ((laugh)) yeah, yeah, yeah. And, and about this, what do you think are the limitation of these activities? The downsides of bringing these activities into the school classroom?

O: (3.3) Umm. (3.5) I, I don't think there, there's a downside. (2.0) The, (3.0) maybe the downside is that we waste, (1.5) we wasted a whole lesson to do, umm, you know, maybe even trying to find pi, for example. You know, I've got a very good activity in finding pi, but it takes one whole lesson to do it. Eh, <or> I can just tell the kids "pi, is 3.14159" – and that's one minute! ((laugh)) So, (2.0) umm, that's, that's the problem. Just that it takes time, and we don't have – some schools don't do much maths (1.3). The school I'm at only does 200 minutes of maths per week. It's, and we only see them 3 times in that week. It's just not enough, yeah. Another school I was at we did 200 and (2.0) 70 minutes? Something like that, 250 minutes of maths a week, and I could do more activities in that class. Yep.

I: Of course. And, and, and, (5.0) this, this kind of, aah, school organisation could change from school to school in Australia?

O: Mmm. Yes, yes.

I: OK

O: So the minimum is, I think the Government has a minimum of 200 minutes (2.0) aah, per week, of maths. But some schools do 300, some schools (2.0), yeah, so … It- when you have minimum, minimum times, it's very hard. Yeah.

I: Of course. And, (1.2), what do you think it's important to observe, and to do as a teacher to during these activities?

O: (2.0), umm (5.0). Well, if, if I, umm, can identify a misconception from the start, like I do a pre-test, or something like that, and then I, I think "Oh, this person (3.0), these people don't know what a term is, what the bearings are", I will be watching them and hoping that this will help them. So, umm, (3.2) Sorry, what was the question again!? ((laugh))

I: What do you believe could be important to observe and to do as a teacher during these activities?

O: Well, I ((laugh)) so I (1.3) would be trying to help them ah con- with the concept of what, what it is I'm (1.3) trying to do. So for trigonometry for example, umm, why is sin 30s a half, no matter what, no matter what the lengths, no matter … So, umm, (1.2) I guess I'm (8.5), I would- (2.3) if after that activity maybe doing another test afterwards to see if they still have the same misconception. [I: yeah] or it's changed a little bit.

I: Yeah. And what is your, mmm, instructional guidance during these activities? Do you, umm, (3.0) for instance, aah, (4.0) leave time to explore, or, or <to> you, <you> try to umm (5.0) propose them a problem? Or …

O: Oh, I think it depends on the student. I would like to leave them to explore for themselves, but some students need <more> guidance and <more> (3.5) pushing to try and discover the, the idea. Yes. So, like with that trigonometry question, umm, (3.0), you know, measuring things or going outside and just (4.0), it's it doesn't matter what the lengths are, as long as they're in the same ratio. So what's ratio? So

that's, umm, what I would be trying to (4.2) get across. Umm, but some students, it will take a long time, you have to do it again and again. So … (3.5).

I: Yeah, yeah. And, about <some>- your experience in particular. What convinced you to propose this activity in your classroom?

O: What, was, what, …?

I: What convinced you to propose these …

O: Ahm, just (2.5), well, umm, I think I've read some research that it helps ((laugh)). Umm, that's one thing, and number <2>, it's, (0.3) umm, (7.0). Well, just from, from students' comments. That, that, that, "That's really helped," umm, "That wasn't boring," "that's …" So, I've had positive feedback, but also research has said – I've read somewhere that it's, it does help them. (3.5) Yep.

I: Of course. And, and you (1.0) are you, umm, in a certain sense, supported in proposing and implementing these activities (0.4), <or>, umm, what kind of collaboration or support would you need to (1.3) implement more easily?

O: Umm. I definitely su- support more movement in maths classes. What I would need is, umm, (3.2) more time to plan (1.5) the activities, or to <find> the, the things to have access to the materials that I might need. (2.0) Umm. (2.0) So I need more time, (2.0) and (6.0) well, if I had more time or, or … I don't know, they pay for someone to come and show us (3.0), umm, some activities to do. Something. We need help, because, and we need more, aah, more class time. So less, content and more, umm, class time to get, get in deep into the problems. Yeah.

I: And do you have some colleagues, (1.2) aah, umm, (1.0) with which you can share your experience, (1.1) in the school classroom that also made some of these kinds of things?

O: Mm. (2.0) I, ah, I don't, (2.0) ooh, at the school I'm at I don't think we – none of us, I think all of us would like to do some <more>, but none of us, umm, have time, so, (2.0) yeah. I, I think teachers would like to do more, in general. Yes.

I: Yes. Of course. It's great ((laugh)), it's a, a, a direction that, I think could, could be (2.5) a good resource for the students. And, uh, (2.0) umm, sorry, one things about your school context. Eh, is the school in, in the city of Melbourne?

O: Mhmm (sounds like she's clearing her throat)

I: OK. [O: Yes] And, and, do you have, mmm, both boys and girls …

O: Yes, so, girls and boys school, Catholic, umm, <the> (3.0) most students come from non-English speaking backgrounds. <And>, low, umm, (2.0) <socio-economic>, umm, (2.0) yeah. So, not – it's not a, not a rich school. It's (soft laugh) at all. [I: Yes. Of course]

O: A lot of kids struggling, families struggling.

I: Yeah. And, and – (4.0) the very last question. Umm, (3.5) you have already mentioned it a lot, but, (2.0) if you can explicit all the constraints that, uhh, you think could limit you in proposing those activities in school practice, what they are?

O: (3.0) OK, <umm> (7.0). The time [I: yes], aah, (1.2) access, (1.3) umm, (1.3) cost, umm, (3.3) student management, (9.0) and, just even (2.0) knowledge, like some ac-, somethings <I>, even after 20 years I haven't thought of how I can include movement in it. So it's my own knowledge, so my umm, (2.0) aah, (4.0) professional development, I think we need a bit more. Yeah.

I: So, great, I think I, I have …

O: That's a lot! ((laugh))

I: A lot. Yes, but, but, also in Italy ((laugh)) There are quite the same situation! ((laugh)) So, I know, I know well! ((laugh)) (1.3) So, all that, I want to really thank you for your time, and your precious, umm, (2.0) aah, (2.0) glimpse on your experience, and your (2.4) great, aah, great work at school, and aah …

O: I try. (2.5) I try, I'm not sure it's great, but I try! ((I: laugh)) Yeah, so, umm, yeah, it's, it's sad when students don't like maths, but, (2.0) anyway.

I: Of course, we are, we are, we are here for studying this fact in particular, because (2.2) it's, umm, it's sad, it's a really sad for the subject, for maths. ((laugh))

O: So I'm not sure in Italy it's like this but in primary school, they do lots of – I would say they use lots of materials and movement in maths, but then when they get to high <school>, it just (1.3) stops, that's it. And it's just books, <writing, reading> …

I: Also in Italy.

O: Yeah. (4.0) Anyway, (2.0) we do the best we can.

I: Yeah, yeah. ((laugh) So, so, thank you, thank you …

O: But, umm, maybe if your research, umm, shows, the, err, that movement does really help, it's much more, (0.4) it helps understanding a lot, then maybe the principals will start listening and they'll give us some time, and money, and yeah.

I: Of course. I- umm, if you are interested, I, I could give you a report of the research, when I (1.2) have some, results [O: mhmm] <and> I have your email so I can [O: OK]

O: Sure, I'll be interested.

I: Yeah.

O: Thank you.

I: Thank you so much for your time and your precious (3.0) work.

O: Thank you. (3.0) Good luck!

I: Thank you.

O: Bye

I: Bye

End of recording

Teacher R

22/04/2022

[..]

I: Sure.

R: OK, <so>, I might start at the end, if that's alright? So, I've been teaching <for> aah, approximately 25 years. Umm, in those 25 years I've been a Head of Department or a Head of Curriculum, in mathematics, for, approximately 20 of those years. Umm, currently I'm actually on secondment to the Queensland Curriculum and Assess- Assessment Authority, from my school, umm, so that's for term 1 and term 2. Umm, but, umm, I'm (1.8) full time employed at a school called Moreton Bay College, (1.0) in Brisbane. And that's an all-girls school, from aah, pre-prep right through till Year 12. (5.0)

I: Great

R: And, umm, yeah. So, and in terms of the school itself, umm, it would be considered in terms – if you were considering socio-economic, it would be considered sort of within a (2.3) middle <to umm> (1.5) upper, umm, <class> type school. So. Umm. We are not select entry, so if it's not select entry, it's open entry to students of any ability or any socio-economic background.

I: Thank you. And, to, to, to break the ice with some, more conceptual thing. Umm, I want to ask you if you can summarise in a sentence or in a word – what is mathematics for you?

R: (6.0) Oh, golly! Umm ((both: laugh)) (3.0) Oh, I could spend hours talking about that! Umm, so, for me, mathematics <is> about, umm, it's, it's the <language of science> and so many more disciplines, umm, including music, and, and a lot of the, umm, I don't know, I guess visual arts as well. Umm, so, for me, umm, (3.0) mathematics is the, the fo:undation, the <core> of much of what we understand as knowledge and understanding in the world that we live in.

I: Thank you so much. And, now I want to ask you some feelings about the questionnaire (0.4) you have completed. And, ahh, the first things is about the topic, that is the body, mm mm, the active, bodily experience learning activities in mathematics, and I want to ask you if, did it seem a topic, a topic familiar or something far removed from your school reality?

R: (4.2) I would say that it's quite removed >from my school reality<. Obviously, we do have hands on activities in class where students might use umm, concrete materials, particularly in areas like, ah, measurement. But, no, to be honest, it's it's not something that (0.5), that I would <utili:se> often. No.

I: And, umm, (3.4) talking about some, mm, topics covered in the, in the questionnaire. Did you find, any, mmmm, (2.0) ah, (3.5) question, any item, that you did not expect to <find>, or questions that you, mmm, some important aspects that you feel that are not covered in the questionnaire?

R: (7.2) Um, no I found that the, the – to be honest I, I found the questions quite intriguing. Umm, they sort of challenged my own ideas and beliefs about education and specifically maths education. I think what might have been missed, umm, whether that's from an Australian context, or a context that's more wide spreading, <is> about time, and the curriculum. Umm (3.0). Unfortunately, ah, well – I shouldn't say unfortunately, but … The experience here in Australia is that, in mathematics, certainly, we have a very <crowded curriculum>. It's very content heavy, (2.2) and (1.5) <there> are, in my experience, over the past 25 years, (2.0) there's little opportunity <for>, umm, (2.4) teachers and/or students to, (1.0) umm, have, err, (1.0) experiences, learning experiences, outside of what we might classify as, the, the regular, umm, sort of, err, explicit teaching model.

I: (5.2) Of course, thank you. <And>, umm, about (2.3) an example (2.5) of, err, an active bodily experience that you have implemented or that you have seen [R: uhuh] in, in your context. Could you give <me> some insight about it?

R: (4.0). Yes. Umm, I, I have a – oh, actually my, my school, we, we, (1.5) One of my colleagues, umm, introduced this to me and I, I really love it. Umm, with the work on umm, the cartesian plane and also graphing linear functions? Umm, we actually set up, umm, on one of our larger, umm, playing fields a set of axes. So a, a horizontal or an x axis and a vertical axis. Umm, and we actually, have the groundsmen actually, they, they come out, and they set up a scale along each axis for us as well, using some spray on chalk, and, we have the students then, you know, stand along the umm, (2.0) we have students who are st- standing along the sideline. <And> we get a student to plot a point, the other students, sort of, um, engage with that. And then, from there we move on to graphing a linear function, where each student is assigned an x value – so each student will stand along the horizontal axis, along the x axis, and then we give them a function, and then they have to figure out what their y value is going to be. [I: mm] So whether the move, sort of, in the positive or negative direction. And that, that's a really fun thing. The girls love it ((I: laugh)), they really do! And then, what we <do>, is, we have races. So, we, we, umm, we actually, sort of, have, it … because the girls are quite competitive. So, we'll have like a race to see how quickly they can actually do it. And we have a little competition between each <class>, umm, to see who gets, like a little box of chocolates or something like that. So, there is a little bit of extrinsic motivation, <but>, it works really well, the kids, the girls love it, they really, they do.

I: And it, it, umm …

R: Except (7.4) that I would still be very, very interested at least to promote that type of (1.6) physical learning, yeah, for our girls – most certainly.

I: (4.2) The, the activity you, have, described – are, mmm, (4.7) are conducted outside the classroom?

R: (5.8) Yes. Absolutely yes. We, we take the girls outside onto one of our large ovals, our large playing fields, yes.

I: OK, thank you. And, eh, about <the> hmm, the importance that you have already commented about the, the activities. Aah, why do you believe, could be important to include this kind of activity for learning mathematics?

R: (4.3) Umm ((cough)), because, I, I go back to the idea about, umm, experience, and experiential (1.1) learning. Umm. We, we talk a lot about muscle memory, and I think muscle memory is very important. And having, having students, umm, children actually writing solutions and things like that I think is, is vitally important. And I think that's fundamental to them learning. But I think also the experiential, umm, <aah>, learning experiences that kids have, umm, where it-, it's embedded in their memory, they re- they can recall it, and then the teacher at a later time can also then recall it, and, ((cough)) pardon me, umm, and talk about "well, remember when (2.1) we did this" or "remember when such and such did that" and so on. So, you're drawing on their personal account of their personal experience, and I think that's a very valuable learning experience for the kids.

I: And, and do you believe they have the, ah, formative (2.3) outcomes, in a certain sense? They are memorable, but there are some form- formative outcomes in particular that come from these activity?

R: Oh, certainly! Umm, yep, and particularly in the way that it's structured because … in, in particular when we move on to (2.2) the girls being <on> the playing field and we're plotting a linear function, (2.4) the teacher explicitly turns around to the girls and says <"have a look"> and, and they can see how they've all <lined up> in a straight line. And so then you reinforce that idea of, of they are part of a

linear function. So, that, that's, you know a very concrete, and, and personal example of, of how they've been able to, umm, immerse, umm, into what is a linear function?

I: (3.8) Yes. Of course.

R: And that can be extended to, obviously, to when you start to talk about quadratic functions and, you know, other types of functions as well.

I: <And> (1.8) about some limitation or difficulties that you experienced when carry out these activities. What do you believe are the main difficulties experienced (3.9) for you, but also for students, during these activities?

R: (4.7) I think, umm, (2.4) <the> (1.6) I'm very fortunate, the school that I'm at, umm, we don't experience significant (2.7) umm, behavioural issues. Umm, or learning, ah, difficulty issues with students. <So>, our students, are, if you like, and it's not the right term, I agree, but they're very compliant and they will follow teacher instructions. Umm, the challenge that we have experienced with that is, <if> you just go into that activity (2.6), umm, without having set a foundation, umm, some students will struggle, (2.0) and so, prior to that we will, ah, talk about, umm, (1.5) err, substituting an x value into a linear function to get a y value? We also, umm, (3.7) ask the girls, or encourage the girls, that when we go out, even into the playing field, that they bring their calculator with them. So those girls who aren't very good with mental arithmetic can actually work it out on their calculator. And then they can determine, you know, where they go to. Umm. And the other thing that we've found is that, (3.7) when we initially started doing this activity, (2.8), umm, we didn't actually, umm, put a scale on the axes, and we didn't put values on the axes. And that was challenging, so what we did was – we set up, umm, we, we, we created a whole set of <cards>, umm, and we labelled each of those intervals with a numerical value, using one of the cards, so, 1, 2, 3, negative 1, negative 2, negative 3 and similarly on the y axis. And that way, (2.2) students would understand <where they needed to be and where they needed to go>, sort of thing. So, umm, when we first started this activity, it was a little bit clunky, ah, it wasn't perfect, but by putting some little strategies in place we found that it, it really worked quite well.

I: So, there are <some> (2.8) teaching strategies that you carry out to overcome the difficulties you, you encounter. And, <and> (5.8), mm, how is the process, err, that make you able to, umm (3.2), to comes up with this solution, (1.2) when you encounter the difficulties?

R: I would have to ad- … (3.1) Yes, yes. I, I, bet it was, it was very much a trial and error type situation! So, umm, in-, initially when we – because it was a f:antastic idea and we knew it was a f:antastic idea, umm, <but> (3.2), we sort of (1.0) jumped into it, ahh, and we hadn't considered necessarily all of the possible ways that it could go wrong. Umm. (1.4) We learnt very quickly! ((both: laugh)) So, what we then … Oh, I mean, we learnt from our mistakes, to be perfectly blunt. I mean, we, we realised, well, this didn't work because little Julie, she wasn't able to worksheet, you know, a particular girl might have an x value of negative 2, and she's not good with positive and negative numbers and we're expecting her to be able to, you know, to do <calculations in her head> (2.0), umm, involving negative numbers, umm, and so we overcame that by allowing the girls to bring their calculators. Umm, ((cough)) we also, then, umm, talked about the idea of, well, (3.6) they don't know (1.0) <where> the, you know, in terms of the cartesian plane, and where, you know, the negative values are f- for the vertical axis, the negative values are for the horizontal axis. And so we actually created that as an activity. Umm, we, we, we broke it down, and we said "well no, wait a sec, (1.2) before we even start getting the girls to plot points (1.3), umm, using themselves, well, let's actually introduce them to a cartesian plane, aahm, let's talk about preponderance, let's talk about, (1.3) you know, where the x value is negative and the y value is positive and which quadrant is that, and that sort of thing." So, umm, (3.0) you know, we, uh, we really sort of (3.2) brought it back <to> just developing, you know, from the ideas of, you know, um, René Descartes himself. You know, well, (3.8) here's, you know, here's a plane, let's, let's look at what it

actually tells us. And what it can tell us. Having said that, umm, you know, with the … that, that does take time. I mean, (1.5) if we're doing that with, say a Year, a Year 7 maths class and then maybe a Year 8 maths class, (2.3) just doing, that (1.2), you know, that could take, you know, probably 3 or <4> weeks, 3 or 4 – umm not weeks, sorry, 3 or 4 lessons [I: lessons] umm, and in (2.0) and that's significant, yes.

I: So …

R: Umm, but we see that as a, as a valuable learning exercise.

I: It, it's great because you, you have (1.6) a failure, an initial failure, in a certain sense, more difficulties in the first time, and you, try to think about, ummm, (4.7) more define the activity, not to reject <the>, the possibility to do. And in, in some, in some case teachers prefer to, umm, reject. They are not, (3.3) aah, totally, umm, (5.6) aahm, agreed with the possibility to, aah, to modify. They, they think that, they don't work- this activity don't work, and it's all … I, I find it so interesting.

R: Yeah. (2.3) In that particular case, for that particular example, I would suggest to you that the vast majority of our teachers loved the idea of the activity. And it was about, "ok, now let's sit down together. How can we improve on this, how can we make this better. What did – when you did this with your class, what did you find, when you did this with your class what did you find? How can we do this better? What, what were the things that were lacking?" So, so (1.7), on the whole, teachers were, were (1.2) very much prepared to get involved with that particular activity. Because, what it was able to do was to, co-, to transfer the abstract, to the concrete, to the graphical, because (1.0) the kids were the point. So, they started with the linear function,(1.3) they became a part of that linear function, in terms of their x value, (1.2) and then they became (1.2) a part of the actual graph itself. And so, for us, that was a very valuable learning experience. The challenge that we had is that we c:an't do those sorts of (1.3) wonderfully rich learning experiences (2.8) in every situation. Because, one, it's not applicable (1.0) necessarily, and two, even if it was applicable there's always a time constraint in terms of being able to cover a very content-heavy curriculum.

I: So, the- the main, umm, limitation of this activity in a certain sense is the- (8.2) ah, they are two. I (1.3) I observe in your, in your, mm, sentence. The first is a time constraint, (3.2) and the second is about, (1.5) also (1.2), mmm, (6.0), the investment of energy of our teacher in a certain sense.

R: Oh. Yes, yes. Yes I would agree with that. Umm. And that's not to take away from the fact that ((cough)) umm, (1.3) the teacher is a great teacher or a very good teacher. It's the fact that, umm, as educators, you know, we, we, we are professionals, and so therefore certain teachers' approaches will be done different to other teachers' approaches, and as professionals you would expect that. And also, even within that particular classroom, <a teacher will be able to gauge>, umm, quite early on in their interactions with their class, whether they're, they are a class that on the whole <responds well to>, umm, (1.4) hands-on activities or whether they are more attuned to just: "Here's the algorithm, here's the technique, and here's how you do it". So, there's, umm, you know, there are a lot of other variables that are taking place, or, a lot of other, ah, things that are taking place, umm, and, and as you and I both know, education is something that happens in real time. Umm, so, a teacher might go through something like linear functions from a very abstract perspective <and> the class will understand it, they will, umm, be able to umm, then move on and, you know, umm, develop upon that. And then in other situations, for other classes, the class might not be able to, err, understand that in an abstract context, and so, therefore that's where an activity such as, you know, the outdoors activity, um, might come into its own. Or it might not.

I: Yeah, yeah, yeah. You are right. And it depends on <many>, many variables. The students are the first variable, in a certain sense, of course. And about (3.2) other (3.2), umm, factors that could, (2.8)

<emm>, (2.0) impact on, umm, on the proposal of these activities, what convinced you to propose this kind of activity, in the classroom?

R: Umm, well, actually, it was – I wouldn't say it was by chance, but it was quite simply that one of <my>... As the Head of Department I obviously, umm, am responsible for a number of teachers. I had a teacher come up to me and say "Hey, look, we'd love for you to come and, aah, visit our classroom, we're going to do this activity today." And I got to the classroom, and then no sooner did it get, did I get to the classroom but we were outside on the playing field, and I was going, okay, this is interesting, and what's going on here, and the teacher had already set up the, umm, the, the, the horizontal and vertical axes. And what they did was, was very interesting, actually. Is, they just got some, umm, measuring tapes, very large measuring tapes, I will say. So, you know, like your measuring tapes that you would use, umm, for throwing events at an athletics carnival. So they basically just stretched those out. Umm, yeah, aah, perpendicularly as possible to each other, and, umm, yeah, went ahead with the activity. And I thought, this is, this is wonderful. And the kids loved it. Aah, the girls just, you know they, they just had so much fun, umm, you know. And, at the end of it, you could see that every single girl had taken something out of it, and it was, and this was actually before the teacher had taught it in class. So, the teacher got the girls to plot the points, then their points, umm, (0.9) out on the oval, or on the, on the playing field, before they'd actually done it on graph paper or what have you in class. And so therefore, it was extremely concrete, and the girls, you know, they had experienced it, it was an experiential, umm, ah, (0.9) concept or experiential thing. And then when they went back to the classroom, umm, (2.0) for the remainder of the lesson, which I, I also, umm, went back to, and the teacher started talking about, you know, coordinates, and graphing things, and all that sort of thing, the girls could just >bang, bang, bang, bang, bang<. It was really wonderful.

I: They are smart, on the, on the, um, the (2.0) relation of the, of word, and (1.2) concrete things that they experience. (3.2). And, err, what …

R: Yes. Absolutely.

I: … what do you believe could support in proposing and implementing this activity? What, what kind of support needs teachers to, to implement this activity?

R: (5.9) Umm (3.4). I think, I think there are a number of issues. I think time is an issue, and we've already touched on that. Umm, but, you know – and, and time is the age old issue. I mean, umm, you know, we, we could spend, you know ((thinking noises!)) hours and hours each time but not necessarily have better outcomes. So, it's also how – so the extra time is great, but it's also how we use that time. (3.2) I think the other thing that, umm, (5.5) that needs to happen is that it needs to come at the policy level. So, (0.6) at the level where curriculum design occurs. (2.5) And that, at that stage, (1.2) their time allowances (1.4) are made <for> umm, you know, the, the, to, to allow for, umm, particular activities, or activities in general. I, I think, unfortunately, umm, you know, and – and the curriculum – >regardless of the country< – the curriculum is always written with the best of intentions, and it's well researched, across, you know, a variety of countries, in a variety of contexts. (2.3) But, it's, umm, we, we, we still operate as Sir Ken Robinson you know, has famously said: "we still operate very much in an industrial model". Umm, and that, it's it's pumping in and pumping out. Umm, (4.2) now, when I first started teaching, I wasn't opposed to that. I, I freely accepted it. But, in my (3.6) more mature years, it doesn't work. Umm. (4.1) It, it works <for> the middle core. It doesn't work for, umm, the students who struggle, and it doesn't work for the students who are gifted. Umm. So, I think it's a structural thing. I think as much as schools would love to be able to in- incorporate more hands-on activities and, umm, and e- experiential, umm, activities, err, in their classrooms, I think the fact of the matter is that, here in Australia, ah, given that we have a very driven con-, or very content driven curriculum, that is <extremely> challenging, and particularly in secondary. And it's almost impossible, I would go so far as to say that in senior secondary, so in, in our, our Year 11 and our Year 12, umm, here

in Queensland, it's virtually impossible to have <hands-on activities>, and, and, and, and sort of, you know, umm, <activity-type situations>. Because it's just, it's s- so heavily content driven.

I: And, about the, the, the inclusion of virtual, ah, or digital technology in this kind of activity. Do you ever <seen> things, aah, that, involve …?

R: Yep. I, I'd, I've, I've, umm, I've experienced some digital type technologies, I've – and used those myself. Things like Geogebra, for example. I've created a lot of apps, using Geogebra to, umm, to demonstrate, umm, geometric principles. You know, so, ah, looking at parallel lines, or angles in a triangle, or the like. Also trigonometry, and those sorts of things. Umm, and then, also, you know, obviously, providing those, ah, Geogebra apps to the students so they can actually play with them for themselves. Um, they love that. That, that's that's really lovely. Umm (1.3), also, things like, umm, where you get them to create – there's an app, and I <can't> think of the name of it, for the moment, but … Basically it's just little blocks and, and basically you, all they do is they just add these little blocks together to come up with a 3 dimensional shape and then they have to, umm, draw the, the front, side and, umm, top views (1.0) of those shapes. So they create a shape. Umm, so there's that, that sense of ownership, umm. And then from that they have to, then, umm, draw, you know, the various perspectives, of that particular 3 dimensional shape. And obviously, you're more cap- (0.6) you, your, your students who are still struggling, they might just keep, you know, the shapes they design >relatively simple<, so, but that's within their, their, their realm. Umm, but your more capable students, they're going to go for all sorts of things. And then you have the, you know, the kids, the, you know, the more capable kids will give it to – you know, they'll design 3D shape, (4.2) and then they'll give it to, you know, the person sitting next to them, you know ((I: laugh)), the capable person sitting next to them. You know, and "here, have a go at this one, see what you can do." So, look, in terms of the digital world, yes there are lots of things out there. Umm, yeah. I, I, I have, have played with some of those digital, umm, you know, those digital apps, like I said. So, Geogebra in particular, but, that, that, err, other one, where you, you build <trigonometrical shapes>. And, I, I've used that, that – the one where you build the 3 dimensional shapes, umm, initially. So, what th- what you do is, you, you put something up for the kids (1.9) on the, on the, aah, the data projector. And, and then, umm, you say, "OK, well, well let's, let's look at this, so this is the front view, this is the side view, this is the top view, the aerial view. And, OK, well, what, what's, what are those things? What are those faces that we're looking at, look like?" And so, you develop that, then you get the kids to play with it and so on. So, there are those sorts of opportunities.

I: I, I asked for, mm, digital technology because I, I know that in Australia there are, umm, a great, umm, focus on the digital, umm, emm, technology, so I, I believe that could be (2.3) ah, a space within the curriculum for developing this kind of activity in the digital <technology> (0.8) environment, in a certain sense.

R: Yeah. The, the, the one, <one> footnote that I would add to that, though, is that when you talk about (2.2) digital technology, like, you've obviously looked at the Australian curriculum and it says, and it will say, umm, ahh, add and subtract fractions with and without digital technology. All that really means is, with or without a calculator. So, it's not <really,> sort of, delving deeply into what y- you're referring to, or what I've just been referring to. It's really just saying, you know "take out your calculator and check your answer" type of thing. But I do agree with what your saying, I think there's wonderful opportunities out there in terms of the digital <world>, the digital <realm>, in terms of what we can be doing, umm, in, in, in, you know, the mathematics classroom. Umm, (2.6) again, it comes back <to> umm, (2.8) it, it, it does come back to time. But it also comes back to, umm, (4.2) educating teachers, umm, teachers want the very best for their kids. Every, every, every teacher worth their salt, wants the very best for their children. The, the challenge that teachers have is that they are time poor, umm, in terms of (2.2), aah, err, lesson preparation, >and being able to go out< and research for resources. Umm,

a-, and, quite simply, they don't know what's out there. So it's, it's, ah, it's a bit of a case, in terms of digital technology is that they don't know what they don't know. ((I: laugh)). And I'm guilty of that, so, yeah.

I: Of course, thank you. So, the, the very last question is about, ah, [R: yes] the, the teaching strategies, ah, or, the, the instruction guidance that you believe could (2.7) ensure the effectiveness of these activity? In particular, what are, the, the role of the, of a teacher during the these activities?

R: Yeah, (3.8) umm, I think that would vary. Umm, I think, aah, in the case of (0.5) the (0.5) cartesian plane example that I talked about earlier, umm, you wouldn't just get kids to go out there on their own and, and, (2.9) you know, do their own thing. So there would need to be some teaching guidance. Umm, (3.1) however, you know, <as> umm, (2.4) time goes by you might be able to hand over some of that responsibility. I think in terms of digital technology, umm, and, eh, as I was mentioning before, ah, using Geogebra to investigate a, a, a series of geometric properties, such as, you know, the sum of the angles, the interior angles of a triangle. The sum of the interior angles of a (1.5) quadrilateral – the, the, <ahh> the alternate angles, and so on. ((cough)), I think, umm, you could have a variety of ways you approach that. The teacher could approach it just be simply having that up, on, you know, in Geogebra, having the app up and going through it, showing students, so it's just a demonstration. <Or>, that the teacher could actually umm, say to the students "OK, well, here's an activity. What I want you to do, here's the app, I want you to go in there and I want you to play around with these parallel lines and just move them around a bit, and see what happens, to, you know, to these alternate angles. Umm, so they-, so I, I, think in terms of digital technology you could go back to a, umm, I do, um, we do, and you do type approach. Umm, depending on, I guess the, umm, the teacher and their confidence. <Also> depending on the students that the teacher has in the classroom. Umm, because, umm, sometimes you'll have a mixed ability class, where you've got students who already know this right down to students who, unfortunately, probably never will know this. Umm. Or, you know … So, (1,8) I, I think that's part of the beauty of, part of the beauty of teaching but also part of its (1.7) great challenge <is> that, as a teacher, umm, it's not like being a doctor. When you're a doctor, a medical physician, you're meeting with one patient, they're telling you one set of symptoms, and you're making one diagnosis for those symptoms. When you're an educator, you've got anywhere between 20 and 30 or even more students. They're all trying to tell you their diagnosis, (2.5) or, or their symptoms. You've got to try and diagnose all of those students (2.5) at that time, in real time, and come up with some solution. And, unfortunately, because of (2.8) the way that our education system is, (3.2) <we don't have the same opportunities as the physician>, as the doctor. We have to come up with some sort of middle idea that's going to hit as many targets as we possibly can. So, it, it's like a doctor, or a physician having (1.4) 30 people in a, in a, in a consultation. All of them throwing their symptoms at the doctor, the doctor then making a diagnosis ((I: laugh)) and it's supposed … well, it, that's true, it's ma-, you know, and then trying to make a diagnosis that's going to cater for the vast majority of those people. And some of those people (2.8) are not going to be cured. And that, as a (0.9) teacher, is what we face <every single day>, with our students.

I: (5.4) Yeah, of course. I agree with you it's, it's a great struggle for, for teachers, <and>, and they need supportin it. I also ((sigh)) think about this fact. So (1.4), R., I, I asked you all the questions I have prepared, so, thank you so much for your time and your precious contribution.

[…]

Teacher St

06/04/2022

[…]

I: Thank you.

St: OK. I'm (3.2) teaching at St Ursula's College Toowoomba, which is a girls school. (1.3) Ah, originally it went from Grade 8 to Grade <10> (0.9), <and> then in 1993 our numbers were going down, so we introduced Senior. So, it went from Year 8 to Year 12, a- and, it is a boarding school. Originally when I started there were (2.9) 250 boarders, and (1.2) 200 day girls. <And>, now there's probably, umm, (1.3) probably only 30 boarders, and (1.3) 400, 450 students. Umm, it's an Ursuline school, so Angela Merici is the patron saint, umm, and they, the school has done tours to Italy to visit, umm, Brescia and Garda and places like that. Uh, I haven't been on a tour, but I'd like to go on one. Umm. (1.0) Oh yeah, the school doesn't pay for it, you have to pay for yourself ((both: laugh)) so, it's a little bit, yeah, a little bit expensive. About $5,000 I think, so … [I: mm] Umm, I've (2.7) mainly been teaching maths, so, I've been there (0.8) 37 years. Mainly teaching maths. <I> (2.2) taught maths and science when I started. I really like science. <And>, I, I like to introduce, umm (1.1), I do astronomy, too, at, at home. [I: Wow] I like to introduce astronomy (0.9) at school and show students, ah, photos, or, or warn them about things that are upcoming, and that sort of thing. Umm, but yeah, I'm just teaching maths at the moment, but I'd like to have some more science, but, (2.0) umm, … Yeah, so at the moment I'm teaching (2.8) <Grade> 7 and 8 maths and then a Year 10, umm, (1.4) Methods Maths it's called. Which is maths for kids that are going to do the harder maths, in Grade 11 and 12, <and> (3.0) in <Grade> 11 and 12 I'm teaching a composite class of specialists. So, there's 2 Year 11s and 3 Year 12s doing the specialist maths – matrices and vectors, complex numbers, that sort of thing, so … Umm, (1.0), yeah. So it has been a composite for a while, that sort of specialist maths, because of the low numbers. So [I: yes] yeah.

I: Thanks, great.

St: And, I do a lot of, I do a lot of <soccer, footsal, football>. So, yeah, I, I (0.7) coach footsal and football. Yeah.

I: Fantastic! And many, many, many experience ((laugh))!

St: Yeah! ((laugh))

I: Thank you. So, mmm (2.4) to break the ice, I, I ask you to, umm, (3.0) to summarise, in a single word or a sentence what is mathematics for you?

St: (2.1) OK. For me, one word, it would all be about, umm, patterns.

I: (4.2) Wow! Thank.

St: That's the most important thing for me.

I: (3.0) Thank you. So, aah, and now I, I ask you some question about the questionnaire. [St: mhmm] <And>, the feeling in particular about, err, the questionnaire. [St: mhmm] And the first thing is, what do you think about the topic of the questionnaire? Did it seem familiar, or something that is far removed from your school reality, (1.5) for instance?

St: (1.3) Umm, yeah, I like the topic, I think I like using, umm, hands-on activities, and (2.0) the, the only problem is with the <time> constraints – getting through the content and all that too. So, it's very hard to (4.2) umm, do that, like, for example, we were doing, umm, (5.2) speed, distance, time the other day

and I, I was using one of those (2.2) motion detectors, where [I: mmm] these, the graph was projected on the screen, and the students had to (1.2) either move towards it or back and (1.0) their graph would be projected over top, of the, over the top of the one on the screen. So, umm, they, they eventually get a feel for it, so you give them 3 goes, and see if they can get it. So they have, have like 6 seconds to.. (1.2) umm, the graph has three sections, so it might have a, (1.3) might have a section like that [I: yeah], a section like that [yeah], and a section like that so (0.8) they have to, time it in 3 seconds, so normally they're, they're too quick – so it's 6 seconds, normally they're too quick (1.2) and, umm – yeah, or they go the wrong way. And then you can do it as a velocity graph, too, so I like, like introducing that (0.8) when we're doing, umm, graphs in (2.0) Year 7, so I did that last week, so … And then they get a bit annoyed that they don't all get a turn, so, it's, yeah … So they want to keep doing it until they all have a go, so … (2.0) Yeah, I'll have to do that next term, because we didn't finish it ((laugh))! ((I: laugh)) That was our last, last lesson on, ah, last Thursday. Yep.

I: OK. And, <and>, about some question in the questionnaire. <You> have, (1.0) umm, the, (1.2) the, the impression that there is some, (1.5) mmm, inconsistencies, some aahm, question that <you> did not expect to <find> in, ah, in the questionnaire, or some (0.8) important aspects that are not taken in consideration, for instance?

St: (5.8) I, I think, umm, I thi-, umm – I'm not sure if this is what you mean, but I think (2.8) ah, yeah, the time constraints, and doing these sorts of activities, that's (0.5) that's the problem that puts a lot of teachers off – as they take time. But, I think they're really, umm, meaningful, and students, students get a lot out of it. So, (1.0) like when we're doing (0.8) trigonometry and angles, I like to go out and, (1.0) and get them to measure angles with, with the clinometer, and, and, you know, measure distances (2.0) to the base of a tree, because they're, they're not very good at <estimating distances>, so you ask them how wide's the classroom, and (3.2) you g-, you get some ridiculous answers, so – like 80 (0.8) 80 metres, and you think "what"!? Yeah, I don't know what (indistinct: 6:20) ((laugh)) whether, whether they're being serious, but some kids just, just have no idea on heights and things, and all that. And, when the space station goes over I'll say "that's" (if it's directly overhead) "that's about 400 kms you can see up into the sky", and (0.8) they don't even realise there's people in it, so, (0.7) they (1.2) yeah they …

I: So, so what, what do you believe (1.1) is the, mmm, (1.5) mmm, the importance (3.2) for learning mathematics of this kind of, of activities in particular? The, the, what are the, the main reasons why it's important?

St: (4.5) Well, (3.2), I, I don't think, I don't think it's a lot of, umm, (0.8) a lot of <rules> <and> a lot of right and wrong questions. I know a lot of students (2.4), umm, (0.6) they think mathematics is all just about <rules> and getting something right and wrong. (0.6) So, I, I like using (0.8) a little funny problems, too, where (0.8), umm, (1.0) they have to be within the ball park, but, so there's, there's no right answer, there's some answers are better than others. So, I think students are used to (1.2) loo- looking in the back of a text book and seeing if they've got it right or wrong, and then, (0.8) if they, if they get a lot of wrong answers, then that puts them off. But if you can, if you can get them thinking about (1.5) you know, estimating things, or you know, how many, how many pizzas are sold by, (2.1) aah, Domino's, in Australia. And if, if you could lay out all of those pizzas, what area would it make up. Or if you could stack them at, stack them up high, how big would it be – that sort of thing. So, if you can get them coming up with things like that, they start thinking about … So they're using their <rules> and, but they're applying it to, you know, a situation that's, sort of, umm, silly, ah, like "how high would you stack them", but it becomes a (1.0) a big problem with disposing of waste and garbage and all that sort of thing, so it has (0.5) a real world application, so, that's, that's the sort of thing I like using because, (0.3) umm, yeah, doing real world stuff and all that. Mm.

I: Yes. (0.5) Of course. <And> (0.7) wh-, what, what kind of outcomes, err, would you expect to obtain (1.8) from the implementation of an activity in which, ah, students are engaged with their body?

St: (4.5) Oh, I th-, I think they will, they will learn it a lot better, and (2.2), umm, basically rather than just writing something down, and (0.4) trying to learn it by rote, if they're actually involved in carrying out the activity, that they will actually (2.2) – it will have a lasting (1.0) imprint on their minds and all that makes you remember it a lot (1.3) more clearly. And, yeah, it should be more relevant, too.

I: (2.0) OK. [St: mm] (2.5) So, erm (3.0). Do you believe that are some difficulties, aah, that you (1.9), for instance, experience when carrying out this activity? (5.5) Of, aah, [St: aah]. … difficulties that could be for you, (0.2) ehh, of you, as a teacher, or of students, when, aah, (3.3) acting during this activity?

St: (2.8) Well, they, they can become, I think, some teachers might think, becau- because they're <noisy> that they're not, they're not on task. ((I: laugh)) umm, <So>, (2.5) and, and, and the groupings, too have to be ff- fairly important, too, so if you, if you group students (2.1) [I: hmm] they need to interact with each other. So, (2.0) I do have some girls that don't like, well, they like working alone, so they find that a bit difficult, umm, a bit hard to get them to (0.5) <interact with other students>, so (2.5), but very important, umm, for social skills too, if they're doing all >that sort of thing<, and (1.3), basically, (2.0), I think if they (2.5) if you allocate the groups correctly – like someone's a time keeper and someone's the chair person, >that sort of thing<. And they can hear what other people are coming up with, too, then, umm, (2.0) then they work better. So, (1.0) we, (0.8) we do have this in the <senior> school, in the modelling and problem solving tasks – they do an assessment task. And, (1.3), they can, they can work in groups, and, (1.6) <umm>, bounce ideas off each other – as long as they, (0.3) the assignment has to be their own work. So, (2.0) they, they, can't just copy the other person's and all that. So, you can, yeah, you have to check that they haven't ((small laugh)) done that, but it helps, it's quite helpful for them to work in groups, and, yeah.

I: Yeah

St So, that's, that's part of the (0.5) the Senior syllabus in Queensland, which is good. (1.5) Yeah.

I: (6.2) And <you>, think there are, mmm, (1.5) any limitation of this activity? Some (2.7) downsides of bringing this activity into the classroom?

St: (5.8) Umm, (3.9), I guess, umm, sometimes you think "<how could I> do that (2.1) activity differently?," Umm, (3.0) <like> for, for example, in, in our school there's a lot of (0.5) cancellations, and (2.0) umm, yeah, meaningless (1.3) ((laugh)) cancellations of a lot of things they don't, they don't really need in the senior school, but in the, in the junior school there's all these cancellations, index laws and everything like that. Umm, (1.7) so, that, that (1.5) becomes, (2.5) umm, well kids become <a bit>, umm, (2.8) <bored> with it, I guess, so [I: mmm] if you could turn it into some sort of <challenge>, umm, and, and use technology to (2.8) to look for a pattern. So, if you can do things like that with (1.8), umm, (08), yeah, making them into a problem solving-type activity. But, rather than just, yeah, cancelling things out all the time and the kids get (0.4) a bit bored with that, and it's very hard to turn that into a physical activity!

I: Yes. (2.2) Of course. <And> about <some> teaching strategies, ah, <or> eh, kind of (0.4) instruction or guidance, that, uh, you implement to ensure the effectiveness of this activity, there are.. (0.4) The grouping is, is one, one of, of them. But do you have any other strategies that, aah, implement to, err, to be effective with this kind of, ah, act- implementation?

St: (5.2) <Umm>, (2.0) I think, (3.6) <mainly> (2.0) to, to see if it's, it's effective, so (1.0), aah, for example, we were doing one on (3.2), you know, the catenary with the chain hanging down, so we had, umm, bits of (2.3), bits of string hanging down, the students had to measure that. <And>, they were working in, in groups of (0.3) <3>, collecting all the data. And then they had to use, umm, <Pythagoras>, (0.8) and, (3.2) umm, and that was one of their assignments. So they had to hand in (4.0), umm … their assignment

was work on the catenary and, (3.0) umm, and just how well they went in that I thought was (0.5) that was quite effective. That, yeah, the students got into it and (2.0) … Some of, some of their data was wrong, at first. So they were measuring the sag wrong. You know, the sag (2.0) from the floor to the, to the string rather than from <the> (2.2) err, (0.7) from the top [I: yeah], from the top of the poles to the middle, they were going the other way. And using Pythagoras, but it was all wrong, because the sag wasn't right ((laugh)), so … But then, then they worked it out, so they were getting funny results, and, (1.5) yeah, because the (0.8) yeah, one side was longer than the other side – that quickly showed up and they were, when they were doing Pythagoras but they were (0.9) getting the square root of a negative number ((laugh)) and all that, so …

I: Yeah

St Yeah, so (1.0), so I think it, I think, yeah, doing physical things like that does, does help them. Umm, (2.0). Yeah, collecting, collecting data's very important, because they're not [I: hmm] not very good at it to start with, but they do get quite good.

I: (0.4) Of course. <And> do you think it's imp- (2.0) it's important to.. (1.8) What is important to observe and to do as a teacher during this kind of activity?

St: ((deep breath)) Yeah, it's (0.5) it's very hard, umm, because you want them, you want them to be successful and sometimes you want them to do it, (0.8) <be successful in a lesson>, so it's very hard not to give away, (0.5) [I: mmhmm] umm, give away the answer. So, the teacher [both: ((laugh))] – it's, you have to ask the right questions so you don't, yeah … "what about if you tried this" – that sort of thing, so that. That's very <hard>. And, I know, (2.0) umm, sometimes, sometimes I give too much away, and, yeah. And other times, I'm [I: It's difficult to] [St: give much away at all] [St:And other times..] [I: difficult to shut up ((laugh))]. Yes! (laugh)) Yeah, so it works out well when they're (0.6), when they're all on task, and you can see that they're (0.4) questioning one another and all that, so – yeah, that's good, so. But, yeah, sometimes they're just lost and yeah, you don't' have to help them too much ((laugh)), so, yeah.

I: Of course, a-, and, err, umm, (1.6) what convinced you to propose this activity in your classroom?

St: (5.0) Umm, (3.0) <well> I've, I've <been> a member of (2.0) of a few projects and all that, and I've, (2.0) I've worked in, umm (6.0), well I've <been> a member of the NCT and the National Council of Teachers of Mathematics and I've been following, I follow things on, (2.0) on the web and all that and I, I think it just, yeah – concrete models and all that when I was doing my teacher training. They were always big, and that's always stuck with me. So (4.2) yeah, trying to use real world data, that's really important. And I, I really like, yeah, the mathematical modelling, and I think that's (4.0), that's just amazing, so. (1.3) And trying to get kids into that, it's quite hard, because they're after a right answer all the time, and, (0.5) yeah. So, but I like the modelling tasks that we've got in the senior school now. I think that's (1.3) a big step forward. That's, umm, very helpful, for them. They, they seem to go quite well at their assignments, and, see, in the senior school, in Year 12, they (1.5) have a task worth, modelling task, worth 20 marks. And then they do (2.8) two 15 mark exams at the school. So that's 50% of (0.5) their marks at the <school>. And then outside the school they do the external exam, which is the other 50%. So, the, modelling task, <is> 20% of – well – 20% out of the 50%, ow!, well, 40% of the 50% at the school. So, it's a fairly big task, so (2.2), yeah, so they seem to like it, and it's meant to be timetabled, you're meant to give them 3 lessons, (1.2) in (1.0) the, umm, 3 weeks (0.9) period, so [I: oh] they can work on it with their peers, yeah. (3:4) So, (2.0) hmm.

I: <And>, a- another- Oh yeah, I, I, I think that (5.0) probably you simply tryied to, to propose these things in the <school>. And, umm, do you, encounter any constraints that limited you in the proposal? Or, for instance, you are supported in proposing and implementing these activities?

St: (4.8) Yeah, I think, umm, (0.9), the two – so we're doing, we're doing these sort of hands-on activities in the, in the junior school. <And> the teachers, the teachers are quite happy to, (2.6) aah – for example, the (4.2) the (3.3), originally when I did the catenary I had each group, I gave them a, a piece of string with a known length, and it had what the sag was on it, so they had to set that up. And getting it the distance between, you know, the 2 stands to get that sag. Umm, so, that did take them a while to do that. So the teachers, when they did it, did it this year, <they> (0.7) wanted to speed it up a bit, because it took quite a lo-, quite a while to do it last year. So they actually told them (2.5) the distance between the 2 posts and then they just had to measure the sag. So I had it the other way, so the other way took a lot longer, because they had to move the posts until they got the sag right, not the length. So, the teachers wanted to speed that up a bit, because it did take a bit of time, and, (1.2) umm. Yes, so the staff are pretty good, so they're after hands-on activities. I know (3.5), the, the transfer between things they do in maths and science – I always see that as a big problem. Because we're doing equations online, and everything, and they (2.5), they don't see that as, you know, the gradient in, in chemistry when there's a reaction rate, or something like that, they (3.0), they think it's (1.3) completely different, so (3.0) the symbols are different too, so, (1.5) yeah. [I: yeah]. So that's, that's one of my worries ((laugh)): the transfer of knowledge. (4.2) Yeah.

I: But is also the transfer between the knowledge that students have experiences, (3.0) during, during these activities, and, afterward, when they come back to a more formal (2.8) mathematics? (4.0) Is it an issue in <your> teaching, this point? The transfer of knowledge (2.3) between the two different <fields> in a certain sense. The first one, that is an hands-on activities, and the formal one that is, (1.2) traditional method of, of, doing maths. Could you encounter difficulties on this point, this transfer of knowledge in your students?

St: (6.0) Umm, well, yeah, I do, I do see it with (3.1) … So they're doing science, and they're, and they're graphing something with, you know, a spring, and a weight and the, and the force, and they're, they're graphing that. And, because they're using (1.4) ah, force equals (2.2) mass x acceleration or mass x weight, sorry, mass x acceleration mg and, and, we're using $y = mx + c$. They, they don't see that as, umm, as the same thing. Umm, (2.8) I was, a few years ago, we were teaching (2.8) umm, (2.6) in (1.8) – before it was called Specialist it used to be called Maths C. And there was a lot of, umm, (2.0) vectors in there, and (1.6) the kids were getting confused, because the physics teacher, (2.0) ahh, was using different symbols to me, so I tried to, (2.0) umm, (1.8), yeah, copy the physics teacher's symbols and say, these, these are the same things, we're just using ((both laugh)), they're just using different symbols, fiddle and tiddle instead of the vector and all that. So the kids were getting confused, so, (1.0) so I said they're all the same thing, but they still wanted me to do what the physics teacher was doing. So, (1.8) yeah, they just saw that as an extra thing to learn, so, (2.0) yeah.

I: Of course. And do you have collaboration with your colleague, or some external colleague not in your school, in, ah, doing and in designing those kinds of activities, for example?

St: Yes, so now we've, we do have a, um, (3.3) a lesson, it's called Professional Learning. So, it's with, umm, (2.0) <teachers> that's on a spare, so we get together. The only thing is, so, I'm with a (3.2) umm, another maths teacher, and then a French teacher and another, umm, design and technology teacher, so (1.8) it would be better if I was with (1.2) <more> science people, or things like that. So the way the timetable works, because I'm on spare then, they're obviously not on spares together. So it's <very> hard to (0.8) have the dialogue with, with the right people. So, (1.3) it probably works best when we have a student free day, at the, (1.3) at the start of the term. Umm, and if we're, if there is time, to do it then, >but normally what happens<, the, admin has all other plans – has it all mapped out for what's being done. So there might not be much time to do other things. So – >but it's gradually getting there, now<, so, (1.7) umm, yeah, so we've, we have this professional learning community thing, which is good, so, umm … And I'm on, I'm on another (1.5) committee the QAMT maths teachers association,

so that's, umm, (2.6) that's once a month, and we have journals, so we, we send out information in journals and all that sort of thing. And then locally there's the Toowoomba Maths Teachers Association, so we, we have a meeting there once a month, so, yeah. Just helping with, umm, new teachers and other things in the, in the curriculum. Yeah.

I: Great

St We don't get many people to the meetings though, there's only ha-, the last one we had there was only about 8 people ((laugh))! So, Vince and Peter actually came up. Vince Geiger and Peter Galbraith [I: yeah] turned up and did, did the modelling. So, yeah, there was, aah, oh, (3.5) 9 people counting me, yep, so. But they enjoyed it, the people that were there, so that was good. And it was recorded too, so it'll be on the QAMT website, so, yeah.

I: Yes. Than you, you have a bit of support in your, in your work ((laugh)). Someone to dialogue with [St: yeah]. Yes, it's great. So, I, I want <to>, to thank you for your time and, ahh, your (4.5) participation in ahh in this project. I will inform you, ahh, about the, the result, if you are interested, because I have your mail, so I can [St: Yes] send you something!

St: Yeah, very int-, very interested, yep. That would be great.

I: Of course. We conducted this, ahh, this research in Italy and in Australia. [St: yeah] I can't <be> in, in Australia, I couldn't be in, in Australia for the pandemic emergency, so I [St: yep], it's, umm, something that really affect <my> research obviously, but these are, a good way to, to be connected to, to the Australian context, so …

St: Yeah, I think with the pandemic it's made, umm, people use Zoom more, and (1.4) yeah, so, I know, I, (1.2) I do, umm, oh, these talks through – I buy the Sky at Night magazine, and they have all these talks coming out from England and New Scientist has all these talks, too. And, umm, so you can, yeah, just log in to a webinar, I think that costs about um (3.2) £10 or something, but it's better than missing out. [I: yeah] so I think "oh". And, oh, they're recorded too. I can look at them 5 times, and there's handouts that go with them, so – yeah, it's good. I get a lot of knowledge from that. And I, actually, sometimes I think I was actually there! So ((laugh)) because it was early in the morning, normally about, umm, 4 o'clock in the morning, so [both: ((laugh))]. Sometimes I fall asleep, but.. Yes.

[…]

Teacher Su

08/04/2022

Su: OK. <So>, umm, I have been teaching maths for <40> years [I: woah!]. This is my 40th year, (2.0) so that's exciting for me. <Umm>, and every year I love it more. Umm, I'm currently, ah, <the> Head of Faculty for mathematics at, um, a boys Catholic school. (3.2) So, my school has just over 1000 boys from Year 7 to Year 12. [I: hm]. Mmm. <So>, umm, I, ahh, this is only my second year in the school, (4.0) umm, 2 years before that I taught for 2 years in a girls school. (2.5) <Umm>, prior to that <I> (3.0) worked at, <umm>, a curriculum office for Queensland in Australia writing mathematic syllabus for Queensland. (2.1) <So>, writing a new course, ah, for the Senior students, which was (1.2) interesting. And, yes, I've taught primary and secondary, so I've had quite a range of experience.

I: And where is, your, your school?

Su: (2.0) My school is <in> Queensland, Australia.

I: (3.0) Fantastic! ((laugh)) So, umm, to.. A question to break the, the ice, heh. What, what is your (0.8), in a word, in a sentence, (3.8) mathematics for you, if you can summarise?

Su: (2.0) Mathematics is pattern and beauty. (4.2) <Umm>, (2.1) yeah! I, (1.2), my passion for mathematics, I'm not (1.2) a Ph.D. mathematician, umm, I'm just somebody who's always loved doing maths. I like the fact that there's a right answer, <umm>, when I've had to do English at school I found it a challenge, because you never know (0.7) what the audience is after. <In maths, you do> [I: yes]. Umm, (3.1) <and> I <like>, trying, <to turn students on> to doing mathematics, who are not interested in mathematics. <So>, at the start of the year, I will look at the results that students got the previous year and I do a big speech at the start of the year, (0.8) to all my classes, umm, whenever I have new students. And I always say "I don't care how many times you ask me a question" [I: haha] "I will <always> be patient, I will always answer, you can ask me 26 times the same question". And they say "what happens after 26"? And I say "nobody ever got to 26." [I: laugh] If they don't understand, I say to them, it's my fault and I have to find another way to explain it. I think too many maths teachers only have one way, (1.4) and you need to have a variety of ways. You might use patterns, you might use pictures, you might use blocks. You need to find a way that will suit that student. Umm, (4.2) [I: great] Yeah, and I think the main thing is <that> (0.8) anyone can be good at maths, if they take the time. [I: mm]. <So>, that's what I push with my students – and I like to show them (1.0) the real world implications. How it's going to be useful to them.

I: (4.0) Great! ((laugh)). So, <umm,> some question about the questionnaire. In particular, the first question is about, the, <mmm>, what do you think about the topic? The topic is active bodily experience learning, activities for learning mathematics in particular. [Su: mhm] <And> (2.0), I don't know. Did you, did it seem familiar or far removed from your (2.0) school reality, <or> (0.8), I don't know.

Su: Uhh (1.2), OK. I've only been in my school for one year. (2.1) So it's very <far> from the reality of what is happening in my school? I came into the school, umm, I didn't know when I was employed that I was employed for this reason, but I was employed because I think differently about maths, and I have a different approach, and over half the students were <failing> (1.5) in mathematics <and> when I met my staff I said "you love maths, you're passionate about maths, so why aren't your students? What are you … what can we do to get them to be as passionate as we are?" <And>, I think (0.4) this topic really appealed to me, because having taught primary, where you do a lot more of the physical side, (0.3) umm, in every kind of learning, <and>, I think, sometimes they get to high school and the teachers go

"here's the text book. Turn to page 123, do the left hand column." And it's so boring. And so, I'm, I'm looking at exploring different approaches, and so this really appealed to me.

I: Mmm. Fantastic! (2.2) And, some observation about the, err, topics covered into the questionnaire. Did you <find> the question relevant, or did you notice any inconsistencies or something did you not expect to find? (4.3) <Or> there are some important aspects that you, ah, feel that (2.1) were not taken into consideration?

Su: (5.5) So, it was a little while ago, since I've done that [I: yeah] umm, looked at those questions, so I can't remember the exact questions. But I don't remember thinking (2.0) anything was left out, or, or anything was irrelevant. Umm, I just (1.2), I thought the whole (1.1) whole idea was exciting. [I: Oh! Fantastic!]. I'd like to see the, the, finished, umm, (2.3) ah, report.

I: Yes! Of course.

Su: Do I get a copy?

I: Yeah, yeah, yeah. I will send you.

Su: Fantastic.

I: Of course. <And> so, about <umm> this kind of activity. Can you give me examples in reference to active bodily experience mathematics learning activities you have implemented, <or> you have seen?

Su: (3.8) <So>, umm, ((sigh)), because I've taught primary and secondary (2.2), I've <seen> quite a variety of approaches, <and> (1.2), in the primary school, particularly with the younger students, when you're doing things like <counting> I might say "all right – everybody <move> into groups, and let's make 3", or "let's make 5, or let's make groups greater than 4". Or "let's make groups that are in even numbers", so all the maths concepts are very easy to do in a physical sense. When I'm teaching <secondary> (1.5) people generally don't do things like that. Umm, but I've taught maths and science and used a more physical approach. Umm, not <all> the time, but at times. Like, umm, particularly when I'm taking, umm, classes for the <lower> ability learners. Umm, (1.2) so one of the classes I taught for 2 years was a Year 12 class that were, (0.5) in (0.4) Queensland we have <4> levels, and this class was the bottom level. Now, usually the Head of Department doesn't take these classes. They like to take the higher ones. I like to take the low ones and make them excited about maths. So, we did things like, when we learnt ratio. <So>, like 5 as to 2. Umm, we would get blocks and make (2.8) umm, representations of <that> using maybe 5 red and 2 white. And then, I said "what happens if the ratio is not 5:2, but it's 2:5?" So, the other way round. <So>, this was in a girls school and, (1.3) all the girls started pulling blocks off, and putting other colours on this, and, and, one girl, who's the bottom in the class, just turned it over. (1.4) And everyone went "can she do that?" and I said "you tell me, can she do that?" And they all got very argumentative, which is fantastic! Because they're all arguing and trying to prove why they're right or why they're wrong. And, in the end, it was so good for her confidence too, because she was the only one who came up with the most obvious response. Then when we were doing different shapes. (2.0) Umm, I would get, umm, boxes. Like we have a chocolate box, I don't know if you – do you know Toblerone?

I: No.

Su: Have you heard of Tobler- [I: no] oh OK, so it's a chocolate, and it's in <a>, a box (0.6), [I: yes] the end is a triangle [I: OK] (0.7) yeah, and it's <long>. So I said "let's pull it <err, umm>, let's (2.0) <draw> around each side, (0.5) put it on a sheet of paper (0.5) and then do a cylinder and a square, a cube, and all the different shapes." Put all those pictures up on the, the <board> and then they had to try and match them up. So they were getting out of their seat and, (1.3) and (2.1) arguing again, matching, but those discuss-, (0.8) I say "argue" but really it's discussion about (0.8) why they are right, or why they are wrong (1.5). And it was good. And then even just looking at the, (1.2) the different shapes, and saying

(1.2) “let’s make that shape” so, in groups, “let’s make a triangle, let’s make a square. (1.8) Does the triangle – do all the sides have to be the same length, or can we do it a different way?” So, it w- they, they got very excited [I: yeah] about it. [both speaking: and..]. <endless> number of ways that you can involve physical, whether it’s small or your whole body.

I: Of course. And also, do you include sometimes, some activities with <technology> that involve the body?

Su: (4.7) Technology with the body.. (8.2) I can’t think of anything! (3.3) If you can suggest something I might, it might (4.5) give me more idea of what you mean?

I: <Umm>. For instance, ah, if <you> use some iPads with some <softer>, (1.4) like, err, <umm>, (4.2) <some> (5.0) games, say, which you, umm, (2.0) use your, umm, (4.2) the shape on the screen <to> [Su: oh, yeah, yes] compose something …

Su: So, I do actually use a l- (1.2) we don’t have iPads in my school, we have, aah, laptops. But, umm, I use a number of different websites with my students to play games to <really> cement their understanding of different concepts – measurement, or, umm, length, or whatever it is that we’re doing. Umm, yeah, so quite regularly I do that sort of thing. Yes. [I: So. Thank you] Also things like using, umm, (2.8), aah, like a, a <l:aser> [I: <aah>] like a surveyor would use, to measure distance (1.2) you know, how long [I: great] is the room. Those sort of things, so. The boys in particular really enjoy it. [I: Yeah, of course] And then I explain to them, (0.8) this equipment is the same thing that a surveyor will use to (1.1) make the road, or, umm, I had a man come to measure my house for carpet, and he used a laser instead of a tape measure to measure the length of my hallway. Yeah. [I: yeah] Then he had to use his tape measure, because the hallway was too long ((both: laugh))!

I: A-, and do you, umm, (3.2) Why do you think it’s important for (1.8) learning mathematics to involve the body movement of your students?

Su: I think the <more> senses and the more parts of your body you use, (0.6) the greater the, the retention of the knowledge, and the skills is going to be. Because, (1.3) even to the point of using <colours> in my classroom, (0.6) for cards or writing on the board if I’m teaching simultaneous equations. I’ll use 2 or 3 colours to show them – this coloured equation is substituted into this part of the other equation. And, I had a teacher who was struggling to teach that to her students. And I said “let me come and help you.” And I, I did this with her class! And the boys were all saying, “<ohhh> now I’ve understood,” you know. So, just using (0.8) as many different approaches as possible is going to help them improve their understanding.

I: Of course. And what kind of outcomes do you expect to obtain from such activity?

Su: Obviously you want them to have greater understanding of the content. And some students are going to really improve a lot, and some not quite as much. But my main focus <is> (1.3) improving their passion for the subject. Because I think if their, their attitude, (2.2) umm, to learning mathematics is more open and they’re more excited, they’re more like to engage in the subject.

I: Of course. Uh.

Su: So at the start of the year I will have (1.8), my Year 10 class, so those boys would be 15, 16 years old. At the start of the year I had quite a few who failed last year, with different teachers. And, for whatever reasons. I think teenage boys often are disengaged in learning (1.5) totally. Umm. And so, I said “all right, (2.0) we’re not boys any more, we’re men, and we’re going <to> learn lots of things. We made posters, we made (2.2) shapes and measured things, and we did a lot of physical things, like that. The more I think about it, the more I realise how much I am actually doing. I had one boy, he said he failed last year. He got 95% on his first test. And another one got 90. So these, these boys who previously were failing and had almost given up – I said “just give me a chance, and I can show you”. Now, the,

one of them sent me an email in my holiday, because we're on Easter break now. He sent me an email, he said "thank you for making me love your subject." He said, "when I see it on my timetable for the day, I'm excited to come to school." And, (0.4) it's just those <small> things that you do that can make a big impact.

I: Of course. It's [Su: Yeah] I agree with you. So, a- and, do you, what difficulties did you experience when carry out these activities?

Su: (3.5) OK. The biggest difficulty I would <say> is that the lady who was in charge of maths before me, (3.2) and is actually younger than me – she's probably 8 to 10 years younger than me but very conservative approach to mathematics. Ahh. She was (4.2), how can I say (1.3) not – she didn't <say> anything, but she can see, with all my new approaches, her face was (6.2), like she didn't approve. [I: mm] <And> all the staff in my department (4.5) umm, were <trying> out these new things. Especially the second half of last year. And you can see her face like (1.2) and she would say things like "<why> are we doing this? Why, why are you changing everything?" (3.4) And, (1.3) but my staff, (1.3) the rest of them were excited, and they love her. So it wasn't that they were going against her, but – they could see that trying new things, and trying to make it more interesting for the students (1.2) was really making the students more engaged in the subject. So, yeah, the biggest difficulty was changing the attitude of (3.4) a couple of the older staff members. But my oldest staff member – he's 65 [I: oh!] <he's> so happy! He said "this is great, the students want to learn" and he takes a lot of the lower classes. And he said "ohh, it's so refreshing to come into class and …". Like, I bought a lot of equipment, umm, (2.8) even from primary <school> websites, <so> (1.8). You know, blocks, and cards and (1.8) dominos – do you know dominos? [I: yes] Yeah, dominos, but with fractions on one side and pictures of fractions. And they have to match it up, and all these different things. So teachers, (0.5) and I have it in a cupboard behind my desk, and the teachers can help themselves. So the teachers will come to me now, especially the ones with the low classes or the younger students. They say "we're doing volume, what have you got in the cupboard?" [I: ((laugh))]. And it's, so they're really getting engaged to them now, so, (1.2) it makes me happy. ((laugh)) [I: Yeah, of course!]

I: And, and …

Su: Yeah. So, you, you get those that get excited from day 1. (2.0) You get those that are negative (3.0) they'll be the last ones to change. And you get those in the middle that go "<I'll> just watch those ones. If it works, then I'll try it." [I: aa ((laugh))]. Now we've got the top ones (0.8) doing it from day 1, we've got the middle group, and now just got to get those <last few> to get excited.

I: Yeah. And, and, what convinced you to propose this kind of activities in schools?

Su: (5.5) I've always done this kind of thing ((laugh)). Umm (1.6), when I was in school I was not a top maths student, which is funny, because now I'm Head of Maths and I wrote a maths curriculum. <So> (3.3) I understand what it's like for students to struggle. A lot of the time the maths teacher is <the> top academic who has always found maths easy and exciting. So, I think it's good to have someone like me in this position, <because> I can change attitudes and I can change (0.5) the way people see maths. And that it's not only for these el- elite 5 or 10%, it's a thing for everybody. If you go to China, (1.2) people will never sit at a dinner party and say "Ohh, I, I can't do maths. I'm not good at maths." But in Australia, (2.3) and I don't know what it's like in Italy [I: yeah, yeah] (unclear: *18.3*) Australia – people say it all the time! "Oh, I'm not good at maths. [I: yeah, yeah] I can't do maths." You'll never say, "Oh, I can't do English,"(1.1) or "I can't do Italian." [I: Yes] No! You would be embarrassed to say that, but (3.8) yeah. [I: It's normal to, to …] and I can't change the whole country, but I can change the part I'm in ((laugh))!

I: Of course. [Su: Yeah] And, and what kind of, ah, (2.1) difficulties (4.2) experienced by students, aah, you observed during, aah, those kind of activities?

Su: (6.0) The <main> difficulty I think is, (0.3) umm, (0.5) their fear. Fearing of failing, because (1.2) some of them have failed for the last 3 or 4 years. (3.0) <So>, I like to find activities where <there> there's an entry point for everybody. (1.5) Every student can have some success at a certain level. And I like to do these activities in groups, of 2 or 3. Usually 3 in a group. I find that's the best group size, and I've done some research into it and, and read, you know, different reports and they say, around 3 is a good number. And if you form the groups appropriately, don't just say you can work with your mates. But, you can, you put the right students together. And then you give them a <task> where (3.5) it's not like "oh, here's the problem, can the group solve it" but it's (2.0) this student has this bit of information, student 2 has different information, student 3 has (2.7) maybe the equipment. Now how are you going to all contribute to come up with a solution? So, every person in the group has a job. And maybe the student that's not so strong at maths, but maybe they're better at English, hmm, they can read and unpack the question [I: yeah] (0.8) and then when the others start to suggest things, then their job can be to say "yeah, I think that'll work" or "no, how about we try something else." So they can be more a, a <critical> person within the, the situation?

I: (3.0) Of course. And, so I, I'm, I found in your, in your, (0.4) in your answer, <some> aspects that (1.2) what kind of, mmm, (0.8) teaching strategies (4.0) other teachers' strategies do you, <umm>, implement to ensure the effectiveness of these activities? What do you believe (0.7) is important to observe, and to do, as a teacher, during this kind of activities?

Su: (6.8) I guess I want to see engagement. (2.6) I want to see that every student is involved in the process, and not sitting back going "it's too hard, I can't do it" [I: mm]. Umm, but I also want to see that they actually understand. (3.0) <So,> (2.2), umm, I did a little project 2 years ago with a Year 7 group at my previous school, where we put in >problem-solving lessons once a, a fortnight<, once every 2 weeks. <And> they worked in <groups> that we formed, and, (2.2) it did, we did <surveys> of the students to see, <be:fore> and after, to see how their attitudes changed. And there was a very big improvement, like about a 15 or 18 per cent improvement in attitude towards coming to class! And towards doing maths. Umm. But I also want to see that their understanding, and their skills are improving. <So,> to do that, you can observe them in the groups, but I think it's still good to do it with pen and paper and problems. Let's have a try: how did they go <before> you brought all of this in, how did they go after? And to see that there is some kind of improvement. So, I like to <do> regular, informal (1.80) quizzes. So the students will come in, at the start of the lesson, and I'll just say, as they're walking in the door – a little piece of paper with 4, 5 questions – "It's quiz day!" And they all just laugh, it's no stress, because they know it doesn't count for the marks. And they do those quizzes, and it's on things that they've learnt, in those problem-solving sessions, as well as everything we've been doing those two weeks. So it's (2.4), you know, umm, revising, (1.2) constantly, what we're learning, so that when they get to their tests at the end of the term, (2.8) then they should have a, a deeper understand, because if they don't understand something I can pick it up early, and, and fix that problem.

I: Of course. And, [Su: mmm] and, <and,> umm, (4.0) what do you believe could be the <support> that a, that a teacher need when implement those kind of activities?

Su: (3.5) I think, it's good for teachers to work collaboratively together. (3.0) It, <ideally>, teachers would have maybe an hour once a week, where they can meet, (2.5) and have some time release so that they can plan these activities in a more structured way. And say: "Alright, now we're moving into Pythagoras and trigonometry, what's a good activity we can do for a lesson this (1.2) for this two weeks? How can we approach this?" And each teacher (2.2) either that or teachers just taking turns. So one fortnight you do it, the next fortnight I do, the next fortnight someone else. So that the work is not all on one person. But ideally, some time (3.2) ah, available to work, as a collaborative group. Because, I like <to> umm, listen to all my staff, and not just say you're the experienced one, I'll listen to you. (1.2) When you've got the loudest angry voice, I'd better listen. But, I like to also make sure that my younger

(0.8) and <more> maybe energetic, excited teachers – they get an equal say. (2.3) And I've done that with (3.9), you know, moderating for marking, and things like that, and some, some degree of planning, but not to this degree that we're looking at, umm, (1.2) more the active learning. (2.0) But I, I have (2.3) made my teachers actually (2.0) put once every two weeks, at least for one activity lesson, (1.1) so they can do things differently.

I: (3.3) Yes. <And> what … [Su: I talk too much, sorry] No, no, no, no, no, it's fantastic! [Su: ohh] <And,> (3.2) I'm, <I'm> interested in what do you believe could be, umm, constraints, for a teacher to implement. What kind of constraints could en- encounter in, in, in this context, or, or some internal factor? [S: I think …]

Su: I, I just think that the biggest constraint <is> older, more experienced teachers, not wanting to change. They'll say "I've done it like this for 30 years or 40 years. It's working, why do I need to change (4.6) And the thing is, (1.2) maybe it's not working. (1.3) But they are just accepting a certain number of students will not pass the subject. (2.0) And to me, (1.6) that means something has to change. If a student is working in class, and trying, they should be able to achieve.

I: Yes. (3.5) Of course. And, ah, [Su: yeah] and what could be a... In, in ah, in some case (2.5) there are teacher that try to implement this kind of activities, and they, and, and in a certain moment they perceive (1.5) a failure (4.2), that (2.7) this these activity <aah> don't, don't give, <<the, mm, the>> don't produce the outcomes they [Su: yes, yes] they expect. And what, what do you believe could be the problem …?

Su: <So,> I think it's important (2.4) <too> not just give up after trying once or twice. But to look at it and go: (3.4) what part worked and where did we think it's failed? And t- (0.8) for <me> particularly with doing group work, what I found when doing this with my Year 7 level experiment was (2.7) if <you> didn't form good groups, (3.5) then you had failure. If you just said, go with your friends, (1.5) it, it often led to problems, because >one group worked, one group didn't<, all the >smart kids were in this group, all the strugglers< were in a different group. So, it just didn't work. So, forming good groups, (1.5) <not having groups that were too big>, <and> (2.1) teachers really having a good <plan> (1.6) of what the structure of the lesson is going to be, and what the outcome is. What is their success criteria so that they know when they've achieved that, their learning goals at the end of the lesson. That they know they've been successful. And I think if <you> (3.5) when you first do this with students it can get noisy, (3.0) it can get, <umm> a bit cha:otic, and it also depends on the class size. Like, I've worked in schools with 33 students in a class. And I've worked in schools, I've had a class of, like, (1.7) probably my smallest class was15 or 16 students. And there's a big difference to the approach, (1.4) depending on the size of your class. So, I think, yeah, sometimes the noise factor, aah, teachers in the classrooms nearby. So how can we approach this, maybe having a classroom (1.2) <designated> for this, where (3.6) you can <have> some time al-, where you're away from the rest of <the> (4.2) the maths classrooms where the noise is not going to be an issue – next to the drama room, or something – dance room or whatever. So it's not a problem! [I: yeah, yeah, yeah] Just, (1.2) I think, there's a way to work these things out, if you really think about it. But, again, that (3.9) having time for the teachers to work together and pl:an can overcome some of those obstacles, because you can share those ideas.

I: Of course. [Su: mm] Be-, because I, I think about fact that, umm, (1.5) could be difficult for a teacher to have the, the knowledge, and the time to, to <plan> [Su: mmm] Mmm, it could be a constraint <to> umm, (4.5) to, (2.8) to decide to propose an acti-, on a, an activity that, could [Su: yeah] give you some that you don't expect, it, it, it's really -.

Su: So, umm, <I'm> bringing in a problem-solving group for my <high> academic students. Because my school has a lot of lower level students, and a lot is done for them. But those top students, there's not much happening for them. So, I want next (1.3) after the holiday, after Easter, I'm going to be bringing

in for, for the middle school, Years 7, 8, 9, I'm bringing in a program for the top maybe 8 students from each. And, (1.2) we have to have planning time, but I also have (0.8) I'm not doing it all myself, I want my staff to be skilled, so I'm going to look after one year level and have two other teachers to look after year levels. But I'm, in my holiday break, I'm doing a lot of reading, (2.0) finding problems that are suitable for that age, so that I can give this to my staff so they don't go in (3.2) feeling overwhelmed and they don't know <where to start>. (2.6) And I think as a, as a <leader> I, that's part of my role, to enable my staff, and once they start and they get excited about it and they see the reaction of the students, <then> my theory is then the staff will then start coming with their ideas too. (2.5) But I want to give them something to get started.

I: (2.0) Of course. So [Su: yeah] really, thank you. You give me a lot of insights to [Su: Oh! OK] to, to analyse the, err, the Australian situation. I am, (4.6) I start this research, ah, and, err, after a few months (3.0) start also the pandemic emergency. So, I [Su: I know] so I couldn't be in Australia, and, ah, <I'm,> (2.3) it's something that's really, umm (5.3) make me really sad because I want to, to, to encounter teachers in, in Australia. [Su: yes] I want to see what, what, what could be a school in Australia. (2.2) It is probably (2.0) really different from (1.5) Italy, but.. (2.0) Eh, it's, it's a good way to, to have a glimpse from a teacher, as you give me …

Su: Yeah, well, if you come to Australia come and stay with me. [I: Yes, it is nice] I have a big house. ((both laughing)).

I: Thank you so much. [S: yeah.] So, I will inform you about the results of the research, obviously. [S: OK] And, err, em, (3.6) out of curiosity, simply out of curiosity. When, umm, <I> put the questionnaire in, err, I, err, I submitted the questionnaire in Italy, umm, the circulation is quite good. I, umm, put it in, in the mail address of schools and so on. In Australia, I receive, aah, less answer, really less answer, and I don't know (1.2) if, is <a> problem about the topic, or is aah …

Su: No. I don't think it's the topic. Umm, and I was hesitant to respond myself at first, because there's so <many> fake (3.0) [I: aah, OK] emails and fake, fake things and I was thinking "is this real, or is thing going to be – I'm going to get a lot of, err, spam emails or something?" Because … I wasn't sure, and then I though "no, no, I'm going to do it." And I'm glad I did, because it's been very interesting to talk to <you> and meet you. Umm, yeah, <so> do you need more people in Australia?

I: Yeah. I would like to, to have more people, because, aah, <I'm> (4.2) This is impossible to, to compare the two situations, [Su: of course] of course. But, it's, it's interesting if I can, have, umm, (2.5) quite (1.6) comparable number of, err, responses.

Su: Yeah. So, if you want, you could send me the link for people to complete your survey. Send it to my email, and I can send it to some maths teachers at other schools that I know.

I: Oh!

[…]

Teacher T

04/04/2022

[…]

T: OK – I don't know what the last (1.2) question was but, umm, ((I: laugh)) I'm at Somerville House, it's a independent girls school, it's, aah, umm (2.5) kindergarten through to Year 12, umm, girls school. And I teach, in, Years 11 and 12. Umm. (4.3) Sorry, what was your last question about?

I: The last is: (1.5) <err>, how many years you have been working as a teacher?

T: <Ohh> (3.0) a <long,> long time as a maths teacher ((I: laugh)) a l-, yeah, (1.2) we'll say a long, long time, OK. And I've been at the school for 8 (1.7) this is my 9th year at the school.

I: OK.

T: Mm. I've been a Head of Department for a very, very long time as well.

I: ((laugh)) Err, and, umm, (1.8), the other thing is, what is mathematics for you, in a word, or in a sentence?

T: (5.8) What is mathematics? Umm. (4.0) I guess is to, it's (1.2) umm, I find it enjoyable. I enjoy it, (1.3), umm, (4.5) I don't think my kids necessarily enjoy it, as much as I find ((I: laugh)), but I, I find it (3.2), I think it's, I think it's fun, it's.. (3.3) I like to work things out. I'm, I guess (5.3) there's things, like, you need to know procedures and that sort of stuff so you can apply it. But, it's about, you know, applying the mathematics to (1.7) different situations, interpreting those situations (2.0) using your mathematics. Umm. I like mathematical modelling. Umm, and I like being able to build (1.5) use the maths that I know to >try and build models and try and make some sense of things, maybe, sometimes<. (4.2) I'm not very good at any of it, (2.5) but I like doing it ((I: laugh)).

I: Well, (1.0) thank you. And, er, (3.6) the, err, the second question is about the questionnaire, your feeling about the questionnaire. So, umm, (3.2) if you remember (2.5) something about it. Ummm. (3.0) The, the questionnaire is about active, bodily experience learning activities in mathematics (3.2) in which <body (1.1) and movement> of students are, mmm, involved. So, what do you think, what did you think about the topic of the questionnaire when you complete it? (3.2) Seem, umm, familiar, or far removed of, mm, (2.0) from (1.2) your school reality, for instance?

T: Look, it's (2.3) horses, it's, it's horses for courses. You use activities when it will enhance the, the learning. Like, for instance, sometimes, (2.4) umm, we'll get the kids in, and we'll get them, umm, (3.8) measuring things, and, or drawing things. But, umm, like with technology now, umm, like, (2.4) we had a, an activity where, umm, they had to measure the area of the car park. So rather than, (1.3) like they still did some measuring, but they also <used> Google maps, and they, they got the area of the car park and the perimeter off Google maps. (2,0) Umm, (3.2) like, I know in the questionnaire you, you talked about lots of different things. But I mean, (2.2) the trouble I find with (4.8) activities is (2.2) they take up a lot of time (3.1) and maybe some kids don't get anything out of them, and some kids do get really some things out of it. Like, it's not, (2.4) it's not that everybody gets something out, out of the whole thing, and the amount of time that you spend on it, (3.5) doesn't necessarily equate to the kids actually knowing any more than, than, when they started. (2.6) Umm. (2.6) Sometimes they do, and, and, sometimes they don't. And sometimes it just becomes a nice little, umm, (2.9) interlude, inter-interlude for them to have a bit of a play. But (1.5) in terms of (2.8) outcomes, and (2.7) umm, meaningful outcomes, I don't know that they actually get, get those particular, get, get any out of it, you know? (I: mmm) And as you go through into Grade 11 and 12, (2.8), you get less time to do those sorts

of things? Like, if we're talking about graphs and that sort of stuff, then I'll always do graphs on, on, on technology, so the kids can see the graphs, and manipulate the graphs, and, and, and work through those sorts of things. Because they need to have an understanding of that, of that sort of stuff. So, (1.2) 11 and 12 is not really so much measuring things, but actually, (2.0) using the technology, I guess, to develop an understanding of, (1.5) like, functions and relationships and, and that sort of things between variables.

I: Of course. And do you, umm, <observe> the gestures during, err, the activity, for instance?

T: (4.2) The ones who just muck around?

I: Students' gestures like "the graph of the function grow" ((trace in the air, with the right hand, a trajectory of a function that grow)). And, and they, err (4.2) interpret <the> action of growth ((laugh)).

T: Yeah, I mean, (2.5) yeah, they do, they do, sort of (3.0) it's the same sort of deal, like some kids will sort of understand it, and, and, go with it, and, and (2.5) it's, err, it's also a multiple, you know, you revisit those sorts of things, umm. But, (1.7) it's also a time factor in terms of being able to have, allocate the time. And I guess, and I don't know, I guess the same is over in Italy is (1.2) you've only got so much time, and you've got all the, so much content, and you've got to try and del, del- cover all of those sorts of things as well ((I: laugh)) so it becomes, really a balancing act I guess.

I: (4.2) Of course. And, (0.8) al- also in Italy, it's, it's a big matter, ((laugh)) the <time> and the, the, pressure o-, in the school. [T: mm] So, eh, about, mmm, the, the topics covered, eh, did you find <the> the questions (0.8) relevant, or you notice something that is, ah, inconsistent for you? Or, something which not expect to <find> in it? Or some important aspects that are not taken in consideration in the questionnaire?

T: (3.8) As I said to Vince, umm, (3.6) the questionnaire's black and white, like, you know, whereas I find that there's a sort of a grey area in there? Like, (1.6) umm, (2.2) like the questions sort of related to, you know, either you use it or you don't, or you do this or you don't do that. Whereas, in actual fact, (2.0) sometimes you do and sometimes you don't. And sometimes you make a decision to do it. So, (1.3) it's not a case of, umm, (4.4) you always do it or you don't always do it. It's, it's just that you, it is, ah, you know, you've got to decide what's the best way to <go>. And I guess it's that grey area that (1.5), you know, it's hard to do, ah, with a, with a survey because you've got to be specific about the sorts of things you ask. But then, as a consequence of that … (2.0) I mean, there was a couple of questions there was "other" there, and I, I wrote some comments in the "other" because of the fact that, umm, (1.3) what they a:sked, (1.2) umm, what the question asked it didn't seem to fit with where I was, where I was thinking, so, yeah, that's what I did.

I: (4.0) OK. (2.2) <So> yes, it, it's, the, the problem of the questionnaire that could be superficial over things. So, you are right, (0.7) obviously, so the other thing is that, (2.2) yes, you have to decide you do or don't do it in school, and, [T: mm] it's something hard to answer.. you are right.

T: (3.0) And <see>, sometimes, too, you mightn't start off that way, but then in a lesson something will happen. Like, particularly with (2.6) like a graphic calcula-, graphic technology or something like that, you can sort of jump in to it. <So,> you mightn't <plan> it, but it's just the way it <evolves>, that you might decide that that's the best way to go with it, on the spot, and just deal with it (3.2) then.

I: Yeah. So (2.3) mmm, (2.0) <you> (1.2) eh.. (1.0) In your opinion, do you think that carry out (3.2) activ-, the- this kind of activities, like, <to> to (1.0) introduce the graph, or (1.8) something like this, is important for learning mathematics (2.1) and why?

T: (9.6) I think it's yes. It is important the kids unders-, (2.1) umm, (3.8). When they're building their understanding of re-, of graphs and relationships – particularly if you're trying to, umm, (1.7) teach transformations of graphs, (0.9) and have an understanding of, umm, how the transformations behave.

And for the kids to realise that (1.7), umm, it doesn't matter what function you have, that, you know, you've got to, umm, your transformations and.. and based on those transformations it'll behave in a particular way. And they can then use that to predict what it is. But (2.3) the technology allows the kids to develop those sorts of understandings, umm, as they go along. And, I mean, like you've also got your statistical stuff, like, if you're looking at, umm, regression and (1.3) you've got variable, two variables and you want to see if there's a relationship between those variables, you can use statistical regression and that sort of stuff to be able to do that sort of thing as well. So, umm, (3.5), yeah, I think it, you know, it it, <certainly>, it had its place and it's an, it's important. Umm, it's also, umm, (1.9) important that the kids, umm, are able to do the stuff, umm, (4.0) I don't mean draw a graph as such, necessarily, although it's funny, I've been doing this for a very, very long time. And when I first started teaching, we used to draw graphs. We used to look at the derivatives, and we used to (2.1), umm, (4.5) sketch it by hand and all that sort of stuff. And then along come graphics calculators, and we could do all of that sort of stuff on a graphics calculator, because the argument was, that why do you need to spend so much time drawing a graph when you could actually just do it on a graphics calculator and see what's going on and then you can do some more stuff with it. Which is all <true> but now we've gone to drawing graphs again, by hand. Where you've got to look at, you know, the derivatives and the stationary points and all those other sorts of things. So, (1.1) umm, and you've also got the calculator, so, like, when we have assessment now, we've got (1.3) two assessments, one with technology and one without technology. So the kids need to be able to do it both ways, (1.1) umm. (1.7) And so there's just, you know, this, there's a lot more stuff that they've got to be able to do. (2.4) But, yeah, the answer to your question – I think it's important. And, and the kids need to know how to do it. But there's also, you know, lots of trade-offs along the way with all of that.

I: But, it, is it your (3.1) decision to make, aah, both, aah, technology evaluation and an assessment without technology, or is, aah, mmm, something that is required by some policy?

T: (2.2) It's there, it's required by policy. We have, a, an education authority. Umm, (3.8), yeah, we have the education authority in Queensland. Umm, and so, when they s-, we have an external exam. And within that external exam there's two papers. <One paper has got technology, and the other paper doesn't>. So to try and mirror that in our, in our teaching and also in our, umm, in our internal assessment, <we> have two focuses as well. One without technology [I: OK] and one with technology.

I: (4.2) OK, thank you. So, <umm> you, you already mention some of them, but could be that there are more. Umm, what (2.2) do you believe could be some, (1.3) some difficulty, difficulties when you, umm, carry out these activities in classroom? What are (0.6) the, also the, the difficulties experienced by students, in a certain sense, in those activities?

T: I think it's, umm, first of all, it's, it's the time involved in doing it. It's also the kids' understanding (1.2), umm, what it is they've got to do. So, (1.2) they (3.2), it's not like (4.2), like even with using a tape measure, or using a trundle wheel, or using a ruler, or using a compass, iii- (1.4), you know, ii, (0.5) they just don't, kids don't do those sorts of things, play with those sorts of things, or, or anything else like that. So every time you want to do something like that (1.8), you've got to sort of show them, you know – how to do this, and how to do that. And so it, it takes time. Like, using a compass, <or> (0.5) even with using the technology to be able to, you know, draw graphs, and all of those sorts of things. You've got to spend the time (0.5) to, a lot of time to do that, before you can actually get on with the investigation, and actually do the investigation or whatever it is you're trying to do. And then, (2.5) at the end of it, the kids have spent so much time (1.5) trying to draw the graph, they've actually missed out on what the actual learning was supposed to be! So, i- in terms of (3.2) what you want is, you want the kids to have these sorts of understandings, but (0.6) they haven't got the understanding that you want because (2.3) you had to spend so much time teaching them how to use the, the, the technology. And the trouble is, too, what I find with the kids is that, (3.0) they don't transfer it, and they don't, (0.5) they

don't recall it. They don't seem to see it as being important. So, every time you want to do something like that you've got to go back and teach ((laugh)) how to do it again!

I: Yeah.

T: So, you know, it's sort of a never ending cycle [I: ((laugh))] and so it becomes a, yeah a difficult, a difficult – it's difficult sometimes, yeah.

I: And, and, do you, do you implement some strategies to overcome this kind of difficulty?

T: (3.8) Well, we have – all our, all our (0.8) teaching is done out of our class OneNotes. So we have a, a master OneNote, and then the teachers have their own individual OneNotes, and they download the resources out of the master into their own, umm, into individual class OneNotes. So in there, we have all the activities. So we have, like, resources (1.5) umm, about how to do particular things, like using the graphics calculator. We've got resources that the kids can refer to, and the teachers can refer to as well. [I: OK] So, we do have those sorts of, umm, and we have videos to do different things, umm, to different, like, particularly with the graphics calculators, or something like that, 11 and 12 we've got (0.5) videos that the kids can access and, that sort of stuff, mmm. (0.2) But, you know, it still doesn't necessarily mean that they'll know what they're doing.

I: No! Of course. And, (0.6) for instance, for, (0.4) for transfer <the> the knowledge, the students' knowledge, do <you> use <some> (2.8), some teaching strategies in particular? Some.. wh-, What is the (0.4) instructional guidance that you implement, to (2.2) ensure the effectiveness of this activity? Do you use something in particular like, discussion or (3.1) some, ahh (4.2), umm, (1.2) particular didactic material, some schema, of, aah, (1.2) of lesson, in particular? Or not, i- it's important to observe and <to> (3.9) communicate.

T: Yeah, I, look (3.1) I guess I, I sort of think that, umm, of solving problem. I teach solving problems, I think (2.1), umm, (2.4) kids solve problems, so <you> set up problems that allow, that encourage (16:19 **there are several seconds here with no sound or distorted sound** restarts at 16:24) to be able to do that, so they have to – they transfer it that way. I mean, (3.2) I've, you would have groups, like, (4.3) we have collaboration spaces, where the kids can collaborate, and they can write, umm, [I: mm] notes and stuff like that. (1.2) Umm, and so the, you, and the teacher can refer to those, and, and look at those sorts, and look at those things and so they can pull the different ideas together. Umm, some teachers use that more than others, but, umm, yeah, in OneNote there's that sort of collaboration space. But, I think it's sort of <more> about, umm, (3.8) getting the kids to use what they've learnt, so, I guess setting problems is, is the way that I encourage (3.0) umm, the kids to try and transfer the stuff that they've learnt, umm, into, into different situations.

I: Of course, thank you. <And, then> another thing I would like to, to ask you is (2.0) what convinced you to propose this activity in classroom? (6.1) You simply [T: ohh] try, or there is something that convinced you that (0.9) could <be> fine?

T: (6.5) Ohh, I guess I've been doing it for a long time, so, you know, you decide what's the best way to, to get the kids to understand what's going on, so, (2.2), umm. If, if, if over, (0.4) I guess with experience if you, umm, you get, you get to know that this one works, and this one, <these> activities, don't necessarily work particularly well, so … And with the time involved, like you always, you might try something new but, umm, (3.2) generally, um, yeah, you get an idea of what's going to work and what's not going to work, and you-. (2.4) But, you know, it also, (1.5), so different teachers have different (3.1) <ways> of doing things as well. So, umm, (2.2) not one way fits everybody. And just the same as not the one way of teaching something fits every kid, so, (0.8) you've sort of got to have a variety for, for teachers and also for students.

I: Of course. And, and you. (3.8) are there any <constraints> that limited you in the proposal of those activities? ahh, (2.0) Or (2.0) for instance, eh, are you supported in proposing these activities? (3.4) Some …

T: The biggest one, the big constraint we have, I gue-, <well>, there's a few of them. Time is obviously a big one. [I: yeah, yeah] But it's also, umm parents' and kids' views of what mathematics is, (0.6) as well. Umm, they have a particular view of what mathematics is and if what you do doesn't fit within that view, ((huh)) then (in our school anyway) they're very vocal about, you know, this, this is not what it should be. So, (2.8) there's a fine line that you've got to walk with, umm, (3.6) getting kids involved, and also making sure that, umm, see the other side of it is that, whatever I do, everybody's got to do it. So, if I've got, I've got 8 classes in, Grade, umm, 7. So everybody's got to do the same, the same sorts of things, at the same time. Otherwise, (0.2) the kids go home and say, well, some teacher's doing something different. It doesn't matter that they might be doing it a day different. They have to be doing it at the same time, pretty much, at the, at th- and, and doing the same sorts of thing. So, (0.8) that sort of <tends> <to>, to limit, umm, the sorts of things that you can do – a, a, single teacher can do. I mean, how teachers do it in their classroom, (0.8) is up to them. So, they can, you know, they, some, like you can do it as an activity-based thing, or you can do it as, aah, just a very, umm, traditional type. Operate in a very traditional type way, but (2.1) umm, (2.1) in terms of, (2.8) umm. It's also, I guess, teachers' perceptions of, of how things go, as well. So, there's a whole bunch of things that you've sort of got to take into account when you're doing, when you're trying to put some of that sort of stuff into place.

I: Of course. Eh, and (4.0) what do you believe, mmm.. What kind of, (2.3) collaboration or support do you need (3.3) to implement in (4.5) in an, in a better way, without (0.5) many (0.5) problems, for instance, in, in your classroom?

T: (4.2) Aah – I just need to do it! ((laugh)) [I: yeah] It's not, It's not, it's not, it's not much, yeah, in terms of … I, I don't need an-, like, I mean, (0.6) we sort of plan it (0.8), umm, (4.4), like I said, we've brought all our resources and all our work in our class OneNote, so (0.8), we just (1.2) add new resources. So it would be a new resource that we would add, add to the OneNote. I guess, in terms of <consistency>, it would be ensuring that everybody does it, that, umm, (4.2), umm, (3.3) … yeah. So, like, for instance, at the moment (1.4) we try to do, umm, (3.1) modelling and problem-solving task. I wanted to make them, (0.5), umm, so that the kids would, would actually do it, so I made it assessment. ((cleared throat)) But it hasn't worked out particularly well. So, we're going to try something new with that. Umm. But, with Covid and, umm, all the disruptions that we've had in term 1 this year, with, with everything else like that it's been (3.5) really difficult to, to do that. So we're going to try and do it in term 2. But, there'll be other disruptions in, in the school [I: yep] plan that impacts everything, you know.

I: Of course, and also impact my, the, the, the research I conduct, because ((laugh)) because I, I, want to go to Australia, and I'm, err, still [T: oh yes] in Italy! ((both: laugh))

T: Yeah, well, you've got to come over, haven't you! ((laugh))

I: Yes! Could be, could be, that I will come ((laugh)) Finally ((laugh)).

I: So, then, the final question is out of curiosity. That, err, is, in Italia, we had many more respondents <to>, aah, the questionnaire than in Australia. So, I could not come to Australia, err, because the research has been concurred with pandemic emergency. And, I, I don't know well the Australian daily context in the, in the school for this reason. <And> (3.0) so, I, I, was wondering if you could tell me something about the, the (0.7) the circulation of questionnaires in Australian context? If you, by chance usually receive many questionnaire, via mailing list, <or> (1.4) is it (1.5) usually provided (2.2) incentives, (2.2) such prize for participation? (1.5) <Or> otherwise could be only an issue (3.0) that is topic related, that it's not interest for teachers in Australia, (1.3) this kind of topic in particular. But do you.. ?

T: Well, the only reason I knew about your survey was because Vince emailed me and said "this is a survey." Aah. Who have you contacted in Australia to, to, to, umm, to do it? Because, I didn't even know anything about it, until, like I said, Vince emailed me and said, you know, can you have a look at this, and, (1.8) umm, be involved? So, umm, (2.0) I think probably you might find (4.3) (unclear *24:20-24:24) Like, you wouldn't get everybody involved, but, I mean, there might be more schools willing to be involved. But, (0.8) they just don't know about it. So, I don't … I guess, umm, (2.3) you, like, you could contact, I don't know, have you contacted the Maths Associations and stuff like that in Queen-, in Australia? ((I Nod with the head)) You have? OK. (3.8) So, I don't know, well, yeah. (3.4) I don't know. I, (2.8) it's a really interesting thing, like, I mean, umm …

I: (3.2) Yeah, yeah, for this reason I ask. It could be a culture of fact, in a certain sense ((laugh)).

T: Yeah, well, I mean, I think you will probably find that, people are (1.6) particularly for this term, term 1. Term 1 was a horrible term. (1.5) Umm, we didn't start for two, like most schools didn't start for the first, umm, two-, two or three weeks because of Covid – the place was locked down. And then it's just been, and we've had floods in Queensland. (2.0) Umm, I don't know about, like the rest of Australia, but we've had floods in Queensland, we've had, umm, closures for storms and all those sorts of things. So, it's just been (2.2) everybody I think has pretty much been on survival. So when did the survey come over to Australia?

I: (7.0) Of course, (3.5) you're right, (1.5) I think. Yeah.

T: Yeah. When did it come to Australia?

I: When?

T: Yeah, yeah, when did you put your survey out? Over here?

I: <I> I put it, (0.3) umm, at, (0.2) erm. The first, umm, <submission> (4.0) umm, (3.3) was in November.

T: OK. (2.0) All right.

I: The second submission is in, err, February.

T: Oh OK, February, February would b …

I: In the end of February, (1.2) I mean. [T: yeah yeah] And the third is, in, aah, (1.8) at, at the end of March.

T: OK.

I: They are the three periods.

T: OK. And what, did you send it to the, what, to the maths associations, did you, in each of the States and stuff like that, is that what you did?

I: I, I tried to contact the Maths Association, but <they> (2.2) didn't answer, to …

T: Didn't they? OK.

I: … to us. I, I don't know. Some, umm, Maths Association publish on the FaceBook pages, <the>, the questionnaire. But I don't know, could be, could be, emm, (1.2) an uninteresting ((laugh)) research.

T: Ohh no. [I: Why?] Yeah, look I don't know, I, umm, (6.0) yeah, I don't, I don't, I don't know. If you've gone to that sort of level, I, I, don't know what else you, does … I mean, there's different (2.1) assoc-, different, sort of, like FaceBook pages, and stuff like that, I guess, but, umm, it's really hard. Because, I guess, this is your PhD, isn't it? This is what, for your PhD? Yeah.

I: Yes.

T: So, you're looking at, so, trying to compare what Australia with Italy are you?

I: Compare, juxtapose, mmm, notice if there are some, aah, variables that are similar or are really different, [T: OK] so I want <too> mmm, I want to (1.2) have a glimpse on the Australian part.

T: Mmm, mmm. (1.2) Mmm, mmm.

I: So, (8.2)

T: Yeah. (5.8) I don't know. Umm, (5.0) so, do, is Vince one, well Vince is one of your, umm, your [I: supervisor, yes] Supervisors, yeah.

I: Yeah, yeah, yeah

T: He's got a lot of contacts in Australia, so he should be able to help you with [I Yeah]

I: Yeah. But he say that he, he had a lot of (3.0) problem also in other questionnaires. Like, it, it's a particular moment (2.4) <to>, for teachers. <They> [T: yeah] (4.2) They don't answer <and>.. Too <many> activities, too many (0.5) they are not, not reacting in this period ((laugh)) [T: no, no] and, and could <be> and they have a reason to do it, obviously.

T: Well, look, if it wasn't for Vince having asked me to have to have a look at it, I wouldn't have looked at it either. So, I mean, (3.0) because he just doesn't (5.3). You could <try>, honestly, you could try emailing individual schools. Like, rather than going through Associations, just Google, like schools, in Queensland and in New South Wales and, and, and email the Heads of Departments. I'm not saying you're going to get anything, any more a better response, I don't know, but (1.2) you could try, just (2.0) contacting individual schools and just sort of [both talking *29:28]

I: I, I'm search for the list of the school in the ACARA, ACARA site [T: Yeah]

T: Oh, ACARA, yeah

I: Yeah. Umm, but they don't have a public list of school emails, and so, (9.2)

T: Email addresses?

I: Mmhm.

Long silence

T: No. Umm, (10.00) see most of the ones in Queensland, would be the school name, like ours is Somerville.qld.edu.au so most of the schools in Queensland would be their school name. Umm .qld.edu.au Umm. I don't know what New South Wales …

I: Yeah, yeah, like in Italy, it's, it's the same ((laugh)). There is a, an index [T: yeah, yeah] that is associated with the institution and schools

I: So. I've asked all the questions I want to ask you.

[..]

Teacher X

27/04/2022

X: I've been, aah, (3.2) teaching, aah, (3.2) over 20 years!

I: ((laugh))

X: So, (3.4), it's a, yeah, it's a lo-, a long time. ((I: laugh)) Aah, the school which I'm at, aah, I'm in, I'm in Canberra. (4.0) And we have, aah, high schools (1.4) and colleges (1.2) and so I- I'm in a, in a high school. So that's from, aah, Year 7 to Year 10. (2.2) Ah, the colleges <do> matriculation, Year 11 and Year 12. So, I've, ah, I've always just worked in high schools. <Umm,> (2.8) so that's first form to 4th, 4th form. Aahm, (2.0) the school which I'm currently at, aah, is one I would describe, (1.2) a traditional high school. Aahm, (3.0) aligned (1.2) with each subject area. So, umm, english, the arts, mathematics, science all separated. Umm, and all working (0.8) individually, to deliver the curriculum. Umm (5.8), but, aah, we, aah, we, we do, the Australian curriculum, (2.1) umm, as, as stipulated, as much as we can, ((I: laugh)) umm, umm. (3.2) <We> <do> have (1.6) a little bit of <string> umm, ah, so, ability levels. But that's more so only in Year 10, (1.4) umm, because it's stipulated in our curriculum. Umm, we have the, umm, the <core> Year 10 curriculum, and then the, ah, Advanced curriculum. Umm. (unclear: *1:42*) same time. Umm, we <do> have ah, (3:3) ah (2.2) an excellence program. (3.2) Ah, ah, that <starts> in (4.2) Year 7, and goes all the way through to Year 10. So that class is, has got your gifted and talented, umm, but that is, err, that class is also the same class for the humanities, aah, for English and for science. Umm, (1.8) so. Personally I wouldn't call it a <true> gifted and talented model, because not all students are achieving at that same level in all four different areas, but, that's what this school has. (3.2) <Umm,> there's <roughly> a thousand students, in the four years, so 200 odd. Umm, (4.2) <and> average class size is about 25 (1.2) to 30 students [voice notification "recording in progress"]

I: Oh, I have some problem with the recording, it's, it's

X: Is it all good? [I: yes, yes] Umm, yes, so it's what I have said, it's, it's sort of classed as a, as a traditional high school. Umm, it <is> it has a reputation, ah, in, in Canberra, of, of, music. So there's a, (4.4) very, umm, umm, (2.3) big music program, umm, band program. Aah, (3.4) and that has it's, own, issues, of course, with, aah, rehearsals and, and performances, aah, taking students away from class. But that's, (1.2) yeah.

I: Great. [X: that's the school]. ((laugh)), thank you, thank you so much. I, it, it's, it's really interesting to have ah, a specialisation in music. We, we don't have in Italy some (1.5), specific, aah, focus. Only in the few years come up, some, aah, [X: yes] some (1.6) experimental school in music. And, aah, to, to, mmm, to, to, mmm, break the ice a little bit, something that is more personal. What, what.. (2.2) Xan you summarise in a sentence or in a word, what is mathematics for you?

X: ((laugh)) Order! ((both laugh)) Umm, as I tell my students, there's only two answers: (1.0) the correct answer and everything else ((I: laugh)). Umm, it's, aah, it's structure, it's, umm, (2.2) patterns, aah, it's, it's, umm, (2.8) umm, (3.3), aah, efficient, <efficient thinking>, (2.2) umm. [I: thank you]. Umm, and, yeah. I think that sums it up. Yeah.

I: Do you want to add something? ((laugh))

X: Umm. (5.8) I, I think it's, it's also the.. (6.8) i-, it's the fundamental, aah, <basis of our society>. (3.8) Umm, of, throughout the world, because without mathematics, <we> (0.8) we wouldn't be having this communication, we wouldn't have trade, we wouldn't (0.4) have engineering, or, or building, or, (0.7)

well, anything like that, where, ah, (1.2) you know it's, it's, it's the language of science, and, of (1.5) technology, [I: yes, of course] it's vital, umm, [I: of course. Thank you] So, yeah.

I: ((laugh)) <And>, some question about the questionnaire in particular. <Emm,> (1.3) <I> I want to ask some feeling about the general topic of the questionnaire. The topic is the active, bodily experience learning activities. And I, what I want to ask you is: (2.5) what did you think about the topic of the questionnaire when you complete it? Did it seem familiar, or something far removed from your school reality?

X: (5.2) ((laugh)) Umm ((I: laugh)). Far removed from my reality. Umm. (0.5) In the ideal world, (1.4) it would be wonderful, (0.5) aah, to be able <to,> to offer that. Umm, (2.1) but, (1.1) the reality is (0.8) <umm> (3.8). In my experience, there are, there are few topics that, (1.5) in high school, allow themselves, aah, (3.0) umm, (2.8) to be presented that way (2.2) <without> it becoming tokenistic. (3.0) Umm. (6.2) The, err, I, I think, in, in Australia (1.2) not sure about Italy, but definitely in Australia, there's a, there's this feeling that, (1.2) umm, (3.4) a lot of students <feel> that they are (1.5) not good at maths, (2.2) from an early age, and therefore are <reluctant> (1.3) learners. Umm, (2.1) and are hesitant to engage (4.2) to, to the best of their abilities, umm, to overcome that. And, and <so> any type of activity (3.3) err, like the, err, active body i-idea would be seen as an excuse or as a reason to (3.9) have, err, play up, and not actually think about it deeply <to>, to get, (2.0) to gain the full benefits of it. <Umm> (4.5) But, umm, and that's (1.6) <partly> because <of> the constraints that we have, umm. (1.2) The physical constraints, the number of students in our classroom, ah, the resources, umm, (2.4) the a- (2.8) and the application within covering the curriculum (2.4) <aah,> as it's been stipulated. Umm, (5.6) and, yeah, and then just, also, the, the variables of, of the students and, and their engagement and their behaviours.

I: Of course. And, and, (3.2), if you can remember (2.2) about the, the topic covered in the questionnaire, there are..(1.8) Do you, do you find <some>, did you find some question (3.6) mmm, particularly relevant, or something unexpected, or something (2.2), that.. (0.5) some, some important aspect that you, umm, feel were not, umm, taken into consideration in, in the questionnaire? (4.3) If you can remember.

X: Aah, OK, again, I think it's (1.4), it's not taking into consideration the reality of, (2.2) of, of (2.4) my experience of schooling. It's, it's not (0.4) static, it's (1.5) very dynamic. There are lots of working parts, there's lots of activities going on, aah, that impact on the students. Umm, (4.8). Err, lots of little things that interrupt (1.4) throughout. Ah, a- and you layer that with, you know, student absence because of the illness, or for whatever reason. Umm, and <then>, to try and gain, <aah,> momentum, in the topic, and to <use> that kind of (3.2) activity, which is (3.8) is not easy <to> i-, to develop or to run, (0.8) you only do it once or twice if you are going to do it. Aah, so, it becomes – it's too hard. <Umm,> when you're dealing with 20 odd (1.3) students [I: Yeah, of course] umm, (3.4) and, and the space to do that. Umm, you know, yes, we may have good weather, but, (2.0) the wind, <or,> (0.5) whatever, and moving things around, or interrupting other classes, (0.7) umm (2.6), and, and the, the time that we have allocated. You know, well, if, I, I keep (1.2) reminding people that <we> see our students (1.5) 3 and a half hours a week, so 3 hours one week, 4 hours the next. We're, we're at school for 40 weeks a year [I: mm] but, take away the first week, take away the last week, take away a week for illness, take away a week for, (1.2) aah, staff illness, take away a week for excursions, (0.4) aah, we're down to 35, 34 weeks. (3.6) [I: yes] Umm, (2.6) you know, how, how do we make it fit? And I keep asking that question and (4.2) there's no answer.

I: (3.0) But, d- d-, mmm, (2.4) do you think that (4.2) also, err, sporadically, mmm (2.8), involving some activities, in which body and movement (1.2) of students are engaged, in your (2.5) mm, practice-teaching practice is important? And, if it's important, why is important for learning mathematics?

X: (2.50) Umm, again, I'll bring it <too>, (2.5) it's only for some topics, (1.0) and for some aspects of those particular topics. Umm (7.8). Aah, i- it, it's important because it allows them to see the application of the theory, (1.8) by doing it. Umm, (2.1) but I would also say that, todays, unfortunately the learning experience (2.7), umm, is not as successful as it was, maybe 20? years ago. (1.3) Or even 10 years ago? < Because of (2.8), the mobile phone> ((I: laugh)) and all the apps. <So,> (2.0), they can just (1.5) download the app (0.5) that deals with (1.5) working out the angle, or working out (3.1), whatever, and they've got the answer there. Umm, (2.5) for most of them. There's a few that, yes, (1.2) can appreciate it, and can see it, but (1.5) this is where it becomes tricky, because the, err, that connection of deep understanding in (4.2) I think we, we seem to have lost it, for (1.2) a large proportion of the population. (2.6) [I: Of course] And information and, and, umm, technology has made that information easier to get to the final result (2.2), so the process (2.2) of getting it is no longer important, where, where mathematics plays a <huge role>.

I: (3.8) And not used to, to, to go deep on, on, err, the information, and on, on their thinking.

X: Yeah. That's right. Umm, (5.2) – yeah.

I: And, and, do you believe that, that, that this kind of activity couldn't help this particular feature? (7.2) Going deeper in, err, in, conceptualise more? For instance, (0.4) I, I don't know, it's, it's only …

X: No, no, not really, no. Umm, because the information a-, and the, err, the final result (1.2) umm, is so easily accessible. There's, there's (2.4) umm, I, I really feel that, umm, (3.8) the desire to have that deeper understanding of, of, (0.3) concepts has been <diminished>. Umm. My, my classic (1.3) example is, 20 years ago, <ahh,> teaching area and volume. (2.7) Aah, there was a really strong emphasis on the students remembering the formulas (3.2) and then applying them. Aah, in the last 10 years, (2.5) we've now focussed more on applying the formulas, not necessarily remembering them, because they can have access to them so quickly. Umm, there's no need to remember what a formula is, (0.3) just look it up. You know, thanks to Google, what's the formula for area of a square? Oh, there it is. Without understanding, umm, which is a pity, because I can understand that (0.5) formula, (0.5) that I've used for, let's say, area of a square, s squared s, where s is for the side length. Umm, (0.6) and a rectangle becomes length and width, or length and breadth. Umm, (1.2), and then we forget that the, you know, triangle – the base and the height is the relationship between the, (2.2) the, the vertic-, err, the, umm, the perpendicular (1.1) inter-, intercepts, but all of that has been lost. Umm, (2.5) umm, (3.3), so yeah, it, it, it, makes it – I, I really feel they are, are, are, at least not in the high school setting, that, err, umm, (1.3) the active, body idea really makes it tokenistic. It's, (3.0) umm, I think it's (1.2) more for early (1.8) conceptualisation of, of, basic ideas in, in the primary (0.2) years, umm, it's more valuable. Umm, and again they're being pushed faster than what I remember when I was, (0.5) young. ((laugh))

I: Of course. And, and (0.5), you, you, you, mm, think (0.8) talk about some, umm, some specific topic that you, you think could be (0.5), could fit, this, kind of, ah, (1.1) purpose. And, can you give me some ex- example of topics, or, (0.6) also, some activities related to this topic, that you have <seen,> or have experienced? I don't know.

X: (5.2) Hmm. Aam. (1.2) Not really! ((laugh)) Umm

I: It's an answer ((laugh))!

X: Yeah, it is – ahah!

I: ((laugh))]

X: I mean, if I go back and look at primary, umm, so it would be early, early primary. The use of, umm, (2.2) of the blocks, for place value (1.3), to me, that is, umm, (1.3) important, umm, because I'm seeing now, I've seen it in the last (0.8) 10 years, that students' understanding of place value (2.8) has

diminished. Umm, (1.3) and that they don't see that relationship, because I don't think they have an understanding of (1.1) a unit, to a 10, to a, to a hundred, to a thousand, umm, (3.2), <umm,> and it's the same with fractions, using the, I'm not sure if you're familiar with the Cuisenaire rods? (1.5) Umm, the different coloured rods. Umm, (2.1) they've, they've gone out of fashion, umm, and so trying <to> to highlight we, we, unfortunately use a round pizza to try and explain fractions, which is so hard, because (3.2) how do you show (0.2) an 8 (1.2) evenly in a ((laugh)) round shape ((laugh))? Umm, (1.0) so (2.1) yeah, it, it's really has gone <out> It's – they've become (0.6) tokenistic. <U-umm> (6.2) umm, (1.6) but, there, that's where it should be, (0.3) I believe, utilised a lot more, to get the fundamentals of, of those basics, (0.2) of the concepts. Umm, you know, (unsure: multiplying*18:16*) using counters, using the, those manipulables, umm, (0.4) you know, can then, can put that into (4.2) actually, umm, (1.8) sharing between people, and that's when moving people around, would work. Umm, (1.7) but again, it comes down to having those resources, having that space, and that time to be able to show that stuff.

I: So, wh- what, do, do you believe could be some, umm, (6.4) some foster factors to implement these kinds of activities in school? What kind of support <or> err <also> mmm, (2.2) what are the, umm, the, the contextual factors also, to, umm, (2.0) to help you to, to, to try to implement <some> of these, umm, (3.2) activities? That could be effective for your teaching, obviously, not only an extra activity!

X: Umm, time. <Time is the, is the big one>. (1.5) Umm, I feel that (2.5) the, 3 and a half hours a week (3.2) in the, in the – is not enough. Umm (5.2) that's the, the first <area>. Aah, the second one would be to have these activities, (0.5) umm, (3.2) available for all (3.2) <with> (2.2) a clear (2.0) instruction (0.5) of when and how (0.5) to use them. And so, then it becomes part, part of the, the culture (1.2) of the whole school, of the whole school system. The whole country. So that it becomes part and parcel, umm. (4.0) A- and, it's got to be, it's got to tie in with (3.8) with, with theoretical work the whole body practical work, so that it all becomes part and parcel of it. At the moment, (1.5) I believe the only type of activity like that becomes like a one off, <umm,> activity, (3.2) and it loses its, its impact. It becomes more of a novelty type thing. Umm (1.7) which means that those students who are reluctant learners see it as an opportunity to disengage further. And not to see it as, aah, a better way of (1.8) <engaging>. (2.2) But, yeah, time.

I: Of course. And, and, and do you think about some possibility to include some, (1.6) umm, (3.0) digital technology (1.2) <or> digital (2.0) apps to have some, err, (0.4) kind of, manipulation of students on, (3.3) I don't know, (2.0) geometrical <thinking,> or, (2.0), umm..?

X: So, I make use of, umm, (3.2) <Desmos>, (3.1) I'm not sure if, if you're familiar with that? But that's aah, an online (0.2) graphing (0.4) program. (1.0) Umm. (4.0) Not, it's not necessarily whole body movement, but at least it, it eliminates that step of trying to draw accurately the, ah, the cartesian plane and then to plot. And it allows the students to see instantly the effect of changing a variable in an equation. (1.2) Umm, (3.5) – so, I, I utilise, aah, in terms of the apps, that's one of the most used ones. Umm, this particular school uses the online learning platform, Education Perfect (2.5). Umm, (0.8) and there's others like that. (2.0) Umm, and, and, they seem to work. But (1.2) it doesn't guarantee their understanding, (3.6) umm, (3.8) because they're not able to <translate what they've done, on the screen> (0.4) to paper or in, in unfamiliar environments. Umm, (3.2) I think there's something to be said with (4.1) I'll use, it's a dirty word, umm, rote learning, and (1.4) practice, (0.8) drill and practice, umm, to become <masters> of those skills, before moving on. Umm, (0.2) it keeps coming back to time. We don't have time to ensure mastery of their skills, and so we'll move on, we'll say "we'll catch up later." (2.3) Later never happens, and so our students fall behind.

I: So, what, what do you (0.3) think could be (0.2) the teaching strategies, the instructional guidance that could (1.8) guarantee the effectivene-, effectiveness of these activity? (2.5) You, you, you, mmm, (2.5) you say that, umm, (3.2) they, they have low knowledge, the, the, (0.2) practical knowledge when they,

(0.2), eh, implement such as activity on, <umm>, (0.6) on a graph, umm, (1.7) motion-app, or something like that. And, and, then, what do you think could be, the, the, mm, (0.7) the strategy that the teachers have to (1.5) implement to, aah, try to, to, to get these activity effective? If there is time to, to do something ((huhh))

X: (7.8) Good question, (1.2) I'm not sure! ((laugh)) (2.5) It's, umm, (11.3) I think, (4.5) I-, uh, (2.2) I think a big issue is the, ah, difference in understanding within a class. (3.5) Umm, (2.0) and so if there was some way of (3.0), of (4.0) grouping students, (2.5) <of similar abilities, (1.2) or similar skill levels>, umm, (2.0) I think that may be <beneficial>, because, the activities would, would, umm, engage all of those students that can be targeted at that one level. (1.2) Umm, you know, at the moment I have (4.2) the whole, the whole range, with students (1.3) who can barely read, (2.8) <to (2.2) self-actualised learners>, <who> (1.3) want more. Umm, in the same class. <So> that makes it really hard to, to come up with an activity (3.2) for everyone. I end up coming up with (2.7) multiple activities, and it just becomes unworkable. So, (1.2) if there was a mechanism, <or> the, the ability (1.8) to be able to (1.4) for each class, or each term, at least, to rearrange classes, so it wouldn't become too much of an imposition, (1.2) for anyone, (3.4) umm, (2.8) but that would be beneficial.

I: Of course. (3.5) And do you think that it's important- during this kind of activity, the teacher has to observe and to do something in particular during the implementation to, umm, to foster, <to> umm, (0.4) the learning during the activity?

X: (5.4) I think so. I think there needs to be some sort of direction, <umm> (7.5), yeah. (5.3) I think <self-guided learning>, (2.8) in this age group is (9.1) it's not efficient, (3.2) umm, in some areas, (2.5) umm, (3.1) and it's not valid for the whole population. (3.2) So, I think there needs to >some sort of< structure, and >some sort of<(1.2) ahh, (3.9) aah, concrete evidence that students need to produce, <or> to at least follow. Umm, (1.2) so then we can at least gauge, (3.2) their level of understanding and development in that topic, or in that activity.

I: (4.2) Of course. And (4.5) are you- do, do, do you think that are you supported in proposing this activity? Do you encounter some, mmm, eh, professional learning, umm, professional development courses that, its (2.2) <on> (3.5) implementation, that engage students in their learning with, aah, some manipulation? Or the presentation of some, <ehh> (1.8) tools that are imp-, mm, important to ? Or do you believe, also some colleague, that, err, sh-, aah, try to implement this kind of activity? Or (3.2) do you think that it's something that exists, but it's not real, present, aah, present in your experience, in a certain sense?

X: (5.4) Umm, (3.3) when it comes to mathematics, (2.5) my experience has been limited, in, in seeing these types of activities. Umm, a lot of professional development that talks about (2.2) whole body engagement, umm, (1.2) generally are in other subject areas, (2.2) and so the translation from one subject to doesn't quite follow. Umm, so it's not effective. Umm, (8.2) umm, (2.0) yeah. How to go forward, I'm not sure. Umm, because it's, it's, I keep coming back to that main issue, that's time, it's, until we have agreement of being given more time to cover what we're expected to cover, to allow us to run these activities, and make it part and parcel of (2.1) of our learning, umm (2.5) it's going to be very difficult, aah, to make it something that's (2.5) more than (1.8) tokenistic, or, or frivolous.

I: Of course, so, I think I asked you all the things I want to ask you.

[...]

APPENDIX 4: RESULTS

EXAMPLES PROVIDED BY AUSTRALIAN EXPERTS

FREQUENCIES AND CROSS TABLES OF TEACHERS' SUERVEY RESULTS

Mathematics content area	Examples	Level-Sublevel	School level	Expert who quoted it
Unspecified	Mathematical games, Card games (Plain card games)	Level 1-Physical	Unspecified	Expert 3, 5
Geometry of shapes	Models for representing lengths or areas	Level 1-Physical	Primary School	Expert 1, 5
Algebra	Real scales for expressing and solving equations	Level 1-Physical	Primary School	Expert 1
Modelling	Representations of three-dimensional models through representations of solids, sections and graphs	Level 1-Physical	Primary School	Expert 1
Geometry	Geoboards	Level 1-Physical	Primary school	Expert 5
Geometry	Dice and spinning tops	Level 1-Physical	Primary School	Expert 1, 5
Probability	Number line, the number line for numerical progression and operations	Level 1-Physical	Primary School	Expert 6
Arithmetic	Dienes /MIB Blocks	Level 1-Physical	Primary School	Expert 1,5,6
Arithmetic (link between geometry and arithmetic)	-for positional notation	Level 1-Physical	Primary School	Expert 5
Arithmetic	-for doing subtraction with groupings (not good material for positional notation)	Level 1-Physical	Primary School	Expert 5
Arithmetic	Linear Arithmetic Blocks -for decimal notation	Level 1-Physical	Primary School	Expert 5
Arithmetic	Abacus	Level 1-Physical	Primary School	Expert 3
Algebra	Fraction wall for teaching fractions	Level 1-Physical	Primary School (Grade 7)	Expert 6
Arithmetic	Children's game with geometric shapes and a ball with holes in the corresponding shapes, to present the concept of variable	Level 1-Physical	Primary School	Expert 6

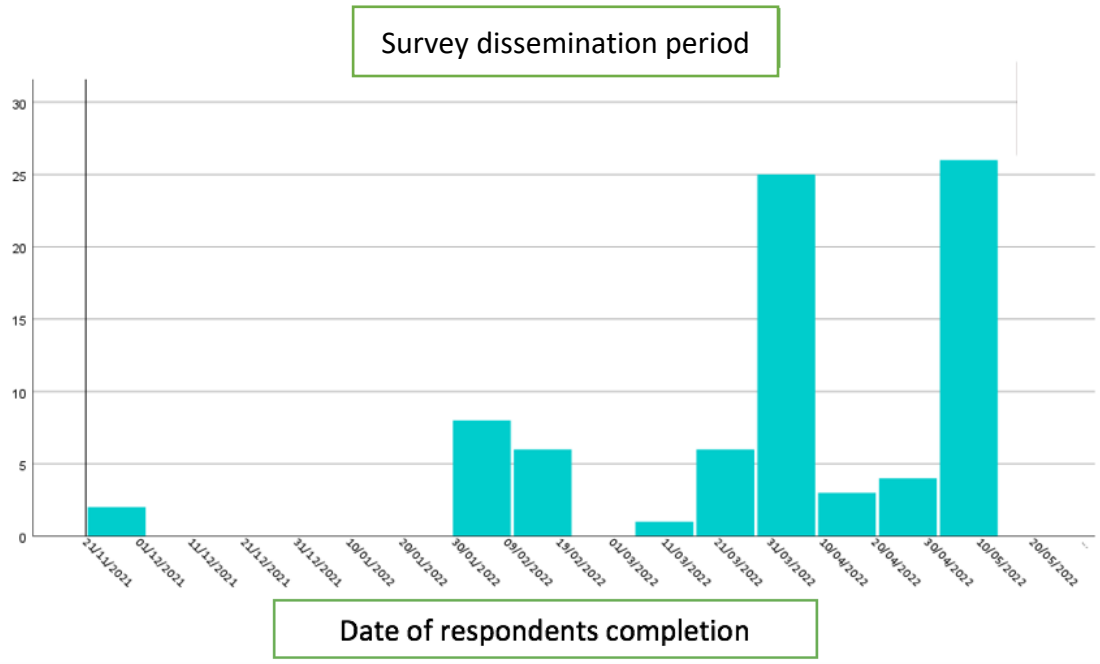
Combinatorics	Finger games, alternately shown and hidden behind the back, for calculating with fingers and the concept of part versus whole	Level 1-Physical	Secondary School	Expert 2
Statistics	Combinatorial calculus with pebbles	Level 1-Physical	Secondary School	Expert 3
	Origami frog jumps: frog-origami jump estimates to explore basic principles of statistics	Level 1- Virtual	Unspecified	Expert 1
Statistics	Dice and shooting simulations	Level 1- Virtual	Unspecified	Expert 4
Without a specific reference	Virtual transposition of physical manipulatives	Level 1- Virtual	Primary school	Expert 6
Without specific reference	Use of calculators and computers	Level 1-Virtual	Secondary school	Expert 5
Shape Geometry	Use of digital technologies to reassemble shapes	Level 2 -1	Unspecified	Expert 4
Geometry	Geometry software, such as Geogebra	Level 2 -1	Unspecified	Expert 2,4
Statistics	Exploring descriptive statistics with sample of students in the class: ask pupils to arrange themselves from highest to lowest and find mean, median etc.	Level 2 -2	Unspecified	Expert 4
Modelling and reality tasks	Determine capacity: how many students fit inside a classroom? The activity involves measuring walls, making estimates etc.	Level 2 -2	Unspecified	Expert 4
Geometry / modelling and reality tasks	These problems can also be conducted in spaces-others outside the classroom. Ex. How many people to let into the school auditorium for a concert? How to arrange chairs to maximize the number of participants?	Level 2 -2	Unspecified	Expert 4
Modelling and reality tasks	Establish the heights of trees or buildings you encounter going around: measurements and trigonometry	Level 2 -2	Primary School	Expert 2
Geometry	Measuring running speed, measuring times and distances travelled, and estimating pace	Level 2 -2	Secondary School	Expert 4
Representation and Cartesian plane	Recognize the math that is in the world, e.g., finding geometric figures in structures and objects one encounters while wandering around	Level 2 -2	Secondary School	Expert 3

	Construct maps of routes that students have actually taken: explore representation and properties of a good representation, alpha-numeric degrees etc.	Level 3	Unspecified	Expert 4
Mathematical modelling and reality tasks	Collecting data and making measurements	Level 3	Unspecified	Expert 1,4
Mathematical modelling and reality tasks	Physical education exercise, Burpees, is approached mathematically in connection with percentages	Level 3	Primary School	Expert 6
Geometry	Circle construction with a long rope attached to a pivot and rotated, to experience the characterizing property of the circle	Level 3	Primary School	Expert 6
Representation and Cartesian plane	Students moving in a Cartesian plane drawn on the floor representing points themselves	Level 3	Primary School	Expert 3,6
Arithmetic	Staging mathematical narratives using their own fingers (possibly using finger puppets, "finger puppets")	Level 3	Secondary School	Expert 3
Arithmetic	Walking along the number line with jumps of different amplitudes, for example, mimicking the movement of different animals	Level 3	Primary School	Expert 6
Arithmetic	Perform operations on the human number line	Level 3	Secondary School	Expert 3
Arithmetic	Workshop between music and dance, to explore number basics	Level 3	Secondary school	Expert 4

FREQUENCIES AND CROSS TABLES OF TEACHERS' SURVEY RESULTS

Distribution

Figure 1. Bar chart of the survey circulation



Section 0: Consent and school level

Q1_ Please, select one of the following:

Table 2. Q_1 Frequencies

		Frquencies	Valid Percentage
Valid	I'm a Primary school teacher	15	19,0
	I'm a Secondary school teacher	64	81,0
	Total	79	100,0
Missing	(System)	2	
Total		81	

Section 1: The school

Q2_ In the current school year, which year level(s) are you teaching?

Select one or more alternatives from the following ones.

Table 3. Q_2 Frequencies

Primary school		Secondary (High) school	
Pre-Year 1 (Foundation year)	6	Year 7	26

Year 1	4	Year 8	28
Year 2	4	Year 9	24
Year 3	4	Year 10	35
Year 4	4	(Senior) Upper Secondary School	
Year 5	7	Year 11	35
Year 6	8	Year 12	35

Q3_ Which best describe your current school?

Select one alternative from the following ones.

Table 4. Q_3 Frequencies

		Frequencies	Valid Percentage
Valid	Government (Public) school	29	39,2
	Non-government (Private school): Catholic or Independent	45	60,8
	Total	74	100,0
Missing	(System)	7	
Total		81	

Q4_ Referring to class formation, which best describes your current school?

Select one alternative from the following ones.

Table 5. Q_4 Frequencies

		Frequencies	Valid Percentage
Valid	Comprehensive (Open)	58	78,4
	Selective	1	1,4
	Special	1	1,4
	Specialist	2	2,7
	International	1	1,4
	School with streamed classes into attainment groupings	11	14,9
	Total	74	100,0
Missing	(System)	7	
Total		81	

Q5_ Referring to inspiring principles, which best describes your current school?

Select one alternative from the following ones.

Table 6.Q_5 Frequencies

		Frequencies	Valid Percentage
Valid	Traditional School	71	95,9

	School based on a specific educational method (e.g., Montessori method school, Steiner school)	3	4,1
	Total	74	100,0
Missing	(System)	7	
Total		81	

Q5BIS_Which typology?

Write down your answer.

Table 7. Q_5BIS Frequencies

		Frequencies	Valid Percentage
Valid		78	96,3
	Alternate pathways for senior students, transitioning into the workdforce at the same time as studying to achieve the QCE	1	1,2
	Montessori	1	1,2
	PYP	1	1,2
	Total	81	100,0

Q6 (Secondary school teachers)_ What subject(s) are you teaching for the majority of hours per week in this school during the current school year?

If you teach more than one subject for the same hours, please select up to two alternatives.

Tables 7. Q_6 Frequencies - Only Secondary school teachers

Mathematics		Frequencies	Valid Percentage
Valid	Mathematics	58	100,0
Missing	(System)	23	
Total		81	

Sciences		Frequencies	Valid Percentage
Valid	Sciences	5	100,0
Missing	System	76	
Total		81	

Physics		Frequencies	Valid Percentage
Missing	System	81	100,0

Technology		Frequencies	Valid Percentage
Valid	Technology	1	100,0

Missing	System	80	
Total		81	

Economy		Frequencies	Valid Percentage
Missing	System	81	100,0

Biology		Frequencies	Valid Percentage
Valid	Biology	1	100,0
Missing	System	80	
Total		81	

Other (Please Specify)		Frequencies	Valid Percentage
Valid	Other (Please Specify)	4	100,0
Missing	System	77	
Total		81	

Other (Please Specify) TEXT		Frequencies	Valid Percentage
Valid		77	95,1
	English	2	2,5
	HPE	1	1,2
	Scaling Test preparation	1	1,2
	Total	81	100,0

Section 2: General

Q 7 (Primary school teachers)_ What is the highest level of formal education you have completed?
Select one alternative from the following ones.

Table 8. Q7P Frequencies

		Frequencies	Valid Percentage
Valid	Graduate Diploma (Diploma of Education / Diploma of Teaching)	1	6,7
	Bachelor's Degree	5	33,3
	Master's Degree or professional degree (MD, DDS, lawyer, minister)	9	60,0
	Total	15	100,0
Missing	System	66	
Total		81	

Q 7 (Secondary school teachers)_ What is the highest level of formal education you have completed?
Select one alternative from the following ones.

Table 9. Q7S Frequencies

		Frequencies	Valid Percentage
Valid	Bachelor's Degree	36	61,0
	Master's Degree or professional degree (MD, DDS, lawyer, minister)	17	28,8
	Other (Please Specify)	6	10,2
	Total	59	100,0
Missing	System	22	
Total		81	

Other (Please Specify) - Text		Frequencies	Valid Percentage
Valid		75	92,6
	B Sc Dip Ed	1	1,2
	Gd	1	1,2
	Graduate Diploma in Education	1	1,2
	Graduate Diploma of Education	1	1,2
	PGCE UK	1	1,2
	Post graduate degree	1	1,2
	Total	81	100,0

Q8 During your college or university education, what was the major discipline knowledge?

Select one alternative from the following ones.

Table 10. Q8 Frequencies

		Frequencies	Valid Percentage
Valid	Mathematics (e.g. Geometry, Algebra, Probability and Statistics, Numerical Analysis)	23	31,5
	Mathematics Education (You took specific Mathematics Education courses)	12	16,4
	Other (Please Specify)	38	52,1
	Total	73	100,0
Missing	System	8	
Total		81	

Other (Please Specify) - Text		Frequencies	Valid Percentage
Valido		44	54,3
	Accounting	1	1,2

	Art	1	1,2
	Biology	2	2,5
	Biology and Chemistry	1	1,2
	Bsc Food and Nutrition	1	1,2
	Children's literature	1	1,2
	Computer degree post grad cert in science to up maths subjects followed by master of teaching	1	1,2
	Computer Science	1	1,2
	Dance	1	1,2
	Double degree… 1 in mathematics, the other in education.	1	1,2
	Economics	1	1,2
	Education with a specialisation in mathematics	1	1,2
	Engineering	1	1,2
	English literature	1	1,2
	English Literature	1	1,2
	Environmental science	1	1,2
	Geography	2	2,5
	Geological Science	1	1,2
	Gifted and talented education	1	1,2
	Linguistics	1	1,2
	Metallurgical Engineering	1	1,2
	Non specialist	1	1,2
	Physic	1	1,2
	Physical Education	1	1,2
	Physics	1	1,2
	Primary	1	1,2
	Primary education	2	2,5
	Primary teaching	1	1,2
	primary, leadership	1	1,2
	Psychology	1	1,2
	Science	3	3,7
	Upper primary	1	1,2
	Total	81	100,0

Q9 At the end of this school year, how many years have you been working as a mathematics teacher?

Select one alternative from the following ones.

Table 11. Q9 Frequencies

		Frequencies	Valid Percentage
Valid	from 1 to 3 years	15	20,5
	from 4 to 10 years	15	20,5
	more than 10 years	43	58,9

	Total	73	100,0
Missing	System	8	
Total		81	

Section 3: Beliefs (a)

Q10 In your opinion, to what extent do the following factors play a significant role in students' mathematical development?

For each row, select one alternative.

Table 12. Q_10 Frequencies

	To a large extent		*To a moderate extent*		*To a small extent*		*Not at all*	*I don't know*
a)**Teacher**'s role	**56**	10 Primary 46 Secondary	**14**	2 Primary 12 Secondary	**0**		0	0
b)**Peer**'s role	**15**	4 Primary 11 Secondary	**34**	2 Primary 32 Secondary	**19**	5 Primary 14 Secondary	0	**1** Secondary
c)**Student**'s role	**57**	7 Primary 50 Secondary	**11**	4 Primary 7 Secondary	**0**		0	0

Q11 What is the teacher's role in supporting mathematical development?

Select one alternative from the following ones.

Table 13. Q_11 Frequencies

		Frequencies	Valid Percentage
Valid	Instructor	8	11,1
	Explainer	20	27,8
	Facilitator	41	56,9
	None of the previous	1	1,4
	Total	73	100,0
Missing	System	8	
Total		81	

Figure 2. Bar chart corresponding the Cross Tab between the major subject of University education (Q_8) and on teacher's role (Q_11)

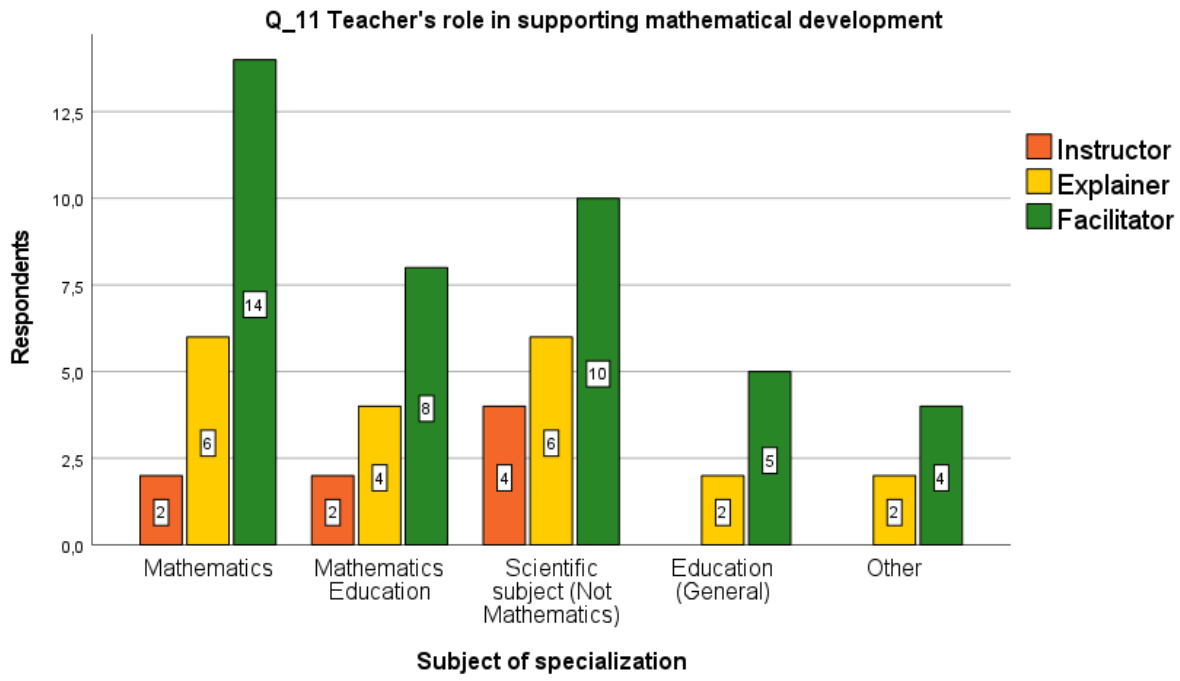


Table 14. Cross Tab between the major subject of University education (Q_8) and beliefs that expository style is the best to present Mathematics(Q_12e)

Subj. Of specialization	Q12_e From Moderate to Large extent	Q12_e From nothing to a small extent	Total
Math	16	5	21
Math Education	6	6	12
Scientific subj. (No Math.)	17	1	18
Total	39	12	51

(Chi-Squared=7.906, *p=0.019<0.05)

Q12 To what extent do you agree or disagree with the following statements?

For each sentence, select one alternative.

Tables 14. Q_12 Frequencies

Q12_a)		Frequencies	Valid Percentage
Valid	To a large extent	23	31,9
	To a moderate extent	30	41,7
	To a small extent	16	22,2
	Not at all	1	1,4
	Total	72	100,0
Missing	System	9	
Total		81	

Q12_b)		Frequencies	Valid Percentage
Valid	To a large extent	44	63,8
	To a moderate extent	21	30,4
	To a small extent	4	5,8
	Total	69	100,0
Missing	System	12	
Total		81	

Q12_c)		Frequencies	Valid Percentage
Valid	To a large extent	21	31,8
	To a moderate extent	26	39,4
	To a small extent	17	25,8
	Not at all	2	3,0
	Total	66	100,0
Missing	System	15	
Total		81	

Q12_d)		Frequencies	Valid Percentage
Valid	To a large extent	7	10,0
	To a moderate extent	37	52,9
	To a small extent	20	28,6
	Not at all	6	8,6
	Total	70	100,0
Missing	System	11	
Total		81	

Q12_e)		Frequencies	Valid Percentage
Valid	To a large extent	12	17,6
	To a moderate extent	37	54,4
	To a small extent	17	25,0
	Not at all	2	2,9
	Total	68	100,0
Missing	System	13	
Total		81	

Q12_f)		Frequencies	Valid Percentage
Valid	To a large extent	19	27,9
	To a moderate extent	18	26,5
	To a small extent	20	29,4
	Not at all	11	16,2

	Total	68	100,0
Missing	System	13	
Total		81	

Section 4: Beliefs (b)

Q13 To what extent do you believe it is important to propose active learning activities involving student' body and movement in mathematics teaching practice?

Table 15. Q_13 Frequencies

		Frequencies	Valid Percentage
Valid	To a large extent	20	31,7
	To a moderate extent	34	54,0
	To a small extent	8	12,7
	Not at all	1	1,6
	Total	63	100,0
Missing	System	20	
Total		81	

Table 16. Q_13 Cross Table (Q_1, Q_13)

		To a large extent	To a moderate extent	To a small extent	Not at all
	Primary school teacher	5	2	2	0
	Secondary school teacher	15	32	6	1
Total		20	34	8	1

Figure 3. Bar chart of the CrossTab (Q_13, Q_6)

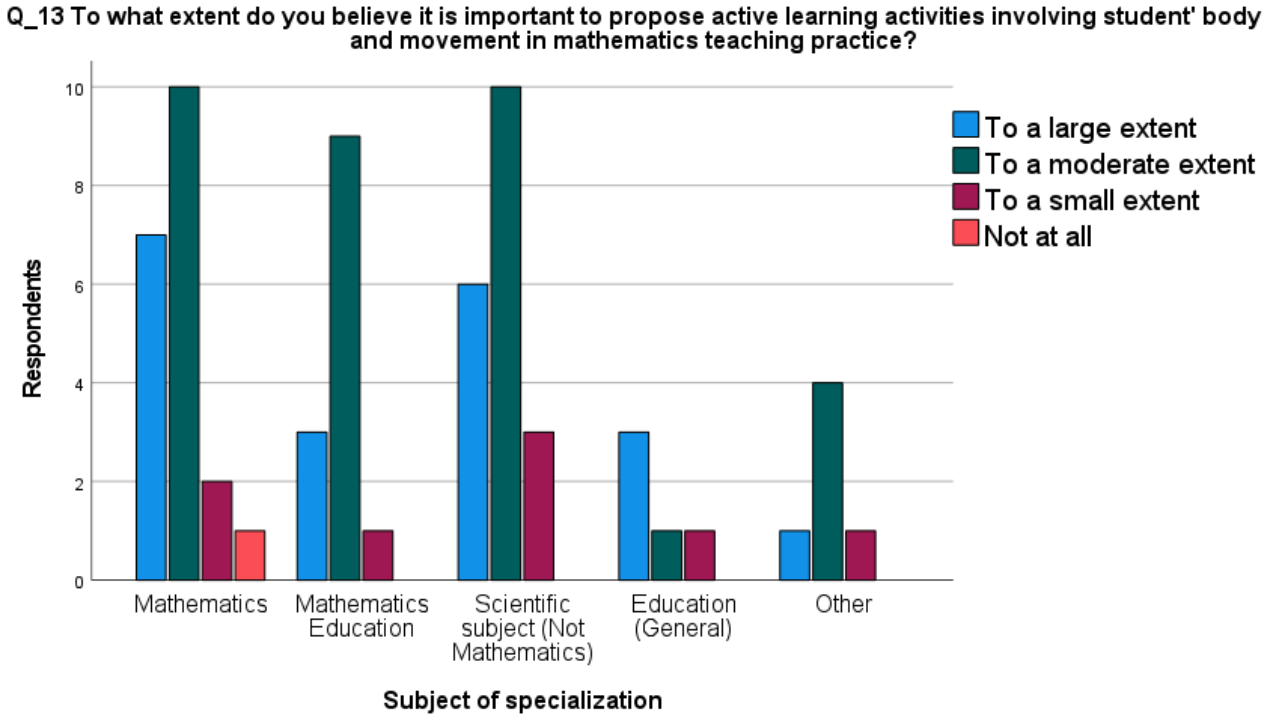


Table 17. Cross Table (Q_13, Q12_f)

	Q12_f From Moderate to Large extent	Q12_f From nothing to a small extent	Total
Q13 From Moderate to Large extent	32	20	52
Q13 From nothing to a small extent	2	7	9
Total	34	27	61

(Chi_Squared=4.807, *p=0.028<0.05)

Q14 For which schools levels do you believe active, bodily experience mathematics learning activities are appropriate?

Write down your answer.

Table 18. Q_14 Levels indicated by respondents

	Levels	Frequencies
Valid		16
	T-9	1
	-99	3
	1-6	1
	7-10	1
	all	3
	All	13

	ALL	1
	All bar maths methods and specialist maths in year 11/12 due to time constraints and topics covered	1
	All but not for every topic	1
	All levels	2
	All levels - including senior mathematics.	1
	All levels but especially in younger students - Primary, early Secondary	1
	All levels that I'm aware of	1
	All of them	1
	all school leavers	1
	All schools	1
	All to Year 10	1
	All year levels	3
	All year levels and beyond (university courses)	1
	all years	1
	All years	1
	All years, but particularly in lower school	1
	All, but at varying amounts	1
	All, but decreasing as mathematical knowledge increases.	1
	Basic levels	1
	Early to mid secondary	1
	For any level.	1
	kindy to year 9	1
	Lower and middle primary	1
	Mainly middle school as senior school are syllabus driven	1
	More depends on the level of the student I find. Lower kids usually need the hands on experience. More able children usually do well with expository stuff	1
	P-10	1
	P-12	1
	Prep - year 12	1
	Preschool to Year 12 and beyond	1
	Primary	1
	Primary, smaller extent in high school	1
	There are opportunities to experiment with active, bodily experience mathematics learning activities in all year and age levels.	1
	Up to 10	1
	Up to grade 12 - depends on the learner.	1
	Up to grade 8 is easier to incorporate, but after then it is still beneficial	1
	Y7 to 12	1
	Year7-10	1
	Years 7 and 8	1
	Years 7-9 (but also most levels in junior school)	1
	years 8-12	1
	Total	81

Table 19. Cross Table (Q_14, Q_1)

			Primary, Basic Class	(To) Middle School	(To) High School (Senior excluded)	All	Totale
	Primary school teacher	7	0	0	0	8	15
	Secondary school teacher	12	4	8	4	36	64
Totale		19	4	8	4	44	79

Table 20. . Cross Table (Q_14, Q_1): The ALL category

			(To) Secondary School and Senior	Mainly for lower classes, but also beyond	For all school levels but not in the same ways	All years (without limitations)	Totale
	Primary school teacher	7	0	0	0	8	15
	Secondary school teacher	28	2	3	4	27	64
Totale		35	2	3	4	35	79

Q15 (Secondary school teachers) Which topic(s)/content(s) do you believe should be taught with this type of learning activity?

Write down 1-3 examples.

Tables 21. Q_15 Examples provided by Secondary School Teachers

EXAMPLE 1		Frequencies
Valid		26
	-99	4
	3D shapes	1
	Add	1
	algebra	1
	Algebra	1
	Algebra and patterns	1
	Any	1
	Degrees	1
	Fractions-decimal-percent	1
	Fractions, decimals	1
	Geometry	9
	Graphing Functions	1
	Graphing should be done with technology such as motion detectors	1
	Linear graphing	1
	Maths	1
	Measurement	9
	Measurement - areas, perimeter etc	1
	Measurement - exploring units of measurement	1
	Mensuration & Geometry	1
	Multiplying by 10,100 and 1000	1
	number	1
	Number	2
	Number work	1
	Number/Algebra	1
	Numeracy .e.g lifesize number lines/number plane	1

	Operations	1
	Pascal Triangle	1
	place value	1
	Pythagoras	1
	Ratio	1
	Statistics	2
	The value of pi	1
	Trig	1
	Trigonometry	1
	Totale	81

EXAMPLE 2		Frequencies
Valid		26
	-99	5
	Algebra	4
	Angle of depression	1
	Any	1
	Chance	1
	Financial maths - percentages, tax	1
	Fractions, decimal, percentages	1
	Fractions/decimal/percentages	1
	functions	1
	geometry	2
	Geometry	3
	Geometry - e.g bearings, shapes and angles in our environment	1
	Graphs	1
	Integers	1
	measurement	1
	Measurement	5
	Measurement and geometry	1
	measurement/space	1
	Measurment	1
	Multiply	1
	Number & Algebra	1
	Number Skills	1
	Parabolas	1
	Pattern	1
	Pigeonhole problem	1
	Probability	1
	Ratio	1
	Ratios, scales	1
	Science	1
	Shape	1
	Space	1
	Statistical variation	1
	Statistics	2
	Statistics - Use of physical materials while collecting/collating data	1

	Statistics/probability	1
	Trigonometry	3
	Trigonometry should be done using clinometers, tape measures etc	1
	Volume	1
	Totale	81

EXAMPLE 3		Frequencies
Valid		26
	-99	12
	algebra	1
	Algebra	3
	Algebra - Use of digital tools to link algebraic ideas graphically, numerically and algebraic representations.	1
	Algebra intro	1
	Any	1
	Any device which collects real world data should always be used.	1
	arithmetic	1
	Calculations	1
	conics	1
	Data- any form of statistical collection, collation and analysis	1
	Divide	1
	Financial	1
	Financial maths	1
	Fractions	4
	Geometry	2
	Geometry/measurement	1
	Graphing	1
	Introductory algebra (gathering like terms)	1
	Measurement and geometry	1
	Nets	1
	Polynomial	1
	Pre-algebra	1
	Pre-Algebra	1
	Probability	2
	Rates/linear algebra	1
	Ratios - I use cooking as a starter for this topic	1
	Scale	1
	Statistics	1
	Statistics & Probability	1
	Statistics/Probability	1
	stats	1
	Stats	1
	Technology	1
	trigonometry	1
	Trigonometry	2
	Totale	81

Q15 (Primary school teachers) Which topic(s)/content(s) do you believe should be taught with this type of learning activity?

Write down 1-3 examples.

Tables 22. Q_15 Examples provided by Prindary School Teachers

EXAMPLE 1		Frequencies
Valido		71
	-99	2
	All	1
	all topics	1
	Division/multiplication	1
	Fractions	1
	Number and algebra	1
	Number and Algebra	2
	time	1
	Totale	81

EXAMPLE 2		Frequencies
Valido		71
	-99	5
	Addition/subtraction	1
	Geometry	1
	Measurement and Geometry	1
	Measurenent	1
	Space and measurement	1
	Totale	81

EXAMPLE 3		Frequencies
Valid		71
	-99	5
	Chance and data	1
	Fractions	1
	Problem solving	1
	Statistics and probability	1
	Statistics and Probability	1
	Totale	81

Table 23. Cross Ttable (Q_1, Q_15 Results cathegorized in content areas)

Areas of the topics/contents to be taught with ABM activities		*Secondary school*	*Primary school*	*Total*
▪ Number and Algebra		28	7	35
▪ Geometry and Measurement	Geometry	17	1	34

	Measurement	12	4	
▪ Statistics and Probability		13	3	16
▪ Percentages, ratio, scales and Financial Maths		5	0	5
▪ Functions and graphics		4	0	4
▪ Computational thinking and algorithms		2	0	2
▪ Problem solving		1	1	2
▪ All		5	2	7

Q16 Do you believe this type of learning activities could have a positive influence on students' ...

For each row, select an alternative.

Table 24 Q_16 Frequencies

	To a large extent	To a moderate extent	To a small extent	Not at all	I don't know
Deep understanding	35	25	2	0	1
Achievement in standard tests	13	34	11	4	2
Reasoning skills	33	24	5	0	1
Mathematics visualization capabilities	48	13	3	0	0
Problem solving skills, critical thinking and creativity	36	19	8	0	0
Interest and motivation	41	18	3	1	1
Attitudes toward mathematics (affect/self-efficacy)	26	31	4	2	1

Q17 Do you believe this type of learning activities could impact on ...

For each row, select an alternative.

Table25. Q_17 Frequencies

	To a large extent	To a moderate extent	To a small extent	Not at all	I don't know
Supportive classroom environment	26	27	7	3	1
Environment conducive to the expression of opinions	25	27	11	1	0
The inclusion of special educational needs students	27	20	12	4	0
The inclusion of students with a different cultural/economic backgrounds	30	17	9	5	2
Teacher's knowledge of students'learning processes	31	26	6	1	0

Q18 In your experience, what are the most relevant limitations for this type of learning activities' implementation?

Select up to three alternatives.

Tables 26. Q_18 Frequencies

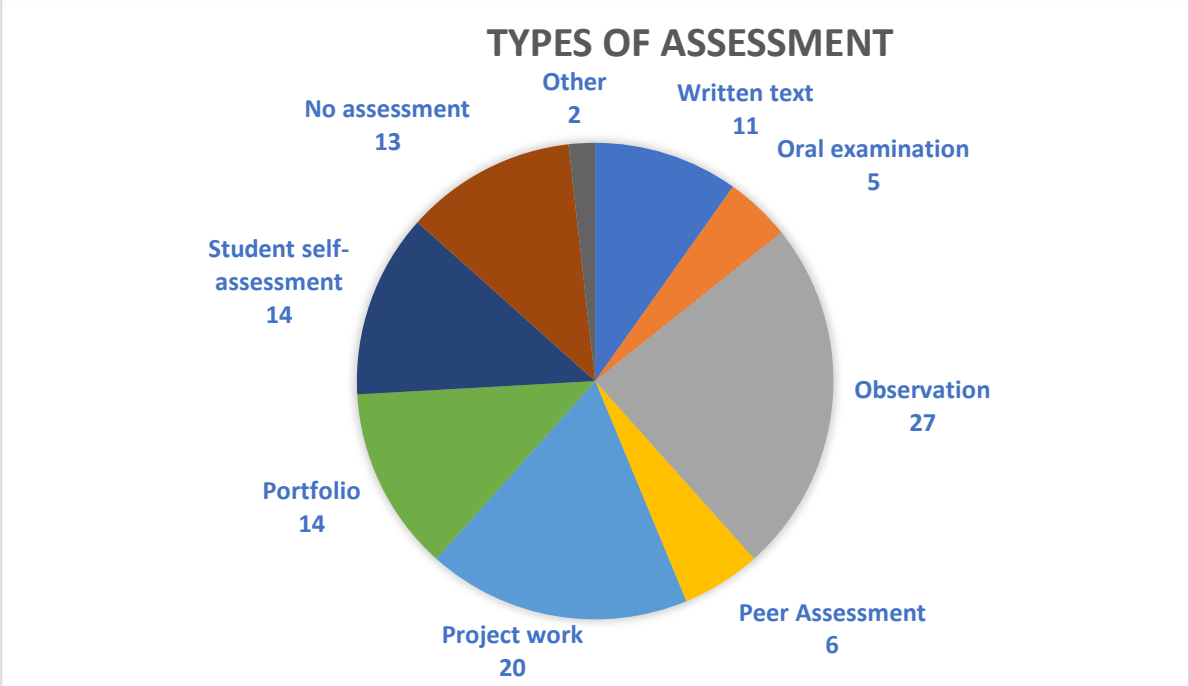
Limitations	Frequencies
Classroom management	42
Students'assessment	3
Suit only low achievers	3
Suit only high achievers	4
Not inclusive for students with a different cultural background	2
Not inclusive for special needs students	4
Time factors	41
Availability of space and resources	36
Not effective as an instructional strategy	6
Only few topics can be taught with these	8
Appropriate only for childhood primary	4
Other	10

Other (Please Specify) - Text		Frequencies	Valid Percentage
Valid		70	86,4
	Attitude of high schoolers thinking it would be babyish.	1	1,2
	Effective and efficient for some topics more than others	1	1,2
	Like most things they can be useful for some of the students. Some students will not engage or take them seriously. They can take up a lot of time that does not result in any sort of meaningful outcomes.	1	1,2
	Needs clear alignment	1	1,2
	Parent inability to see the value	1	1,2
	Specific Archdiocese pedagogical programs	1	1,2
	Students with special needs are often "lost" in these tasks even with peer and teacher support. They benefit more from direct instruction and explaining.	1	1,2
	teacher knowledge of how to teach all topics using these models of instruction	1	1,2
	Teachers not trained in effective pedagogy	1	1,2
	The curriculum is too restrictive	1	1,2
	The necessity to cover the curriculum.	1	1,2
	Total	81	100,0

Q19 What kind of assessment strategy or instrument do you believe is most appropriate for this type of learning activities?

Select up to two alternatives.

Figure 4. Chart of Q_19 Frequencies.



Other (Please Specify) - Text		Frequencies	Valid Percentage
Valid		16	19,8
	-99	63	77,8
	Assessing students working in groups is a problem. You will alowas get one student who does not make the same level of contribution to the task. Hence they may be useful for learning but not for assessment.	1	1,2
	formative analysis (i.e LAF, SENA), PROJECT WORK	1	1,2
	Totale	81	100,0

Q20 Think about Monica's story, please express to what extent do you agree or disagree with the following statements:

For each of the following 4 sentences, select one alternative.

Table 27. Q_20 Frequencies

		To a large extent	To a moderate extent	To a small extent	Not at all	I don't know
a) The activity was in fact effective, as students got to know an alternative way	Primary	2	3	2	0	0

of representing distributive properties/algebraic problems. It doesn't matter if they solved the tasks with the already known solving strategies.	Secondary	11	21	11	2	1
b) This type of activity takes a long time before students become familiar with a new way of working and become aware of how experience with wooden shapes can help them solve arithmetic/algebraic problems.	Primary	0	2	1	3	0
	Secondary	18	15	7	1	0
c) Proposing exploratory tasks and open-ended problems make this type of learning activity more effective than solving predefined tasks in scheduled timing.	Primary	3	3	0	0	0
	Secondary	12	13	7	6	3
d) A high level of student interaction with the teacher and peers during the activity would have stimulated the use of wooden shapes to solve arithmetical/algebraic problems.	Primary	2	3	1	0	0
	Secondary	10	18	9	2	1
e) The reason for Monica's failure is that she failed to convey to the students the goal of the activity: to explore and become familiar with geometric interpretations of distributive properties/algebraic problems.	Primary	2	0	3	2	0
	Secondary	8	11	13	8	1

Section 5 - Filter question

Q21 Do you include active, bodily experience mathematics learning activities in your instructional practice?

Select one alternative from the following ones.

Tables 28. Q_21 Frequencies

		Frequencies	Valid Percentage
Valid	Yes	41	71,9
	No	16	28,1
	Total	57	100,0
Missing	System	24	
Total		81	

Section 5 – No : Why not implementing

Q22 Why do you not include these types of activities in your daily practice?

Select up to two alternatives from the following ones.

Table 29. Q_22 Frequencies and Q_22 Frequencies among the respondents who indicate in Q_13 from a moderate to a large extent

Reasons for not implementing these activities in schools	Number of respondents	Respondents who express in Q_13 From moderate to a large extent
Insufficient confidence with these approaches / lack of guidance	2	2
Difficulty with classroom management	5	4
These activites are not appropriate for my student's school level	5	4
Unsuccessful previous experiences	1	1
These activities are not effective	1	0
Lack of time	6	4
Lack of availability of resources, tools, materials	5	4
Lack of adequate spaces/ Too many students in classrooms	1	1
Other	0	0

Q23 What other kind of instructional strategy of your daily practice do you believe is particularly effective?

Select up to three alternatives from the following ones.

Table 30. Q_23 Frequencies

Other instructional strategies implemented	Number of respondents
Relate the lesson to students' daily lives	10
Apply what students have learned to new problem situations on their own	1
Link new content to student's prior knowledge	10
Ask students to explain their ideas in class	5
Listen to me explain how to solve problems	1
Encourage classroom discussions among students	5
Ask students to select their own problem solving strategies	0
Work problems together in the whole class with direct guidance from teacher	4
Work in mixed ability group	2
Work in same ability group	2
Other (Please Specify)	0

Section 5 – YES : Implementation

Q22 How often do you implement an active, bodily experience mathematics learning activity in your instructional practice?

Select one alternative from the following ones.

Tables 31. Q_22 Frequencies

		Frequencies	Valid Percentage
Valid	Once a week or more	15	36,6
	1-3 times a month	10	24,4

	5-10 times every year	8	19,5
	Less than 4 times every year	5	12,2
	Other (Please specify)	3	7,3
	Total	41	100,0
Missing	System	40	
Total		81	

Other (Please specify) - Text		Frequencies	Valid Percentage
Valid		78	96,3
	Always as students have access to manipulativen all the ti e	1	1,2
	When it is a suitable way to use it.	1	1,2
	When suitable by topic	1	1,2
	Total	81	100,0

Q23 On average, how much time do you spend implementing a learning activity of this type?

Select one alternative from the following ones.

Tables 32. Q_23 Frequencies

		Frequencies	Valid Percentage
Valid	Less than a lesson	16	40,0
	From 1 to 3 lesson	22	55,0
	More than 3 lessons	2	5,0
	Total	40	100,0
Missing	System	41	
Total		81	

Q24 During your classes, you mainly implement this type of learning activities:

Select one or more alternatives from the following ones.

Tables 33. Q_24 Frequencies

to introduce new topics		Frequencies	Valid Percentage
Valid	to introduce new topics	32	100,0
Missing	System	49	
Total		81	

as consolidation activities (to exercise)		Frequencies	Valid Percentage
Valid	as consolidation activities (to exercise)	28	100,0
Missing	System	53	
Total		81	

to revise topics		Frequencies	Valid Percentage
Valid	to revise topics	10	100,0
Missing	System	71	
Total		81	

as remedial activitie		Frequencies	Valid Percentage
Valid	as remedial activities	10	100,0
Missing	System	71	
Total		81	

as advanced (enrichment) activities		Frequencies	Valid Percentage
Valid	as advanced (enrichment) activities	15	100,0
Missing	System	66	
Total		81	

to enhance student's motivation		Frequencies	Valid Percentage
Valid	to enhance student's motivation	28	100,0
Missing	System	53	
Total		81	

Other		Frequencies	Valid Percentage
Valid		80	98,8
	So they can see what they are doing visually	1	1,2
	Totale	81	100,0

Q25 (Primary school teachers) What types of materials/ tools are involved in your instructional practice when you implement a learning activity of this type?

Select one or more alternatives from the following ones.

Tables 34. Q_25P Frequencies

mechanical tools (e.g. drawing tools like compass, etch-a-sketch, perspective tools)		Frequencies	Valid Percentage
Valid	mechanical tools (e.g. drawing tools like compass, etch-a-sketch, perspective tools)	3	100,0
Missing	System	78	
Total		81	

computational devices (e.g., abacus, pascaline)		Frequencies	Valid Percentage
Valid	computational devices (e.g., abacus, pascaline)	2	100,0
Missing	System	79	
Total		81	

physical manipulatives(e.g., tangram, Montessori's materials, origami, wooden geometrical shapes, base-ten Dienes blocks)		Frequencies	Valid Percentage
Valid	physical manipulatives (e.g., tangram, Montessori's materials, origami, wooden geometrical shapes, base-ten Dienes blocks)	7	100,0
Missing	System	73	
Total		81	

daily life objects (e.g., straws, cardboard boxes)		Frequencies	Valid Percentage
Valid	daily life objects (e.g., straws, cardboard boxes)	7	100,0
Missing	System	73	
Total		81	

gym equipment (e.g., ropes, hula-hoop, rods, psychomotor blocks)		Frequencies	Valid Percentage
Valid	gym equipment (e.g., ropes, hula-hoop, rods, psychomotor blocks)	4	100,0
Missing	System	77	
Total		81	

interactive digital tools (e.g., interactive apps like Geogebra applets, Fingu, TouchCounts, on multitouch devices - iPads)		Frequencies	Valid Percentage
Valid	interactive digital tools (e.g., interactive apps like Geogebra applets, Fingu, TouchCounts, on multitouch devices - iPads)	5	100,0
Missing	System	76	
Total		81	

only students' body (or also usual stuff such as pencil and paper)		Frequencies	Valid Percentage
Valid	only students' body (or also usual stuff such as pencil and paper)	4	100,0

Missing	System	77	
Total		81	

Q25 (Secondary school teachers) What types of materials/ tools are involved in your instructional practice when you implement a learning activity of this type?

Select one or more alternatives from the following ones.

Tables 35. Q_25S Frequencies

mechanical tools (e.g. drawing tools like compass, etch-a-sketch, perspective tools)		Frequencies	Valid Percentage
Valid	mechanical tools (e.g. drawing tools like compass, etch-a-sketch, perspective tools)	22	100,0
Missing	System	59	
Total		81	

computational devices (e.g., Position Detector, Calculator Based Laboratory)		Frequencies	Valid Percentage
Valid	computational devices (e.g., Position Detector, Calculator Based Laboratory)	13	100,0
Missing	System	68	
Total		81	

physical manipulatives (e.g., origami, wooden geometrical shapes)		Frequencies	Valid Percentage
Valid	physical manipulatives (e.g., origami, wooden geometrical shapes)	23	100,0
Missing	System	58	
Total		81	

daily life objects (e.g. straws, cardboard boxes)		Frequencies	Valid Percentage
Valid	daily life objects (e.g. straws, cardboard boxes)	18	100,0
Missing	System	63	
Total		81	

gym equipment (e.g. ropes, hula-hoop, rods, psychomotor blocks)		Frequencies	Valid Percentage
Valid	gym equipment (e.g. ropes, hula-hoop, rods, psychomotor blocks)	6	100,0
Missing	System	75	
Total		81	

interactive digital tools(e.g. interactive apps like Geogebra applets on multitouch devices - iPads)		Frequencies	Valid Percentage
Valid	interactive digital tools (e.g. interactive apps like Geogebra applets on multitouch devices - iPads)	25	100,0
Missing	System	56	
Total		81	

only students' body (or also usual stuff such as pencil and paper)		Frequencies	Valid Percentage
Valid	only students' body (or also usual stuff such as pencil and paper)	16	100,0
Missing	System	65	
Total		81	

Other (Please Specify) - Text		Frequenza	Percentuale valida
Valid		77	95,1
	Anything else I can lay my hands on :-).	1	1,2
	Chalk, playground or school environment, sometimes rope/string. I try to make a replica of a paper task lifesize to being with. E.g drawing a circle/number line	1	1,2
	Dice, playing cards, puzzles,	1	1,2
	Food	1	1,2
	Total	81	100,0

Q26 When you implement activities of this type in your classroom, do you usually...

Select one or more alternatives from the following ones.

Tables 35. Q_26 Frequencies

use commercially developed materials, tools		Frequencies	Valid Percentage
Valid	use commercially developed materials, tools	17	100,0
Missing	System	64	
Total		81	

adapt commercially developed materials, tools		Frequencies	Valid Percentage
Valid	adapt commercially developed materials, tools	28	100,0
Missing	System	53	
Total		81	

design and construct materials, tools from scratch		Frequencies	Valid Percentage
Valid	design and construct materials, tools from scratch	24	100,0
Missing	System	57	
Total		81	

Q27 Which of the following ones is/are the major/main criteria that determine your choices in selecting and designing active, bodily experience mathematics learning activities?

Select up to two alternatives from the following ones.

Tables 36. Q_27 Frequencies

	Number of respondents
Colleagues suggestions and information about their own experiences	13
Your own personal experience (as a teacher or as a student)	23
Specific contextual student's needs	7
Specific instructional goals you would like to achieve	10
Availability / accessibility/ affordability of resources	15
Other	2

Other (Please Specify) - Text		Frequencies	Valid Percentage
Valido		79	97,5
	My own experience of the workforce	1	1,2
	specific contextual student's needs, specific instructional goals you would like to achieve	1	1,2
	Total	81	100,0

Q28 In your opinion, what are the main difficulties experienced by students (in learning effectively) during a learning activity of this type?

Select up to two alternatives from the following ones.

Tables 37. Q_28 Frequencies

	Number of respondents
Understand the task	6
Explain their own ideas in class	4
Maintain interest during the activity	5
Physically handling objects and tools	2
Take part in a discussion among peers	6
Apply their mathematical knowledge in the activity	14
Transfer in new contexts what they have learned	15
Formalize what they have learned using mathematical language	15
Simultaneously handling different representations of mathematical concepts (e.g. concrete, figurative, symbolic))	4
Other	4

Other (Please Specify) - Text		Frequencies	Valid Percentage
Valid		77	95,1
	Elaborating on mathematical conjectures.	1	1,2
	Getting distracted by the novelty of the tool and so not making effective connections with the mathematical concepts.	1	1,2
	If they've never encounted these types of tasks they will often look for the "correct" way of doing it and be nervous about failing	1	1,2
	Willingness to try a new way of doing things.	1	1,2
	Total	81	100,0

Q29 [Vignette Tina/ Robert] Overall, which of the two teachers do you most identify with?

Select one alternative from the following ones.

Tables 38. Q_29 Frequencies

		Frequencies	Valid Percentage
Valid	Robert	11	27,5
	Tina	29	72,5
	Total	40	100,0
Missing	System	41	
Total		81	

Q30 [ROB] Select from the following list one thing, that Robert did, that you believe is the most important for supporting an effective learning activity:

Select one alternative from the following ones.

Tables 39. Q_30R Frequencies

		Frequencies	Valid Percentage
Valid	Make explicit the content knowledge at the beginning of the activity	4	40,0
	Design the activity as a step-by-step procedures with scheduled timing	3	30,0
	Divide the class into mixed ability groups	1	10,0
	Guide the whole class when drawing conclusions from the activity	2	20,0
	Totale	10	100,0
Missing	System	71	
Total		81	

Q31 [ROB] Is there anything you would have done differently than Robert to support more effective learning?

Write down your answer.

Tables 40. Q_31R Frequencies

		Frequencies	Valid Percentage
Valid		75	92,6
	Depends on where they are in a topic. I would expect more student direction if we have seen similar problems before.	1	1,2
	Individual work rather than groups if possible.	1	1,2
	Link activity with student's own context	1	1,2
	Not that I can think of right now.	1	1,2
	Offer rewards as motivation	1	1,2
	Remove the high structured with timing and apply more Tina (self exploration of strategy) with self/ specific grouping	1	1,2
	Total	81	100,0

Q30 [TINA] Select from the following list one thing, that Robert did, that you believe is the most important for supporting an effective learning activity:

Select one alternative from the following ones.

Tables 41. Q_30T Frequencies

		Frequencies	Valid Percentage
Valid	Introduce manipulatives and left students time to be confident with them at the beginning	6	20,7
	Introduce a problem and allow students to self-direct the activity, approaching it with their own strategy	11	37,9
	Walk among students to scaffold their understanding and problem solving strategies	10	34,5
	Allow time for students to discuss and share conclusions with the whole class at the end	2	6,9
	Total	29	100,0
Missing	System	52	
Total		81	

Q31[TINA] Is there anything you would have done differently than Robert to support more effective learning?

Write down your answer.

Tables 42. Q_31T Frequencies

		Frequencies	Valid Percentage
Valid		65	80,2
	Happened the students as a class with different questions as they moved through the activity - particularly if they are all finding the same conclusions or arriving at the same location. I'd also encourage every student to work with at least one other as this leads to them learning to work with others and discuss different perspectives.	1	1,2
	Or self selecting groups	1	1,2
	Ask probing questions while walking amongst groups.	1	1,2
	Get members from each group to share their assumptions and strategies with other groups.	1	1,2
	I really like all the things she did. In reality I don't always work like this, mostly due to time constraints in the program and also finding good problems to solve.	1	1,2
	I will sometimes link the problem to a topic they've done before or refresh	1	1,2

	about things they've just learnt that might be helpful after some initial thinking time		
	I would probably have a lesson after that and pick the different ideas and discuss the different approaches students took,	1	1,2
	If needed, give guided practice on how to use the manipulative before beginning the problem	1	1,2
	It needs to be a mixture of Tina and Robert. There is only a finite amount of time. Students can't be left to solve problems on their own as most won't. There needs to be structure and there needs to be time for the students to try it out.	1	1,2
	No	3	3,7
	No, it is great	1	1,2
	Repeat the task with a variety of different materials	1	1,2
	Select specifuc students/strategies to share/duscuss at the end. Ask students to explain/reword other strategies	1	1,2
	She pretty much nailed it I reckon	1	1,2
	Total	81	100,0