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Challenges Confronting Career-Changing Beginning Teachers: A Qualitative Study of Professional Scientists Becoming Science Teachers

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Abstract Recruitment of highly qualified science and mathematics graduates has become a widespread strategy to enhance the quality of education in the field of STEM. However, attrition rates are very high suggesting preservice education programs are not preparing them well for the career change. We analyse the experiences of professionals who are scientists and have decided to change careers to become teachers. The study followed a group of professionals who undertook a one-year preservice teacher education course and were employed by secondary schools on graduation. We examined these teachers' experiences through the lens of self-determination theory, which posits autonomy, confidence and relatedness are important in achieving job satisfaction. The findings indicated that the successful teachers were able to achieve a sense of autonomy and confidence, and, in particular, had established strong relationships with colleagues. However, the unique challenges facing career-change professionals were often overlooked by administrators and colleagues. Opportunities to build a sense of relatedness in their new profession were often absent. The failure to establish supportive relationships was decisive in some teachers leaving the profession. The findings have implications for both pre-service and professional inservice programs and the role that administrators play in supporting career-change teachers.

Keywords Science teacher education; Beginning teachers; Career-change teachers; Career-switchers; Second Career Teachers; Mathematics education; Professional identity; School culture; Science education; Self-determination theory

Introduction

This paper examines the experiences of *career-change* beginning science, technology, engineering and mathematics (STEM) teachers who were transitioning from a professional science-related career to teaching. The experiences of *early career* beginning teachers have been extensively studied for over half a century (e.g., Charters, 1956; Veenman, 1984; Feiman-Nemser, 2003; Ingersoll & Strong, 2011). Ingersoll and Perda's (2010) analysis of science teacher demand suggests that most early career beginning secondary science teachers are fresh graduates straight from colleges with science or mathematics qualifications. The research reported here extends that research by focussing on a cohort of beginning teachers about whom relatively little has been documented, namely beginning teachers with advanced qualifications in STEM who have experienced work in a profession for a decade. We describe these individuals as *career-change* teachers. Although not a numerically significant source of new teachers, they are potentially an important resource. In the context of debate about teacher effectiveness, one response has been to argue for teacher recruitment programs that target highly qualified professionals on the assumption that their experiences and enthusiasm for their subject matter will inspire more students to achieve improved outcomes in school and to pursue careers in the sciences (e.g., Holdren, Lander & Varmus, 2010). Among the perceived advantages of these teacher candidates are the experiences that ex-scientists and engineers bring from their professional life including applied knowledge of their subject matter, people-oriented skills, eagerness to share with colleagues, good communication skills and tolerance of diversity. Understanding more about this cohort is important as programs such as Teach for America, Teach First (UK) or Teach for Australia attempt to address shortages in mathematics and science by attracting professionals or top science graduates into marginalised schools following alternative teacher education courses.

We first provide a background summarising some of the research related to motives for career-changes to transition from their existing careers to teaching. What drives professionals to leave presumably high status professional careers as scientists and engineers and enter teaching which is broadly perceived as a low status job. We then briefly examine issues around persistence with a teaching career given attrition rates of beginning teachers are exceptionally high. Finally, we provide a theoretical framework to examine the experiences of a cohort of post-baccalaureate trained teachers who had decided to take up teaching and were still committed to the profession after three years. Each of the participants in our study had worked as professionals in a career related to STEM for at least 10 years.

Background

Extensive research on beginning teachers who have entered the profession as first career teachers has identified a number of issues around motives for becoming a teacher and for leaving the profession. This section provides a brief overview of these issues.

Motives: Work motivation theories suggest that the reasons for any career-change include both internal and external factors. The internal factors include a range of issues from job interest, satisfaction, and life style (Holmes & Cartwright, 1994). In a study of motives of undergraduate and postgraduate preservice teacher in Australia, Watt, Richardson and Pietsch (2007) explored characteristics, motivations, and perceptions of individuals with STEM qualifications who were intending to become teachers, including those who were changing from established careers. Their findings suggested personal beliefs about teaching ability, issues of job security, time for family and social utility values were influential motives. However their findings were not disaggregated to identify any specific motives driving career-changers. A study by Snyder, Oliviera and Paska (2013), applied Transformative Learning Theory to explore the emotional and rational growth of female career-change beginning teachers moving into teaching from a professional STEM background. They propose that career-change teachers need to develop a completely new way of making sense of self within a “teaching frame of reference” (p. 621). This process of transformative learning is said to “require considerable mental effort to shift into a new professional mindset and integrate a new profession into pre-existing frameworks of themselves as professionals” (p. 622). They noted the process was filled with both positive and negative emotions which emerged as significant in coping with becoming a science teacher. In a collaborative study of a career-change scientist, Ritchie, Kidman and Vaughn (2007) described how one professional scientist described her motives as being driven by experiences with students attending her research institute and the enjoyment she achieved through explaining scientific research to them.

Grier and Johnston (2009) probed the motives for a career change of six STEM professionals who had participated in a traditional baccalaureate preservice course to equip them to teach. . Common motives specific to career-changers included a desire to make a difference and return the benefits that they experienced throughout their education. In a qualitative case study of 68 beginning career-change teachers in New Zealand, Anthony and Ord (2008) identified, through the analysis of interview data, “multifaceted, complex, at times emotionally charged, and contradictory reasons that represented participants’ motives to become teachers” (p. 364). Further analysis revealed ‘push’ factors such as

dissatisfaction with the current job and ‘pull’ factors related to seeking a challenge and personal utilitarian factors such as job security and time for family. Another pull factor was prior experience in some form of teaching. Noting the dissatisfaction with current induction programs in that country, they advocate addressing career-change teachers’ initial expectations about teaching during the crucial period of induction and fostering greater acknowledgment of the skills and experiences these teachers potentially bring to teaching.

In summary, the empirical literature on STEM career-change teachers is not extensive but highlights factors such as career-changers wanting to make a difference by repaying the benefits that they acquired through education as a common motive. Other motives include those identified in research on beginning teachers in general, such as working with children and adolescents, job security, job, enjoyment of teaching, compatibility with family life, and self-education (Organisation for Economic Co-operation and Development [OECD], 2005).

Attrition: Ingersoll and Perda (2010) have identified high pre-retirement turnover or attrition rates for beginning teachers as a significant contributor to science teaching staffing problems. In Australia, where this study was undertaken, attrition rates are comparable with those in North America with between 40-50% of teachers leaving the profession within five years (Maciejewski, 2007). While data do not appear to exist on attrition rates of highly qualified career-change teachers, anecdotal evidence suggests that they may be even higher than other beginning teachers. This suggestion is supported by some evidence presented in a comprehensive review of teacher attrition in the US by Guarino, Santibañez, and Daley (2006). A range of studies reported that more highly qualified or higher ability graduate beginning teachers have higher attrition rates. In particular, teachers with majors in STEM were found in several studies to have attrition rates higher than those with majors in education (Henke, Zahn, & Carroll, 2001; Ingersoll, 2001). One of the main reasons for teachers leaving the profession gleaned from international research is dissatisfaction with a career that did not live up to expectations (e.g., Organisation for Economic Cooperation and Development [OECD], 2005).

In a qualitative study of non-career-change beginning teachers, Flores and Day (2006) proposed formation of an identity is a key mediator in a successful transition to teaching. Identities were shaped and reshaped over time influenced by the teachers’ perceptions of the workplace and the relationships developed. A study of preservice career-change teachers at the conclusion of a practice teaching semester noted that they shared many of the anxieties of non-career-change beginning teachers related to personal lives, classroom management, and preparation albeit “second career student teachers find many of their concerns are magnified” (Haggard, Slostad, & Winterton, 2006, p. 327). However, when

asked to compare their teaching career to their former career, they expressed positive responses suggesting the experiences were rewarding and exciting.

What influences most the development of professional identity may depend on specific circumstances. For example, Beijaard (1995) argued that for secondary school teachers, professional identity is derived, in the first instance, from the subjects that they teach, the status of those subjects and the relationships with colleagues who teach the same subject. For teachers of younger children it is through the relationships they form with their students and the investment they make in the lives of the children (Nias, 1989). Broader relationships within the school and networks with professional community provide further support especially for beginning teachers who are seeking advice and support (Fox, & Wilson, 2009). In the absence of positive relationships, beginning teachers will struggle to develop affirming identities. Wilson and Deaney (2010) described how one beginning science teacher who possessed a PhD in science and had considerable industrial experiences left teaching after three months as a consequence of failing to develop a personal and social identity in the context of teaching.

Although Guarino et al., (2006) did not report any specific research studies on reasons that career-change teachers left the profession, they identified that policies related to the provisioning of mentoring and induction programs, and collegial support were associated with lower rates of turnover among beginning teachers. In addition, Guarino et al., found those schools that “provided teachers with more autonomy and administrative support had lower levels of teacher attrition and migration of general issues” (p. 199). Administrative and collegial support and achieving autonomy were major challenges reported in a range of studies (e.g., Costigan, 2005; Ng & Peter, 2010)

Jorissen (2003), in an interview study of six mature age career-change teachers who were teaching six years after graduating from an integrated long-term alternate route program, found that her participants attributed their retention to the development of positive relationships with knowledgeable and approachable mentors:

The support of expert mentors mediated the development of competence and identity through improvement of teaching performance, the facilitation of transfer of knowledge from teacher education, the promotion of personal and professional well-being, and socialization to the institutional culture. (p. 46)

A doctoral study by Catena (2009) explored through surveys the experiences of teachers prepared through a highly selective colleges in the US. These teachers had scored within the top five to ten percent on college entrance examinations, and hence, were considered highly able. Her findings

indicated 39.4% of these teachers left the profession within the first five years, a figure she claimed was comparable with the 1992-1993 national teaching population. Disaggregated for STEM teachers, the attrition rate identified by Catena was approximately 35%. Her findings contrast with studies cited by Guarino et al. (2004), Schlechty and Vance (1981) and Podgursky, Monroe and Watson (2004) which suggest that teachers with academic ability in the top 25% on college entrance examinations have a higher probability of leaving the teaching profession than those in the bottom 3 quartiles.

Again, there is limited research on what are the ideal circumstances that prepare or encourage career-change teachers to remain in teaching. Induction and mentoring programs particularly involving the support of experienced teachers appears to be an important strategy. Ingersoll and Strong (2011) extensively reviewed the induction strategies implemented in the US and reached the conclusion that there are significant gaps in our understanding of the effectiveness of induction programs highlighting factors such as focus (e.g., pedagogy or induction), contexts, costs and duration that need further research. Ingersoll and Strong argue that the diversity of programs, lack of rigorous research and lack of theoretical frameworks around induction led them to conclude that it was “not clear to what extent general conclusions about induction can be drawn from the research” (p. 204). It is not apparent that induction programs specifically take into account the professional histories of beginning teachers. A point brought out in a study of career-change teachers and traditional first career teachers by Stafford (2008) who suggested that career-change beginning teachers needed different mentoring approaches sensitive to their maturity, prior experiences, life stage, and teaching context. Similarly, in the Australian context, mentoring programs for beginning teachers are atheoretical, ad hoc and focus on general issues of school processes and pedagogical practices (Hudson, 2012).

Schools are organisations that depend on commitment, cohesion and collaboration and where this is not present there is a lack of satisfaction and teacher motivation. The experiences of the beginning years of teaching are crucial as the teacher refines his or her knowledge of teaching (Schempp, Sparkes, & Teplin, 1998) and builds a professional identity as a teacher (Hong, 2010). Thus, although teacher knowledge in all its forms play some part in the moulding of a competent teacher, the sense of being a teacher – a sense of identity – establishes a feeling of belonging and acceptance within the profession. Given the arguments for the value of attracting professionals into teaching, teacher educators need to know more about their experiences during their beginning years. Hence, this paper focuses on those teachers who have had careers in the sciences or related fields before deciding to enter teacher education programs and pursue a school science or mathematics teaching career.

Our goal is to extend the existing research on beginning teachers to explore the experiences of career-change beginning teachers who have advanced subject matter knowledge. Our research questions are:

1. What early career experiences contribute to or hinder the development of a sense of professional identity as a science teacher for career-changers with subject matter expertise?
2. In what ways do these experiences influence the beginning teacher's decisions to remain in teaching?

Theoretical Framework

We draw on Self Determination Theory (SDT) to understand and interpret the experiences of these teachers. Gagné and Deci (2005) have argued from the framework of SDT that intrinsic motivation (which stimulated the career change) is reinforced by satisfaction, trust, and well-being in the workplace. Our premise is that a professional identity as a STEM teacher is derived through re-assessment of an individual's identity, particularly through the development of new positive relationships. From an SDT theory perspective identity is a process of growth towards higher levels of integration and self-organization which emerges through continuous interactions with the social environment (Soenens & Vansteenkiste, 2011). According to Stryker (1968), people's reflective interactions with those around them create their sense of identity of who they are. Where there is a choice of transitioning from one group or career to another, individuals may choose to dis-identify (e.g., from being a professional scientist or engineer) and gain psychological entry to a preferred or more socially acceptable or dominant group (e.g., secondary school science teacher). A teacher's sense of identity and belonging is influenced by many factors, not least their experiences, relationships, and work environment (Hong, 2010). SDT as a meta-theory explaining the motivations behind people's actions provides a useful lens to interpret the experiences of career-change teachers. Broader relationships within the school and networks with professional community provide further support especially for beginning teachers who are seeking advice and support (Fox, Deaney, & Wilson, 2010). In the absence of positive relationships beginning teachers will struggle to develop affirming identities

Self determination theory asserts that the *need for competence, autonomy and relatedness* are essential goal setting regulators that influence career engagement (Deci & Ryan, 1991). We see these dimensions of self-regulated behaviour in terms of an individual's sense of ability or self-efficacy (competence), control over and choice of actions, behaviours and setting priorities (autonomy) and interpersonal relationships that lead to fulfilling or unfulfilling experiences in social and professional interactions (relatedness). Hence, an investigation of the contextual factors in which professional

identity as a teacher is developed is essential, particularly for those beginning teachers who because of their strong subject matter knowledge presumably have an existing strong sense of identity as scientists.

Methods

A qualitative embedded multiple case study approach to data generation was adopted because it allows the researcher to focus on obtaining rich descriptions of contextual factors that impact experiences and to probe how and why questions (e.g., Leech & Onwuegbuzie, 2007; Yin, 2009). Invitations to participate in the study were distributed through principals of approximately 400 high schools state-wide in the public and private sector, at conferences for beginning teachers and via email lists of graduating teachers at two universities. Invitation specifically targeted potential participants who had previous qualifications and professional work careers in the sciences. Initially 28 volunteers were identified. However fourteen participants (4 males, 10 females) (ages ~25-50) were selected for the study based on their academic profile of at least ten years work experience in a science career and convenience of geographical location for data collection. These participants had a degree in science or engineering and had completed an equivalent one-year post baccalaureate Graduate Diploma of Education qualification specialising in science or mathematics to meet teacher registration requirements although some undertook teacher training part time while continuing in their profession. All teacher education institutions in the state were represented among the participants. The courses provided by are required to meet the state's teacher accreditation criteria, and hence, are similar in content and structure and include field experiences. The cohort of 14 participants included two PhD qualified research scientists, a microbiologist, an agricultural scientist, two engineers, a former flying instructor, a medical scientist, an ICT technician, a business manager in a science related company, a nutritionist, an ecologist, a farmer with agricultural science qualifications, and a forest scientist. All were qualified and active in their science or engineering profession immediately before or during their teacher education program. Some participants completed teacher education programs on a part-time basis while working. A brief profile of the participants is provided in Table 1.

Data collection was staggered throughout the teaching year. In year 1, there were four distinct data collection events. (1) An initial 15-20 minute telephone interview was undertaken within the first two months of the teaching year to obtain basic demographic and relevant personal data and to negotiate dates of classroom visits. (2) After five to six months of teaching, each participant was interviewed (~40 minutes) using a semi-structured interview protocol adapted from the literature (Luft

& Roehrig, 2007). This interview focussed on experiences up to that point in the year and discussed content and strategies the participant was planning to adopt for the set of lessons to be videotaped. (3) The following term, participants were provided with a video camera and asked to videotape approximately 4-5 hours of teaching a single topic in a grade 8 or 9 class. (4) A follow-up day-long interview was conducted approximately two to three weeks after completion of the topic and after preliminary analysis of the videos by the researchers. The day-long interview involved joint reviewing of the video recordings by the participating teacher and one researcher, thus providing a rich source of reflections through stimulated recall (Calderhead, 1981). Semi-structured in-depth conversational interviews (Rubin & Rubin, 2005) were conducted that explored the experiences of teaching and the environment in which they worked. We sought to find out what happened, why, and what the happenings meant to the participants. Focus questions, such as the following were used: “Bring me up to date with what has happened since our last discussion”; “Since we last talked has there been any change in your commitment or attitude to teaching?” and “How much freedom have you developed to plan, implement, evaluate and guide your practice?” Other questions probed their experiences of teaching their topic of choice, and associated constraints, resourcing and support. Questions exploring practices and constraints were also posed while the researcher and teacher reviewed lesson videos. As these were conversational interviews questioning varied according to each individual’s response to focus questions.

Experiences of STEM Subject-matter Experts in Secondary Science Teaching

Table 1: *Profile of career-change participants*

Pseudonym	Age	Gender	Profile	Motives	Major teaching responsibilities	Experience
Abi	37	Female	Masters in Literacy; PhD in Science, taught in university courses, assigned to three schools in first year	Frustration with research	Science	Continuing
Alex	30	Male	Degree in forestry, multiple careers, assigned to a remote country high school to teach agricultural science	Job security	Agricultural Science	Continuing
Barry	50	Male	Construction and consulting engineer, assigned on contract to a suburban high school	Seeking less stress	Physics	Left school teaching
Elisabeth	30	Female	Farmer with agricultural science qualification assigned to a provincial high school close to farm	Job security	Science and Mathematics	Continuing
Jackie	35	Female	Bachelors in Medical Science 10 years in pathology lab, single mother	Family demands	Science and Mathematics	Continuing interstate
Jenny		Female	Science degree and had worked in plant nursery for three years. Assigned to a suburban high school to teach science and a language.	Family pressure	Science and Language	Left teaching*
Kath	25	Female	Health Science graduate, worked in fitness centres. Assigned to a regional High School	Interest in teaching	Science	Left teaching*
Katie	35	Female	Degree in science with aeronautics experience. Single mother employed at a private prestigious girls school.	Family demands	Science	Continuing
Natalie	38	Female	Engineering background employed for 10-15 years. Young family assigned on contract to a prestigious government high school.	Family demands	Mathematics	On contract
Pat	32	Male	Applied Science and Human Movement Studies background; worked in technology and outdoor centres.	Job security	Middle years (elementary) Grade 4, 5.	Continuing
Sally	45	Female	Science degree and 15 years in running a business. Employed part-time at Catholic Girls High School	Job security	Science	Left teaching
Roy	38	Male	PhD in biological science working part time in an agricultural research station	Frustration with research	Science	Left teaching
Sandra	26	Female	Recent PhD candidate and Research assistant with experience in molecular biology assigned to a Catholic High School in a lower SES suburban district	Interest in teaching	Science	Left teaching
Tanya	40	Female	Animal scientist, vet, with long experience in working with large animals. Appointed to a provincial city high school	Family demands	Science	Continuing

*Moved overseas and possibly still teaching

As this was a longitudinal study, participants were visited at their schools on at least two occasions in each year that they taught. Visits enabled the research team to record field notes of the school environment and resources (Lawrence & Green, 2005). As half (7) of the cohort left teaching during the 3-year long project, data for some participants are drawn from only one or two years.

This paper focuses primarily on interview data to understand career-change beginning teachers' sense of identity and self-determination. As the researchers were able to visit participants, contextual information added further meaning to the interview data. Students were also surveyed and interviewed but those data were not relevant to the questions posed in the paper. Information from the initial telephone interviews was summarised as memos and presented in tabulated form to provide a profile of the participants. Audio recordings from the extended interviews were transcribed verbatim. Coding was performed by the lead researcher and a research assistant. Preliminary discussions involved clarification of the research questions and the exploration of data in response to these questions. Codes were assigned to individual utterances or text in an abductive manner (Fischer, 2001; Leech & Onwuegbuzie, 2007). That is, codes emerged iteratively by assigning words or phrases that inferred hypothetical meaning(s) to the data given the context. Codes were then revisited and refined when further utterances or texts with similar meanings were identified. Discrepancies between the author and research assistant in coding specific text were discussed and codes revised to ensure that they were in line with the research questions and consistent across coders. Several iterations of analysis reduced the coding to 19 categories. Those categories relevant to the research questions posed here are shown in Table 2 arranged in order of frequency of occurrence. On further reflection and analysis themes were inductively linked to theoretical concepts for instance evident in Self-Determination Theory. For example, many of the beginning teachers discussed their *attitudes to management* particularly about government bureaucracy or school administration they perceived as inhibiting their ability to do their jobs and withstand the pressures of working in a school. Hence, these statements were categorised as a lack of *autonomy*. Similarly, the theme *valuing support* and related codes indicated the importance of building *relationships* within the school both with other staff and students.

Ethical approval was granted by the University ethics committee.

Table 2 *Dominant themes emerging in the data*

Category	Description of category
Relationships	Aspects of the nature of interactions with other teachers, administrators or students
Contexts	Aspects of the school and students including climate, time constraints, work load and resources
Praxis	Beliefs about curriculum, teaching, learning and educational priorities
Commitment	Attitude towards innovative teaching or reflection on teaching to improve professional knowledge and practice
Confidence	Scope of positive or negative feelings of being able to cope with teaching tasks
Pedagogy	Discussion and examples of teaching approaches, strategies including innovations
Autonomy	Situations, events or tasks that enable the teachers to work independently and assume some responsibility for a task
Career motives	Decision making rationale around a career change
Competence	Instances of acknowledgement of competence or expertise in relation to content knowledge
Personal identity	Expression of values, priorities and sense of self independent of school
Professional Identity	Expression of values, priorities and sense of self as a teacher

Note: Listed in order of frequency of occurrence in the data.

Results

It has been argued that the use of narrative and ethnomethodological approaches are central to understand the processes of beginning teacher socialization (e.g., Bathmaker & Harnett, 2010; Costigan, 2005; Goodison, 1992; Ritchie et al., 2007.) Applying a broad theoretical framework such as Self-Determination Theory to understand the experiences of career-change teachers requires the researcher to engage at length with the participants to capture the recounts of their lives in context. Hence the findings are presented through profiles that recount the teachers' stories as told through interviews and observations. The stories primarily focus on the experiences of Abi and Katie, who remained teaching at the conclusion of the study, and Sandra, who left teaching during the study. Their stories are complemented with excerpts from the stories of the other participants to add robustness to the analysis (Yin, 2009).

Participant Profiles

All participants had expressed some intrinsic interest in teaching and many had undertaken some teaching role in their former career, for example as a university tutor in science, engineering training consultant or as summer camp leader. However, some of the reasons for changing their career to

teaching were given as family pressure, responsibilities to their own children and frustrations with their initial career work demands. Of the 14 teachers who were interviewed at the beginning of the project only eight remained teaching after three years. In reporting these findings the focus will be on three cases – Abi and Katie as two teachers who remained in the teaching profession after three years and Sandra who decided to leave teaching after one year. Where appropriate, we will also draw on the experiences of other participants to illustrate salient issues.

Each of the 14 career-change participants were interviewed in depth to source background information on their own schooling, previous careers and reasons for changing career to take up teaching. All expressed a degree of dissatisfaction with their previous careers but had a strong sense of competence and identity as scientists or professionals in their field. Some of the reasons for choosing to change careers are summarised in Table 1. However, in most cases the reasons were complex and amounted to a response to a crisis point in their lives. For example, Barry, a mature age highly experienced construction engineer who ran his own business, was confronting uncertainty in his financial future at a time when the global financial crisis was impacting the building and construction industry. Sally similarly had run a business in accountancy but with the economic downturn sought a more secure job in teaching. A strong theme was evident that the transition to teaching would enable them to fulfil a long-held but latent desire to teach and that there would be less stress in their lives. This expectation was not fulfilled for most. Of the initial 14 career-change participants only Alex, Abi, Elisabeth, Jackie, Katie, Natalie, Pat and Tanya remained teaching after three years. Space does not allow a detailed revelation of each participant's experiences. Thus, the findings focus on the reflections of Abi and Katie whose experiences were shared by the other five career-change teachers who remained in the teaching profession at the end of the third year. We have chosen to report specifically on Abi and Katie because these teachers were primarily employed to teach science with some mathematics whereas the other five primarily taught mathematics or, in the case of Pat, chose to teach in an elementary school. We also draw on the interviews from Sandra who left teaching after one year. We chose Sandra because she had a similar background to Abi and taught a science topic in Year 9. A summary is presented in Table 3.

Table 3: *Experiences of the three focus teachers*

Regulator	Abi	Katie	Sandra
Competence	Reflected in subject matter expertise Facilitated by capacity to teach more able students Limited in relation to understanding student learning needs and pedagogy	Reflected in subject matter knowledge Awareness of limitations but showed initiative to address limitations Awareness of need to build pedagogical skills	Reflected in subject matter knowledge Limited pedagogical skills
Relations	Proactive in relocating to different schools to find relationships that were deemed professional.	Strong professional relationships in competition with personal relations with family	Unsuccessful in building relationships with students and colleagues
Autonomy	Proactive and capable of pursuing novel and authentic activities within the classroom. Often out of step with colleagues in terms of content.	Limited evidence of actively pursuing alternative strategies in teaching constrained by school schedules	Limited to classroom practices and pedagogical approaches but constrained by time and school schedules.

Case of Abi

Analysis of interviews over three years (2009-2011) revealed Abi as a person who valued good relationships and acknowledgment that she could make a contribution to the field that she was working in whether professional science or teaching. We begin by relating some of the self-regulatory factors that contributed to her decision to change career to secondary science teaching. Self-determination theory, as described above, emphasises the importance of perceptions of competency, autonomy and relationships.

The Research Scientist: Abi appeared to have a strong sense of competence and confidence in her identity as a researcher. In reflecting on her scientific career she commented that her research was “groundbreaking” but controversial, and hence, it was challenging to get it published. A particular response from Abi highlighted some of her frustrations with her career in science research. She was clearly dedicated to research but the competition to get grants and the marginalisation of her research challenged her efficacy and identity as a scientist.

I was getting feedback on my science grants that were saying honestly - I hate saying it because it sounds arrogant, but I got really great feedback on grants – ‘this is outstanding, this is ground

breaking' but we were getting no money. That was a really hard thing to go through. But then having gone to teaching, I love teaching. I really do derive a great deal of personal satisfaction from it. I've had that conversation with personal people in my life, friends and things. Saying I'm far happier in myself than I was perhaps [as a research scientist]. (Abi 2011)

With regard to a sense of autonomy, Abi's experiences are not uncommon for graduates in science seeking a permanent career pathway. Her post-graduate research career spanned at least ten years but during that time she remained reliant on grants and collaborations to progress her work. Although being successful in winning a number of small grants and confident that her research was significant, she was constrained in her options to pursue passion areas. Without the freedom and autonomy that personal grants bring she frequently expressed frustration during her science career.

Relationships were another important factor in motivating Abi. However, she described her relationships with scientist colleagues in less than positive terms,

It's the mediocre scientists who are actually dreadful. They give awful presentations that are almost - if you didn't actually know better - you would think that they were deliberately trying to exclude people from what they'd done. (Abi 2010)

She also related how she had collaborated with colleagues on projects only to be left off publications even though she perceived that she had done all the work. These experiences left her dissatisfied and frustrated with professional science.

The evidence emerging from the extensive interviews over three years depicted Abi as a passionate, ethical and committed researcher whose experiences in the culture of research science were mixed. Ultimately, it was a combination of rejection of her innovative findings, lack of funding to support her interests and frustrating relationships that persuaded her to turn to teaching. Nevertheless, there was still a strong sense of identity as a researcher and a person who could change the field in which she worked. She described herself as a natural researcher drawing on personality tests she had done during her career,

I have those academic interests. So I guess the hardest thing for me is it's a natural trait that I actually have, which is where the Myer-Briggs stuff come in. I'm the INTP so I want to build theory, that's just what I do. I think the hardest thing is just trying to find a way to sustain all of that. (Abi 2011)

The High School Teacher: Abi summed up her career-change in a final interview after she had taught for three years,

I had always had an interest in teaching. ...but if I had got a grant in science no I would never have gone teaching. I would have probably continued to have an interest in education at the university level but I probably would not have become a high school teacher. (Abi 2011)

Abi's expectations of what teaching at high school was about were somewhat colored by her own school experiences. She described her schooling in a small rural community from two decades earlier but had not had any recent exposure to schools other than her preservice teacher education programs and associated practical experiences. She felt somewhat unprepared for the career change highlighting that her preservice program provided limited preparation,

They tell you in your Grad Dip as well, they tell you make sure you don't use the ... coffee cup or something like that. That was actually said to me in my Grad Dip. It was like I have worked since I was 14. I don't need to be told that. (Abi 2010)

Abi's introduction to teaching was stressful particularly related to building effective relationships. Professional relationships were seen to be important to her. She envisaged that interaction with colleagues would be professional and contribute to her growing competence as a teacher. However, her expectations were challenged by a range of unfulfilling experiences. She was initially appointed to a school approximately an hour from where she lived and one that had a poor reputation servicing a low socioeconomic and transient population. In the jurisdiction where this study was conducted, the educational authority operates on a state-wide basis. Teachers who accept positions in remote areas get preferential treatment in future placements, and hence, younger beginning teachers without family ties do "country service" for several years before attempting to return to more populated and appealing coastal or metropolitan regions. Abi accepted her first placement in the public system at Beach State High School (pseudonym) and explained her rationale:

I took Beach High in the first place because my understanding was that I was potentially unlikely to get a job for lots of reasons and the only job I might get might be quite rural. So when Beach High came up and it was the only thing that I had been offered I accepted it because

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I thought well at least with Beach High I can still see my husband. It turned out to be very difficult. (Abi 2009)

The difficulties emerged in fulfilling Abi's perceptions of what teaching was all about. Although she claimed to share common socio-economic background with the students at this school, she felt that the school environment was stressful and non-supportive. Her pessimistic perception of the school began with negativity projected from the office staff in her preliminary visit to the school before the start of the teaching semester. She was disturbed by the lack of academic professionalism among teachers and the focus of the principal on student discipline.

Abi was able to move at the end of the first semester to a metropolitan high school in a more affluent and professional suburb. In reflecting on her experience at Beach High School in response to a question about whether she ever felt like giving up, she stated:

When I came back from Beach High School, I thought yes because it [teaching] felt pointless. It felt like punishment for failing at [a career in] science. My penance for the rest of my life is going to have to do a thankless job for incredibly rude kids and getting them to actually take a handout. (Abi 2009)

Her next experience at Leiland High School was in stark contrast. This school was in a high socio economic area with students mostly from professional and business families with a high press for education. The Head of Department, in acknowledgment of Abi's qualifications, created a position for her teaching chemistry. However, Abi soon realised that the department was dysfunctional. Younger teachers appeared to have little interest in teaching science and conversations in staff rooms focussed on sport and recreation while older teachers were suspicious of new approaches being introduced by the relatively inexperienced head of department. Abi felt marginalised and unable to build relationships within her staffroom and attributed the problems to the inexperience of the Departmental Head "She didn't have the depth and breadth of experience to actually manage people." Abi appeared to take no responsibility for the lack of relationships.

Finally Abi was able to accept a position in a third school at the beginning of the final quarter (term) of her first year of teaching. Bushland Park High School was a smaller metropolitan school, closer to her home but with a strong academic profile. Among the courses she taught was an extension class for gifted or more able students. Her initial comparisons highlighted the community climate and level of support,

[The previous schools were] nowhere near as functional as the hands on day to day support that you get by being in that small professional, quite well-knit community that I find at Bushland Park High School. (Abi 2009)

However, by the end of the following year, there were tensions emerging that challenged Abi's perception that her competence was being recognised. In response to a discussion concerning the support she received as a beginning teacher, she described how she struggled to reconcile the impact of the school's professional climate and how she was being recognised for her contributions. She saw herself as committed to students, and thus, worked extra time to meet their needs. However, she was critical of some of her peers who she saw as being rewarded for performance but not really caring about students' learning. Reflecting back on her first year of teaching, although acknowledging the positive community at Bushland, she perceived she was being exploited because of her expertise,

I think people are happy to exploit the fact that you have skills and abilities and you can be trusted to do a particular job but they're also reluctant to acknowledge that you asked you to do that in your first year and no one actually sort of - yeah that there's no [recognition] - it's not the community. (Abi 2011)

Abi remained a very committed person with good practices despite heavy workloads brought on by the introduction of new curricula and the need to undertake mandatory professional development to maintain registration as a teacher. However, she was critical of the lack of autonomy she had in choosing what professional development was relevant and who should participate,

There comes a point where the PD [professional development] that we're all being sent off to as punishment for the 80 per cent of teachers because we can't be trusted to use our time productively and we have to keep a log of our 30 hours of PD [A requirement of the state accreditation authority]. Whereas the reality of good teachers is they're doing it anyway and they're doing more on top of that. (Abi 2010)

Nevertheless Abi valued the relationships with some of her immediate colleagues,

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As a professional colleague, Paul and Kim are amazing. I think we give each other a lot in terms of our teaching. If I want help and advice, then Paul and Kim are my first ports of call. His [Paul's] comment in relation to me is that I'm just this massive nerd, which is true. (Abi 2010)

Abi's sense of autonomy within the broader context of school operations and responsibilities was tested particularly at her first school, Beach State High School. She critiqued the Science Department Head who did not have a planned program but would not let Abi develop one despite her academic credentials in the area. Abi's experience contrasted, for example, with Jackie who as a first year biology teacher changing career from a pathology laboratory scientist was asked to develop the work program for the senior Biology course. In Abi's final interview as a third year teacher, she reflected on the dynamics of interactions in the various schools and acknowledged that administrators would reluctantly acknowledge her competence.

Abi's perceptions of her abilities were realistic. She recognised in the first year of her teaching that her doctoral background would not necessarily make her a better teacher, "Certainly I would say having done a Grad Dip [Graduate Diploma in Education], I would very much hate to see a vision of myself as someone who thinks that simply having a PhD in science would necessarily make me a better science teacher than somebody who didn't have it." She did however admit that she was able to draw on experience and narratives to engage students; a skill which she perceived other teachers without professional science experience lacked. An analysis of her knowledge base revealed a teacher with high levels of subject matter knowledge but scope for developing the pedagogical skills necessary to engage students particularly those less disposed to learning science (Diezmann & Watters, 2014). Her passion for research and willingness to question her practices appeared to augur well for further development of pedagogical skills over time. Nevertheless, she was frustrated by the limited recognition of her competence and experiences. The organisational and management skills that experienced professionals bring to teaching are among the attributes argued to be valued in career changers. However, recognition of their experiences and competencies were at times challenged. For example, Abi reflected on her experience at Beach High School,

One of the things I didn't like at Beach was, every second week, I had to go to this awful teachers' meeting where the deputy principal would sit there and talk about her own personal experiences of teaching for two hours which I felt was a huge waste of my time. But that was, I acknowledge, Beach High trying to support beginner teachers. (Abi 2010)

By the end of the 3-year project, Abi's construction of her professional identity was unresolved. She envisaged herself as teacher with a passion for teaching and a passion for research but not necessarily as a high school teacher. After three schools in the first year of teaching, her only satisfaction emerged through the opportunity to teach more able students in a small socially homogeneous context. Her conversations throughout the interviews over three years focussed very much on teachers and their performance and in some respects she was often critical of her colleagues.

In her final interview, Abi revealed that she had been unsuccessful in applying for university positions in teacher education. Her interest and capabilities focus on self-concept and the teaching and learning of science but the constraints and experiences in schools has dampened her commitment to secondary education, if it ever genuinely existed. Abi's discontent with her career in science was repeated with her career in teaching and she seems poised to continue to seek further career change.

Abi's experiences were similar to those of Tanya, Roy, and Sandra. Tanya, Sandra and Roy had previously held highly professional research roles. Roy was a PhD researcher and Tanya and Sandra had commenced but not completed doctoral studies but remained in a university environment. Common to all was the stress of lack of funding as scientists but now, as teachers, the lack of autonomy and fragile personal relationships with colleagues.

Case of Katie

Katie was modest in describing her background "I think just coming to teaching just after a bit of life experience" (2009). However, her life experiences were rich with early experience in travel and schooling on two continents although she did comment that she had only ever attended all girls' schools an interesting background given her first appointment.

The Aviation Professional: Katie completed a Science Degree in Aviation and pursued a career in flying as a charter pilot and eventually as a flying instructor. Her involvement in acquiring a flying instructor rating was her first experience of teaching which she described as "It's very old fashioned, distinct content that must be covered, very clear requirements about things you need to cover, very sequenced, and because of the nature of flying training, it's very expensive" (Katie, 2009). She had further teaching experience as a sessional instructor in an Australian university foundation aviation course. She subsequently travelled to the US where she was employed as a full-time flying instructor working six days a week in the air. She commented that as a foreign worker in that industry her skills and competencies as a flying instructor were highly valued as an "experienced person". However, family

issues and parenthood thwarted a continuation of her career as a flying instructor. The option of pursuing her teaching experiences but at the secondary school level was seen as more compatible with her family responsibilities.

The High School Teacher: On graduation from the preservice course, Katie accepted a full-time position in an all-girl's independent school. She had some hesitations and while opportunities existed to teach in schools with an aviation program she saw her family as a priority in the selection of a school. In retrospect, Katie's capabilities were recognised early and she was assigned to teach Physics in Year 11 as well as science and mathematics in Years 8 and 9. Being assigned to a Year 11 class in an independent school while on probation is not common. She was proud of this role and saw it as recognition of her academic skills. That she was given that class in subsequent years was further affirmation of her competence. She was also requested to continue teaching her first year Year-8 class when they moved into Year 9 citing the Head of Maths as saying "You've built rapport with the kids, can you keep that class? It's not the class most people want to teach because they're not academic..." (Katie 2010).

Nevertheless, Katie was articulate in recognising that despite her expertise in physics and aeronautics she needed to ensure that her students had confidence in her in all area of content,

I need to have enough content expertise that I don't feel like I have to spend - at the start of every unit - learning it myself so I can know it. I want to at least inspire enough confidence in the students that yeah, she's actually read it herself before she came into class. I do want to have enough content knowledge that - and I feel secure about - oh yeah, I actually know something about rocks. (2009)

As an experienced learner, unlike perhaps many first-career beginning teachers she had the confidence that she could learn and deliver effectively even content outside her speciality. She also acknowledged that she could recognise student behaviours indicative of loss of interest and engagement.

Observations of her teaching confirmed her sense of confidence in her capabilities.

Relationships played an important role in Katie's adjustment to teaching. Early in her first year of teaching she was frustrated and overwhelmed by the expectations of teaching. She had a strong sense of personal identity as a responsible single mother. Her family was important and relations with

her children permeated much of her thinking. In response to a question on her identity as a teacher she stated,

So, my teacher identity at the moment—people’s say, you know, ‘Do you like teaching?’ And I find it very hard to do the basics, even though I know it’s what people expect, ‘Oh yes, teaching’s my passion.’ Whereas really at the moment it’s really hard work and I’m a single mum and juggling home life and teaching is hard. It’s [the workload] big. (Katie, 2009)

She subsequently admitted,

In that first year I had lots of points where I thought can I sustain this? There was so much to do and my family found [it a strain] - my youngest was really quite young. (Katie, 2011)

However, Katie was strongly supported by her Head of Department and built strong collegial professional relationships with those in her staffroom. Summing up the relationships at the end of the second year of teaching, she said,

Everybody knows everybody’s story, because it’s a very friendly - we’ve got our own staffroom, so we come in, in the morning and we do the how are your kids going? How was your morning? What’s up? Everybody knows each other reasonably well. (Katie 2010)

The support extended beyond social support to professional support. For example, Kate emphasised how she valued being able to access resources prepared by other teachers through the school network.

Katie’s conversations during debriefing interviews always focussed on student learning and the problems or interests that different student had. She rarely spoke about her previous career as a pilot instructor and when asked whether she would be interested in teaching in an aviation program at a neighbouring school she intimated that she was too content at the current school to make a change. At an independent school, there are limited opportunities for autonomy for a beginning teacher. Indeed, Katie had full access to all resources and assessment was planned by teams. Her classroom practices were traditional in that the teaching was text-book guided and lessons were primarily a blend of theory and practical work. However, this appeared to suit Katie who described herself as a “traditional learner.”

Katie, among the participants, is unusual in that her professional identity in her previous career was that of a teacher, albeit in flying, and generally, on a one-to-one basis. Her transition to school teacher appeared relatively uneventful other than the stress of workload and new content to be mastered. She appeared to achieve fulfilment as relationships were particularly effective and recognition of her competencies was acknowledged from the beginning of her teaching. Similar to Katie, Natalie, Elisabeth, Jackie, Barry, and Pat all had fulfilling professional careers. They reported good relationships, satisfying work opportunities and some control over the day-to-day responsibilities. All saw teaching as a more family tolerant, less time-demanding and more secure career. However, Pat, the youngest male, was the only participant who discussed teaching in terms of a career pathway through which he would achieve responsibility, for example, as a future principal. Although Katie and Abi remained teaching after three years, others such as Sandra left teaching some within the first three months (e.g., Roy).

Case of Sandra

We now explore the circumstances that surrounded Sandra's decision not to continue teaching as a career. Sandra was chosen to profile as she also primarily taught science and had a biology-microbiology background like Abi. She was also one of the few who decided to leave teaching prior to the annual debriefing interview and was prepared to discuss the reasons for her decision.

The Professional Scientist: Sandra worked in the field of microbiology for a decade after graduating with her science degree. During this period, she started her PhD but withdrew after two years. However, she stayed working as a research assistant in the same laboratory on related projects. She then decided to become a teacher.

The High School Teacher: Sandra had experience in tutoring at university but no other link to schools before completing her preservice teacher education. In describing her motives for a career change, she stated a long-standing interest, "It had always been in the back of my mind. Even when I was at school, it was something that I was interested in but I felt I didn't have the personality for it." She reiterated her enthusiasm for science teaching in a second interview "I'm passionate about the science and I'm passionate about teaching it". Sandra was appointed on contract to a small Catholic all girls high school in a relatively low socio-economic district. She taught three 70 minute lessons in a Year 9 chemistry unit as the focus for this study. The topic was writing formula and balancing chemical equations.

Her approach to teaching was not unlike that of Abi. She was confident in the content and described chemistry as of high interest to her. She valued her earlier professional experiences arguing that the ten years as a scientist provided the background content knowledge,

When I think of myself as a teacher now, I do think about it in terms of, am I any different in terms of if I hadn't had that experience in a lab and as a professional scientist. So I suppose as a teacher, I think the confidence in the content is very important to me. (Sandra, 2010)

However, her pedagogical approach was primarily teacher centred in that there was a substantial proportion of teacher talk with limited discussion with or among students. Content was rigorous and substantial. However, many students struggled to keep pace with her delivery and, as she admitted, she rarely questioned students. Although she favoured practical work, Sandra argued time pressures were such that she could not manage to fit practical work into the lessons.

Sandra discussed three factors influencing her decision to leave teaching. Factor one was a fear of confrontation. Although she liked the school where she taught, she was on contract and no certainty of being re-employed the following year. She struggled with coping with change. Her experiences in preservice practical teaching were mixed having taught in two different schools. Her experiences were soured as she felt isolated and unsupported in one, "there wasn't a real interest in showing me things or including me."

Factor two emerged from her inexperience and difficulty in managing her Year 9 class with several disruptive students creating ongoing management problems. She was concerned about confrontation with students and perceived she received little support to help her cope. She summed up the experience "I enjoy that [science teaching] but I think it's the potential for confrontation that I just don't want to - I don't want to do it". She argued that whilst she was confident of the content "trying to be switched on, not intellectually but more emotionally being aware of what kids are doing and what's brewing over there ... I find that quite draining". She reflected at length on the limited preservice training and collegial support on class management, an issue common to most of the participants in the study.

Factor three was personal as she was living and working away from most of her family and described a combination of stresses,

because I was really quite burned out and I think - I mean, I've got the passion, I suppose, intellectually and academically I really enjoy it but I don't know. I think back to my experience on prac and what I was like then I think I - I mean, although I was much more green than I am now I think I could handle things a lot more and I had more to give. I don't know, and I think now I just think life's too short and to meet with confrontation at work it's not worth it. (Sandra, 2010)

Family issues were influential in both the decision to change careers for some (e.g., Abi, Barry, Natalie) but also to leave teaching.

Sandra clearly felt unfulfilled as a classroom science teacher. Although her competence was recognised by the school, she was allocated to Years 11 and 12 science and she had large degree of autonomy in the way she implemented her programs including participation in out of class science clubs, the major impediment appeared to be the lack of relationships that supported her emotionally. Both her professional and social relationships appeared stressed and despite her passion for teaching science, she perceived that the school context was not purposively supportive with mentors or induction programs. As an apparently shy person she was reluctant to seek out other teachers and take the initiative in building relationships.

The Career-Change Cohort

We now turn our attention to the experiences of the broader cohort. Developing a sense of relatedness at an individual or school level appeared to be one of the most significant factors influencing the successful integration of the career-change teachers into their schools. Many found relationships were difficult to develop. Immediate supervisor support of the participants was spasmodic except for Katie who had good relationships with her Head of Department who would come and model practices in her class. In contrast, Abi (PhD graduate) was so frustrated with relationships with colleagues in her initial school that she sought a transfer at the end of the first term to a smaller school and again to a third school where her knowledge and experience were valued. This satisfaction was short-lived however. As a mature aged (mid-30s) beginning teacher with a PhD, Abi felt resented by older teachers because of her enthusiasm and by younger teachers because of her knowledge. Roy (also a PhD) experienced a similar reaction where he was told that he was “overqualified” and sensed in his environment “the deliberate or inadvertent rejection of teachers with industry experience”. He subsequently resigned after one month of teaching.

Kath's reflections highlighted a common feature whereby the beginning teachers had to work proactively to develop supportive relationships. Kath initially felt isolated but sought acceptance:

I did get that support. It wasn't as though I was completely alone as how I felt at the beginning. I think building those collegial relationships really helped foster that support and from there, you know, if I have a student in my class who wasn't co-operating I could ask someone, what should I do here. I think that makes sense in any workplace that, you know, at the beginning, not everyone's feeling warm to you. (Kath, 2009)

Katie, Alice, Jackie and Jenny all acknowledged the support of colleagues from the beginning although Jenny's came from colleagues in another Department where she taught one subject outside of her specialisation.

A sense of frustration with the behaviour of some colleagues and lack of autonomy thwarted attempts by Jackie and Tracey who were keen to implement contemporary strategies learnt in preservice courses. They sensed "a lot of teachers on staff have even been here for 20-odd years still don't know how to write a piece of assessment with criteria" (Jackie) and hence there was little support for innovation. Nevertheless, Jackie in reflecting on what advice she might give to a new teacher argued that they should:

make sure they have a really good relationship with some staff member, whoever it is, just someone that they can ask general questions as well as specific content - like have someone that you're comfortable to talk to and build that relationship I guess. Don't try to do everything on your own, because you won't cope emotionally, especially for the ones who have gone school, school, school. (Jackie 2010)

In one instance, Alex, who was teaching a topic well outside his expertise, could not find support in the school and was forced on his own volition to network with a teacher in another school. In contrast, Tanya adopted a very proactive approach in implementing new initiatives and because her specialised skills were aligned with the school's priorities she was strongly supported despite some tensions with established staff.

Tanya, similar to Sandra, experienced confrontation with staff in her first year of teaching. She had an assertive personality and possessed particular subject matter knowledge and skills that enhanced

the school's reputation. She subsequently capitalised on her specialist skills establishing a number of new initiatives which reinforced her standing and acceptance into the school community.

For most of the participants, at the school level support was minimal. Only one (Katie) of the 14 participants was satisfied with their formal induction program. Many argued that the induction programs did not address issues around teaching and learning but had "more to do with the procedures and policies" (Alex) of the school. Most felt that, despite their experiences in their professional careers and their capacity to manage the micropolitics of organisations, their backgrounds were rarely acknowledged. Some, including Abi, felt that they were "treated like students".

Discussion

This study was prompted by our concerns about the recruitment and experiences of mature, well qualified STEM professionals choosing a new career in teaching. Our aim was to address two research questions. First, what early career experiences contribute to or hinder the development of a sense of professional identity as a science teacher for career-changers with subject matter expertise? Second, what ways do these experiences influence the beginning teacher's decisions to remain in teaching?

In a preliminary report on this project, a survey of principals within the jurisdiction where the study was conducted revealed a diversity of opinion about the acceptability of traditionally trained teachers (4 year Bachelor degree) compared to postgraduate diploma (postbaccalaureate) programs (Watters, 2010). Approximately 15% of principals would not want to employ diploma qualified teachers. Principals expressed substantial doubt, scepticism and cynicism about employing teachers with advanced qualifications. Although there was some recognition of the benefits of a higher degree, concerns about the capacity of these teachers to build relationships and to implement appropriate educational experiences with young children were expressed. Anecdotal evidence from recent graduates seeking employment confirms these findings. However, principals in this jurisdiction have limited employment powers and often have to accept new teachers irrespective of their background especially in areas of shortage such as physics and mathematics. Hence, beginning teachers and especially those with advanced qualifications confront not only the challenges of socializing and building an identity as a teacher but potentially socially hostile environments. This was clearly the case of Roy who was told he was overqualified and thus left within three months of commencing teaching. In contrast to most traditionally trained teachers, career changers face the challenge of bracketing their former professional identity and embedded practices and values of their prior professions to assume a new identity as a teacher.

Self-determination theory (SDT) (Deci & Ryan, 1991; Soenens & Vansteenkiste, 2011) provided a framework for understanding the experiences of these teachers and to identify some of the conditions that fostered a successful transition to teaching. From an SDT theory perspective identity is achieved when the basic psychological needs of autonomy, relationships and competence are achieved which leads to a sense of wellbeing, satisfaction and harmony with one's condition. Organisational research highlights the importance of social environmental features and further suggests that organisations that are flexible in reconciling employees' work life and their life outside of work have a harmonious workforce (Jacob, Bond, Galinsky, & Hill, 2008).

If we consider autonomy to mean the independent capacity to decide choice of actions to take, then most of the career-change teachers felt that they achieved a level of autonomy within their classroom to implement instructional practices as they felt necessary. When teaching within their area of specialisation all were confident of their subject matter and were prepared, albeit not always successfully (Natalie) to try new ideas. Others, such as Tanya, Pat and Jackie for example, were provided with considerable opportunities to redevelop curricula by the school because of their recognised expertise. However, frustration existed in terms of constraints imposed by bureaucratic systems and curricula (e.g., Abi), school administration (e.g., Katie, Jackie) or time (Sandra).

Relationships emerged as a dominant theme in the data. Most acknowledged that in their former professions, collegial discussions were the norm while few opportunities existed in teaching for such professional interactions (e.g, Abi, Barry). As Abi's early experiences in particular reveal there was a sense of rejection and isolation and a lack of a welcoming social environment. Alex felt isolated and had to connect with a colleague from outside the school and district to build a dialogue around teaching. Barry was concerned that the only topic of conversation in the staff room was about behaviour management and not teaching strategies. Where strong relationships existed and support was provided through opportunities to shadow exemplary teachers (e.g., Katie, Elisabeth, Pat), participants felt accepted into the culture of teaching and participants experienced a social climate that fostered relationships. Despite negative relationships with administration Jackie was sustained by strong relationships with colleagues in her staffroom

Relationships with students were also very important for all the participants. The more mature participants (>30 years of age) emphasised the need for mutual respect and the need to challenge students to achieve their best. Some of the younger career-change teachers highlighted the importance of relationships with students arguing it was important to know the students, and their backgrounds and issues. Relationships played a key role in an emerging sense of identity as a teacher. Individuals had

developed a personal sense of identity as a teacher but few felt that they could identify with their colleagues or department as members of a community.

Participants' sense of competence provided interesting contrasts. Teachers such as Abi, Jackie, Natalie all felt confident, perhaps too confident, in their own subject matter knowledge and somewhat intolerant of the knowledge of peers. Tanya's expertise and her preparedness to instigate change led to conflict with some colleagues. Criticism of other teachers appears to be a theme that runs through the attitudes of many of these career-change teachers. It was also frustrating for some as the school system gave preference to seniority rather than expertise in confirming permanent appointments or considering promotions. Thus, Natalie, a mathematics expert, remained in a short-term contract position as a mathematics teacher while a long serving permanent biology teacher was transferred from a remote school to her school to teach mathematics in her place. However, nearly all agreed that they were novice teachers and lacked strategies to cope with many situations. The extent that administrators acknowledged and capitalised on the expertise or experiences was limited and a frustration to some.

Of the seven career-change teachers still teaching at the end of their third year of teaching Jackie, Katie, Elisabeth, Pat and Tanya had developed a professional identity as a teacher. They were reflective of their abilities, passionate, confident and well supported as members of a professional community. They expressed a long term commitment to teaching. Natalie remained on contract filling casual vacancies. Although tracking the teachers in this study has finished, it is believed that Abi has left teaching and Katie has continued but at a government co-educational school.

Our second research question investigated the relationship between professional experience and continuation as a teacher. We would assert that in the absence of a positive sense of relatedness satisfaction with teaching could not be achieved. For those who left teaching, the single most stated factor had to do with the way they were treated by colleagues, students or the administration. Of the 14 teachers who were still employed after six months, half had to proactively seek relationships with colleagues, in a few instances from those in departments outside mathematics or science. The general response from colleagues was that they were too busy to take on mentoring a new teacher. With the exception of Katie, no structures or processes seem to exist to facilitate beginning teachers' engagement with the professional community. The barriers to forming positive relationships besides elements of individual personalities, was the sense that their experiences and expertise were not valued. Similar to the findings of Grier and Johnston (2009) and Melville and Wallace (2007), the study has revealed that despite the potential that these career-change teachers can bring to the profession, their passion for teaching and indeed teaching that incorporates real-world experiences for students, failure

to build professional relationships is a crucial impediment to retention as a teacher. Indeed being part of the research project provided many participants with a sense of socialisation, networking and discourses around practices that was not available in the physical location of their schools. Self-determination theory has provided a useful lens to examine the experiences of career-change teachers as they attempt to integrate into the culture of teaching.

Implications and Further Research

The high demand for science and mathematics teachers worldwide suggests that concerted attention should be given to the success and retention of all cohorts of teachers. This study has highlighted key issues affecting career changers including retention. Sound relationships and confidence enable beginning teachers who have been exposed to more contemporary reform oriented ideas about teaching and learning can explore the interface between theory and practice – praxis. These claims can be made about any beginning teacher. However, career-change teachers who are argued to bring special attributes of professional knowledge, familiarity with organisations, and maturity, require these attributes to be recognised if they are to feel valued in the profession. Those who enter teaching having experienced the micropolitics of organisations are likely to have the skills and experiences to manage organisational bureaucracy. Their tolerance for organisational mismanagement and lack of support could quite well be less. Those entering straight from school and university are less experienced of workplaces and possibly more accepting of the systems in place. Relationships and feelings about school bureaucracy and its impact on their ability (or lack of) to do their jobs and withstand the pressures of working in education is an area worthy of further research.

There are two major implications relating to the school experiences of these career changers. First, the school plays a critical role as the day-to-day professional community for career changers. Given the increasing interest in persuading highly qualified mid-career professionals to become teachers to meet teacher supply demand and to engage students, schools and school administrators play a key role in recognising and promoting the value that these teachers bring to the profession. Our study confirms and extends the work of Jorissen (2003) who, in a study of elementary grade career-change teachers from a career's theory perspective, found the development of a sense of competence and the restructuring of identity are critical tasks for individuals engaged in a career transition. She noted specific instruction on content and pedagogy was necessary. In our study, content knowledge was not an issue but developing the specific science teaching methods necessary to capitalise on the substantial content knowledge should have been a priority. To achieve this goal, principals and other administrators need to build integrated professional cultures in which new and experienced teachers

collaborate regularly to build that knowledge. Career-change teachers do have the potential to enhance the quality of education but administrators and teachers need to share responsibility on behalf of their students and colleagues to support them (Kardos, Johnson, Peske, Kauffman, & Liu, 2001). However, there is limited literature on what form mentoring, or what strategies to build collegial relationships and professional cultures that work specifically for career-change beginning teachers who have substantial professional identities and backgrounds. The perspective of the school also needs to be taken into account. This study has given us a better understanding of the dilemmas and tensions that career-changers experience. However, hitherto unexplored are the voices of those who work with career changers, teachers' colleagues, heads of department and school administration.

Second, attention needs to be given to induction programs. Most of the teachers in this project were scathing their criticisms of induction and mentoring options available to them. If any formal support was provided, it assumed that the beginning teachers had no experience in working in organisations and managing complex projects. A one-size-fits-all model of induction was rife. Career changers dissatisfaction with their inductions suggests the need for career induction programs tailored to their needs and experiences. However, the efficacy of such a program would need to be investigated.

This paper has focussed on the experiences of career changes as beginning teachers. However, their concerns pre-dated their commencement in schools. During their preservice teacher education courses, their responses indicate that these experienced professionals were treated as if they were fresh graduates from science degrees. However, the reality for preservice education is that this cohort represents a small minority of beginning teachers and tailoring special programs for career changers may be beyond the economic capacity of institutions. However, from an inclusive perspective, the needs of each group need to be addressed.

In conclusion, research on career changers is in its infancy with more questions than answers at this stage. However, this study has broadened knowledge of beginning teachers by exploration of the career-change cohort and identified seemingly productive lines of future inquiry.

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References

- Anthony, G., & Ord, K. (2008). Change-of-Career Secondary Teachers: Motivations, Expectations and Intentions. *Asia-Pacific Journal of Teacher Education*, 36(4), 359-376.
- Bathmaker, A.-M., & Harnett, P. (Eds.). (2010). *Exploring learning, identity and power through life history and narrative research*. Oxford: Routledge.
- Beijaard, D. (1995). Teachers' prior experiences and actual perceptions of professional identity. *Teachers and Teaching: Theory and Practice*, 1(2), 281-294. doi: 10.1080/1354060950010209
- Calderhead, J. (1981). Stimulated recall: A method for research on teaching. *British Journal of Educational Psychology*, 51(2), 211-217. doi: 10.1111/j.2044-8279.1981.tb02474.x
- Catena, A. N. (2009). *An analysis of career choices among teachers of high academic ability*. Unpublished Doctor of Education Thesis, University of Pennsylvania, Pennsylvania.
- Charters, W. W. (1956). Survival in the profession: A criterion for selecting teacher trainees. *Journal of Teacher Education*, 7(3), 253-255. doi: 10.1177/002248715600700314
- Costigan, A. T. (2005). Choosing to stay, choosing to leave: New York City teaching fellows after two years. *Teacher Education Quarterly*, 32(2), 125-142.
- Deci, E. L., & Ryan, R.M. (1991). A motivational approach to self: Integration in personality. In R. Dienstbier (Ed.), *Nebraska symposium on motivation: Perspectives on motivation*: Vol. 38. pp. 237-288. Lincoln: University of Nebraska Press.
- Diezmann, C. M., & Watters, J. J. (2014). The knowledge base of subject matter experts in teaching: A case study of a professional scientist as a beginning teacher. *International Journal of Science and Mathematics Education*. <http://dx.doi.org/10.1007/s10763-014-9561-x>
- Feiman-Nemser, S. (2003). What new teachers need to learn. *Educational Leadership*, 60(8), 25-29.
- Fischer, H. (2001). Abductive reasoning as a way of worldmaking. *Foundations of Science*, 6(4), 361-383. doi: 10.1023/a:1011671106610
- Flores, M. A., Day C. (2006). Contexts which shape and reshape new teachers' identities: A multi-perspective study. *Teaching and Teacher Education* 22(2), 219-232. doi:10.1016/j.tate.2005.09.002
- Fox, A., Deane, R., & Wilson, E. (2010). Examining beginning teachers' perceptions of workplace support. *Journal of Workplace Learning*, 22(4), 212-227. doi: <http://dx.doi.org/10.1108/13665621011040671>
- Fox, A., & Wilson, E. (2009). 'Support our networking and help us belong!': Listening to beginning secondary school science teachers. *Teachers and Teaching*, 15(6), 701-718. doi: 10.1080/13540600903357025
- Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behavior*, 26(4), 331-362. doi: 10.1002/job.322
- Goodison, I. (Ed.). (1992). *Studying teachers' lives*. Oxford: Routledge.
- Guarino, C. M., Santibañez, L., & Daley, G. A. (2006). Teacher recruitment and retention: A review of the recent empirical literature. *Review of Educational Research*, 76(2), 173-208.
- Grier, J., & Johnston, C. (2009). An inquiry into the development of teacher identities in STEM career changers. *Journal of Science Teacher Education*, 20(1), 57-75. doi: 10.1007/s10972-008-9119-2
- Haggard, C., Slostad, F., & Winterton, S. (2006). Transition to the school as workplace: Challenges of second career teachers. *Teaching Education*, 17(4), 317-327. doi: 10.1080/10476210601017410
- Henke, R., Zahn, L., & Carroll, C. (2001). *Attrition of new teachers among recent college graduates: Comparing occupational stability among 1992-1993 college graduates who taught and those who worked in other occupations*. Washington, DC: National Center for Education Statistics. Retrieved from <http://nces.ed.gov/pubs2001/2001189.pdf> 10 October 2014.

Experiences of STEM Subject-matter Experts in Secondary Science Teaching

- Holmes, T., & Cartwright, S. (1994). Mid-career change: The ingredients for success. *Employee Relations*, 16(7), 58-72. Doi: 10.1108/01425459410073997
- Hong, J. Y. (2010). Pre-service and beginning teachers' professional identity and its relation to dropping out of the profession. *Teaching and Teacher Education*, 26(8), 1530-1543. doi: DOI: 10.1016/j.tate.2010.06.003
- Hudson, P. (2012). How can schools support beginning teachers? A call for timely induction and mentoring for effective teaching. *Australian Journal of Teacher Education*, 37(7), 71-84.
- Ingersoll, R. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Educational Research Journal*, 38(3), 499-534.
- Ingersoll, R. M., & Perda, D. (2010). Is the supply of mathematics and science teachers sufficient? *American Educational Research Journal*, 47(3), 563-594. doi: 10.3102/0002831210370711
- Ingersoll, R. M., & Strong, M. (2011). The impact of induction and mentoring programs for beginning teachers: A Critical review of the research. *Review of Educational Research*, 81(2), 201-233. doi: 10.3102/0034654311403323
- Jacob, J. I., Bond, J. T., Galinsky, E., & Hill, E. J. (2008). Six critical ingredients in creating an effective workplace. *The Psychologist-Manager Journal*, 11(1), 141-161. doi: 10.1080/10887150801967704
- Jorissen, K. T. (2003). Successful career transitions: Lessons from urban alternate route teachers who stayed. *The High School Journal*, 86(3), 41-51
- Kardos, S. M., Johnson, S. M., Peske, H. G., Kauffman, D., & Liu, E. (2001). Counting on colleagues: New teachers encounter the professional cultures of their schools. *Educational Administration Quarterly*, 37(2), 250-290. doi: 10.1177/00131610121969316
- Holdren, J. P., Lander, E. & Varmus, H. (Chairs). (2010). *Prepare and Inspire: K-12 Science, Technology, Engineering, and Math (STEM) Education for America's Future*. Washington, DC: President's Council of Advisors on Science and Technology. Retrieved 19 May 2014 from <http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf>
- Lawrence, C., & Green, K. (2005). Perceiving classroom aggression: The influence of setting, intervention style and group perceptions. *British Journal of Educational Psychology*, 75(4), 587-602. doi: 10.1348/000709905x25058
- Leech, N. L., & Onwuegbuzie, A. J. (2007). An array of qualitative data analysis tools: A call for data analysis triangulation. *School Psychology Quarterly*, 22(4), 557-584. doi: 10.1037/1045-3830.22.4.557
- Luft, J. A., & Roehrig, G. H. (2007). Capturing science teachers' epistemological beliefs: The development of the teacher beliefs interview. *Electronic Journal of Science Education*, 11(2), 38-63.
- Maciejewski, J. (2007). Supporting new teachers: are induction programs worth the cost? *District Administration*, 43(9), 48-52.
- Melville, W. & Wallace, J. (2007). Subject, relationships, and identity: The role of a science department in the professional learning of a non-university science educated teacher. *Research in Science Education*, 37(2) 155-169. doi: 10.1007/s11165-006-9020-y
- Ng, J. C., & Peter, L. (2010). Should I Stay or Should I Go? Examining the career choices of alternatively licensed teachers in urban schools. *The Urban Review*, 42(2), 123-142. doi: <http://dx.doi.org/10.1007/s11256-009-0120-7>
- Nias, J. (1989). *Primary teachers talking: A study of teaching as work*. London: Routledge.
- Organisation for Economic and Cultural Development [OECD] (2005). *Attracting, developing and retaining effective teachers - final report: Teachers matter*. Paris: OECD Publishing.

Experiences of STEM Subject-matter Experts in Secondary Science Teaching

- Podgursky, M., Monroe, R., & Watson, D. (2004). The academic quality of public school teachers: an analysis of entry and exit behavior. *Economics of Education Review*, 23(5), 507-518. doi: <http://dx.doi.org/10.1016/j.econedurev.2004.01.005>
- Ritchie, S. M., Kidman, G., & Vaughan, T. (2007). Professional learning opportunities from uncovering cover stories of science and science teaching for a scientist-in-transition. *Cultural Studies of Science Education*, 2(1), 225-242. doi: <http://dx.doi.org/10.1007/s11422-006-9044-7>
- Rubin, H. J., & Rubin, I. S. (2005). *The art of hearing data*. (2nd ed.). Thousand Oaks, CA: SAGE Publications.
- Schempp, P. G., Sparkes, A. C., & Teplin, T. J. (1998). Identity and induction: Establishing the self in the first years of teaching. In R. P. Lipka & T. M. Brinthaupt (Eds.), *The role of self in teacher development* (pp. 142-164). Albany, NY: State University of New York Press.
- Schlechty, P. C., & Vance, V. S. (1981). Do academically able teachers leave education? The North Carolina Case. *The Phi Delta Kappan*, 63(2), 106-112
- Snyder, C., Oliveira, A. W., & Paska, L. M. (2013). STEM career changers' transformation into science teachers. *Journal of Science Teacher Education*, 24(4), 617-644. doi: <http://dx.doi.org/10.1007/s10972-012-9325-9>
- Soenens, B., & Vansteenkiste, M. (2011). When is identity congruent with the self? A self-determination theory perspective. In S. J. Schwartz, K. Luyckx & V. L. Vignoles (Eds.), *Handbook of identity theory and research* (pp. 381-402). New York: Springer.
- Stafford, D. L. (2008). *First career and second career secondary novice teachers' self-assessed value of induction and impact of mentor support to their teacher competency*. Unpublished Doctor of Education Thesis, Azusa Pacific University, California.
- Stryker, S. (1968). Identity salience and role performance: The importance of symbolic interaction theory for family research. *Journal of Marriage and the Family*, 30(4), 558-64 doi:10.2307/349494
- Veenman, S. (1984). Perceived problems of beginning teachers. *Review of Educational Research*, 54(2), 143-178.
- Watt, H. M., Richardson, P. W., & Pietsch, J. (2007). *Choosing to teach in the "STEM" disciplines: Characteristics and motivations of science, ICT, and mathematics teachers*. Paper presented at the Mathematics Education Research Group of Australasia, Hobart, Tasmania, Australia.
- Watters, J. J. (2010, 30 June). *School administrators' perceptions of beginning secondary science and mathematics teachers*. Paper presented at the Australasian Science Educators Research Association Annual Conference, Port Stevens, New South Wales, 30th June-4th July 2010.
- Wilson, E., & Deaney, R. (2010). Changing career and changing identity: How do teacher career changers exercise agency in identity construction? *Social Psychology of Education*, 13(2), 169-183. DOI 10.1007/s11218-010-9119-x
- Yin, R. K. (2009). *Case study research: Design and methods* (4th ed. Vol. 5). Thousand Oaks, CA: SAGE Publications.