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ARTICLE

Examining Bhutanese Science Teachers' Epistemic Views of Scientific Inquiry

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Abstract

Scientific inquiry is regarded as the bedrock of science education in Bhutan. Bhutanese science teachers, for example, are increasingly required to possess accurate and deep epistemic views of scientific inquiry. Hence, this cross-sectional study was carried out to examine Bhutanese science teachers' epistemic views of scientific inquiry. The study recruited 301 science teachers using convenience and snowball sampling procedures. Data was collected using Views About Scientific Inquiry (VASI) questionnaire administered through an online survey mode and analysed using descriptive statistics and inferential statistical methods. Findings from this study revealed Bhutanese science teachers as being ignorant of epistemic aspects related to questions and hypotheses, procedures of investigations, results, and scientific data and scientific evidence, and scientific explanations and scientific theories. The independent sample *t*-test revealed no significant difference between Bhutanese male and female science teachers' epistemic views of scientific inquiry ($p > .05$). The one-way ANOVA revealed significant differences amongst Bhutanese science teachers' epistemic views of scientific inquiry based on academic qualification ($p < .05$). The Tukey HSD post hoc test, however, showed the differences existing only between science teachers with master's degree and certificate qualification in favour of the former ($p < .05$). The three-way ANOVA revealed Bhutanese science teachers' epistemic views of scientific inquiry as being independent of individual and interaction effects of school type, teaching subject, and teaching experience ($p > .05$).

1 Introduction

Scientific inquiry (SI) is the central theme of science education and is found common across school science curricula around the world (Abd-El-Khalick et al., 2004). It forms the bedrock of science education and has been a perennial aim of science education reform efforts (Eliyahu et al., 2020; Lederman et al., 2019, 2014a, 2014b). Today, various reform documents acknowledge SI as one of the underpinning principles required to drive science education (Gyllenpalm et al., 2010). Some of the popular documents, such as *A*

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Framework for K-12 Science Education (National Research Council [NRC], 2012), *Taking Science Back to Schools* (NRC, 2007), and *Science Education in Thailand* (Faikhamta & Ladachart, 2016), for example, collectively advocate to situate and practice science teaching in the contexts of SI.

Teaching science through SI is perceived as one possible means to achieve scientific literacy (NRC, 2000, 2007). There is, perhaps, a widespread appreciation amongst the circle of science education scholars that SI is a particularly effective, relevant, and authentic practice for developing a sophisticated understanding of science (Concannon et al., 2020). This includes scientific concepts; the process of how scientific knowledge is developed, revised, and accepted; and the nature of science in itself (NOS) (Lederman et al., 2014a, 2014b; Schwartz et al., 2012). More importantly perhaps, teaching science through SI is recognised to develop an accurate understanding of the nature of SI (NOSI) (Eliyahu et al., 2020; Roberts, 2008) and the skills necessary to conduct a range of scientific investigations (Schwartz et al. 2008).

While teaching science through SI is perceived to produce better scientific outcomes, this, however, largely depends on science teachers' epistemic understanding of SI (Crawford & Capps, 2016; Krajcik et al., 2014; Nollmeyer & Bangert, 2017). As per Kuhn (2016), it is critical that science teachers possess rich epistemic views of SI and the lack of such required knowledge comes with undesirable consequences. This includes science teachers being unable to plan lessons around the rich epistemic nature of SI, teach appropriately using SI, or help students develop a rich epistemic understanding of the NOS. Hence, accurate epistemic notions of SI are the prerequisite conditions necessary for all science teachers.

2 Review of Relevant Literature

2.1 Concept of SI

Although SI is recognised as an important element of science, there is no one definition of what SI is. As such, SI is variably understood with different meanings and connotations (Bybee, 2000; Minner et al., 2010). A lack of a common definition of SI should, nonetheless, be not much disconcerting nor surprising given that SI in itself is a complex and multifaceted concept. However, SI is commonly referred to as the process of how scientists do their work, and how the resulting scientific knowledge is generated and accepted (Concannon et al., 2020; Lederman et al., 2014a, 2014b). In sum, SI can be understood as any methods and activities that result in the creation of new scientific knowledge.

2.2 Epistemic Nature of SI

In a deeper approach, SI is both viewed and understood from its epistemic features as much as the NOS. Typically, some of the popular epistemic features of SI include being that "different kinds of questions suggest different kinds of scientific investigations; and current scientific knowledge and understanding guide scientific investigations" (NRC, 2000, p. 20). Additionally, another common aspect of SI is that "there is no single set of scientific methods as questions guide the approach and the approaches vary widely within and across scientific disciplines" (Lederman et al., 2013a p. 142). Historically, based on the six epistemic features of SI developed and advocated by Schwartz et al. (2008), science education scholars such as Bartos and Lederman (2014), Lederman et al., (2014a, 2014b), and Lederman et al. (2019) identified eight characteristic features that roughly constitute the overall epistemic nature of SI. Simply put, these eight characteristic features of SI include the following: scientific investigations always begin with a question; there is no single set or sequence of steps in a scientific investigation; the procedures followed in an investigation are invariably guided by the question(s) asked; scientists following the same procedures will not necessarily arrive at the same results; the procedures undertaken in an investigation influence the subsequent results; conclusions drawn must be consistent with collected data, data is not the same as evidence, and scientific explanations are developed through a combination of evidence and what is already known.

2.3 Science Teachers' Epistemic Notions of SI

Globally, there is a growing body of research that reveals science teachers as being increasingly naive about the epistemic aspects of SI. Science teachers, for example, believe that there is a single scientific method wherein scientists, irrespective of the scope of the investigation, follow a fixed set and the same sequence of steps (Lederman & Lederman, 2020; Lederman et al., 2013a, 2013b). Categorically, such a notion is often acknowledged to be very harmful as it makes science teachers consider any scientific investigation as a laboratory experiment (Cigdemoglu & Koseoglu, 2019; Karişan et al., 2017; Mihladiz & Dogan, 2017). Moreover, science teachers with such a die-hard myth makes them believe SI as a mere sequence of lab tasks (Kelley & Knowles, 2016), teaching strategies (Gyllenpalm & Wickman, 2011a, 2011b; Gyllenpalm et al., 2010), or hands-on activities (Capps & Crawford, 2013). Largely, these distorted views of SI were observed amongst the science teachers from the USA (e.g. Capps & Crawford, 2013; Kite et al., 2021) and Palestine (e.g. Wahbeha & Abd-El-Khalick, 2014). In reality, there is no one particular way of doing science, and scientific investigations are openly carried out in various ways, including observations, experiments, and the collection of data for analysis (NRC, 2000). Such type of misinformed view, according to Lederman and Lederman (2020), Lederman et al., (2013a, 2013b), and Lederman et al. (2014a, 2014b), is primarily, but not always, perpetuated by how scientific investigations are organised and practised in school science textbooks, science notebooks, laboratory works, media, and scientific reports.

The idea that hypotheses are common in all scientific investigations is another misconception relatively popular amongst science teachers. As much as the observation made by Kite et al. (2021) in the USA, a recent study by Vasconcelos and Ribeiro (2022) found Portuguese science teachers with a mistaken notion that scientific investigations always test hypotheses. In reality, unlike what is common in traditional experimental research, all investigations do not necessarily test hypotheses as in the case of descriptive and qualitative research (Lederman et al., 2014a, 2014b). At the same time, science teachers, often, fail to explain that scientific investigation always begins with questions, and very recently, this was revealed by Cigdemoglu and Koseoglu (2019), Baykara et al. (2018), and Mesci and Kartal (2021) in Turkey. Scientifically, one needs to understand that, as a rule of thumb, scientific investigation always begins with questions and the investigation of the world without a question that guides the observation is not scientific investigation (Lederman et al., 2014a, 2014b).

Not surprisingly, science teachers commonly believe that scientists follow the same scientific procedures and arrive at the same conclusions. Practically, while some teachers happen to possess correct views, a majority of science teachers in Turkey (Cavus-Gungoren and Ozturk (2021) and Greece (Stylos et al., 2023) rather felt that scientists following the same methods and attempting to answer the same questions can arrive at the same conclusions. While there is no denying that scientists following the same procedures may seldom reach the same ending, it is by no means that they can always have the same sets of results and be able to infer the same conclusions. Generally, science by nature is largely inferential because the derivation of scientific ideas and or conclusions is proportionately influenced by scientific data and what is already known. Moreover, scientific ideas are also dependent on or being influenced much by scientists' creativity, imagination, and endeavour, and by cultural and societal settings where scientists are placed (Lederman et al., 2002; NRC, 2012). Thus, it is essential to understand that scientific data do not remain in isolation and are not self-standing but can be interpreted in different ways (Lederman et al., 2014a, 2014b).

Besides, many, if not most, science teachers fail to make a distinction between scientific data and scientific evidence. Scientific data and scientific evidence, as per most science teachers, are the same aspects of science and serve the same purpose in any area of scientific enterprise. This misinformed view was expressed by a large majority of pre-service science teachers in Greece (e.g. Stylos et al., 2023) and Turkey (e.g. Cavus-Gungoren & Ozturk, 2021). In sum, scientific data is different from scientific evidence in that data is any collection of observations made during the investigation. Scientific data, for the most part, occur in various forms including numbers, texts, sound and voice, physical forms, drawings, and photographs. Scientific evidence, on the contrary, is different and is any kind of pattern, theme, or relationship derived after data analysis and data interpretation (Lederman et al., 2014a, 2014b).

Most science teachers, for various reasons, fail to describe how scientific theories and scientific explanations are being developed. Take, for example, while Pakistani science teachers managed to express accurate notions (e.g. Faize, 2022), an exploratory study conducted by Ozer and Saribas (2023) observed Turkish pre-service secondary science teachers being rather clouded by misperceptions. According to Baykara et al. (2018), any degree of misconceptions are especially harmful and unpleasant as they allegedly circumvent science teachers' abilities to become fully aware of how scientific ideas are developed using data and what is already known. According to Lederman (2007), the development of scientific knowledge, though empirical-based, involves a great deal of human creativity and imagination. Therefore, science, contrary to a common belief, is not lifeless, irrational, or an orderly activity as it greatly involves significant amounts of scientific knowledge and evidence (NRC, 2012).

2.4 SI and Demographic Variables

In science education literature, the relationship between science teachers' epistemic views of SI and their corresponding demographics has not been much reported. However, a few studies conducted in the recent past have demonstrated teachers' epistemic views of SI being closely influenced by their demographics. Take, for example, in a survey conducted by Shallow and Tadese (2021), Ethiopian science teacher's notions of scientific inquiry were found to be significantly influenced by gender and work experience. Recently, in a study by Garcia-Ruiz et al. (2021), Spanish male science teachers scored significantly higher points than their female counterparts, while Crawford et al. (2010) found most inexperienced US science teachers were unable to explain accurate views of SI compared to their experienced peers. Interestingly, in an exploratory study conducted by Mesci and Kartal (2021), Turkish middle secondary school science teachers with master's or PhD expressed more accurate views of SI than their colleagues who just held either a degree or certificate qualification in teaching. Their result was in support of earlier findings reported by Garcia-Ruiz et al. (2021) in the Spanish context. Given these prior reports, science teachers' demographics were included in this research to guide the study.

2.5 Bhutanese Science Education and SI

Science education in Bhutan was introduced in early 1986 (Childs, 2018). By the early 1980s, SI, however, gained a strong foothold in the Bhutanese science education system when Bhutan attempted to contextualise science education based on Bhutan's environment, culture, and economic settings (Childs et al., 2012). Since then, SI has been a central focus of Bhutan science education and it continues to do so even today (Childs et al., 2012; Ministry of Education [MoE], 2022; Royal Education Council [REC], 2012). Thus, SI is increasingly recognised as the foundation of the Bhutanese science education system. The current Bhutanese science curriculum framework, for instance, believes inquiry is the most essential practice to develop an accurate epistemic view of science. As such, it expects both students and teachers to engage in a range of scientific practices that embody the form of constructing scientific explanations, designing and conducting scientific investigations, analysing and interpreting scientific data, and communicating scientific findings.

Notably, research on Bhutanese science teachers' epistemic views of SI is relatively rare. A few research conducted in the recent past implied Bhutanese science teachers as being naive in certain epistemic aspects of SI. Recent studies conducted by Dorji et al. (2022) and Jatsho and Dorji (2022), for example, revealed Bhutanese in-service and pre-service science teachers as being fully subscribed to the notion of a scientific method. Bhutanese science teachers, as per Wangdi et al. (2020), explain experiments as a mere sequence of steps followed by scientists in any area of scientific investigation. While reports on this aspect of SI are quite prevalent, the status regarding Bhutanese science teachers' epistemic views of eight SI aspects has rarely been reported up to now. Moreover, as much as in the international literature, there is no information as to how Bhutanese science teachers' epistemic views of SI are being moderated by gender, academic qualification, subject of specialisation, teaching experience, and school level. Thus, to address these gaps existing in the Bhutanese science education literature, this study examined the landscape of Bhutanese science teachers' epistemic views of SI aspects and related further in terms of demographics. The research was informed by the following research questions:

1. What are Bhutanese science teachers' epistemic views of scientific inquiry?
2. What is the level of Bhutanese science teachers' epistemic views of scientific inquiry?
3. Do Bhutanese science teachers' epistemic views of scientific inquiry, if any, differ based on gender, academic qualification, teaching subject, teaching experience, and school level?

3 Materials and Methods

3.1 Research Approach

This research was a cross-sectional study conducted to examine Bhutanese science teachers' epistemic views of SI at one point in time. It was non-experimental observational research that examined the snapshot views of SI. The study was based on the positivist approach that modeled Bhutanese science teachers' epistemic views of SI identified by Lederman et al., (2014a, 2014b, 2019). While the research applied descriptive statistics to show and describe the patterns of epistemic views, it mainly focused on inferential statistics to draw inferences and conclusions amongst the tested variables (Guetterman, 2019). Thus, data gathered through the qualitative means were quantified to compute statistical analyses, and to draw inferences about the target population.

3.2 Study Sample

The study recruited 301 Bhutanese science teachers who were accessible and willing to take part in the study (Wang & Cheng, 2020). As shown in Table 1, the study sample was composed of both male ($n = 157$) and female science teachers. They were regular science teachers who obtained a formal graduation from the colleges of education. They ranged in age from 24 to 53 years. A large majority ($n = 92$) of them held a bachelor of education (B.Ed.), while there were almost an equivalent proportion ($n = 88$) of them with master's degree qualifications majoring either in science education or specific science disciplines. There were 56 science teachers who held postgraduate diplomas in education (PGDE), while there were 65 of them with primary teaching certificate (PTC) qualifications. Usually, a B.Ed. in Bhutan is offered to grade 12 graduates who then undergo a four-year degree course in education, while PGDE is an 18-month course offered to college graduates who happen to possess bachelor's degrees in science (Rinzin, 2019). While a master's degree remains as much the same as in other parts of the world, PTC which is now phased out was offered to grade ten high school graduates for a period of two years (Jamtsho & Bullen, 2007). As can

Table 1 Demographic characteristics ($N = 301$)

Variables	Frequency
Gender	157 (Male)
	144 (Female)
Academic qualification	88 (Master degree)
	92 (B.Ed.)
	56 (PGDE)
	65 (Certificate)
Teaching subject	84 (Biology)
	66 (Physics)
	71 (Chemistry)
	80 (Science)
Teaching experience	86 (more than 10 years)
	74 (six to 10 years)
	99 (one to five years)
	42 (less than one year)
School level	86 (HSSs)
	69 (MSSs)
	65 (CSs)
	81 (LSSs or PSs)

be seen, a bulk majority of Bhutanese science teachers were from biology teaching background ($n=84$) and science (general) teaching background ($n=80$), though the proportion of science teachers from other science teaching backgrounds did not differ much.

The proportion of study samples did not differ much by their teaching experience, except for the category that held less than one year of teaching experience. As it could be seen, nearly one-third ($n=99$) of them had just been in the service for one to five years, while this was closely followed by teachers ($n=86$) who had been in the service for more than ten years. The proportion of samples differed not much by their school level. For example, many ($n=86$) of them taught in the higher secondary schools (HSSs), though a similar number of them taught at either lower secondary schools (LSSs) or primary schools (PSs). In Bhutan, schools are usually explicitly classified based on the terminal or final grade. For instance, grade 12 is the terminal grade for HSSs, while grade 10 is the final grade for MSSs. The entry grade for HSSs and MSSs does not always remain fixed, and as such, it remains to be either pre-primary (PP), grade seven, or grade nine. Similarly, as grade eight is the terminal grade for the LSSs, grade six is the final grade for the PSs. The entry grade for LSSs and PSs, oftentimes, remains the same and it is usually PP (MoE, 2021).

3.3 Instrument

Data was collected using the Views About Scientific Inquiry (VASI) questionnaire developed by Lederman et al., (2014a, 2014b). The VASI questionnaire in itself was expanded and revised by Lederman et al., (2014a, 2014b) adapting ideas from the Views of Scientific Inquiry (VOSI) developed by Schwartz et al. (2008). Typically, the VASI questionnaire has initially been developed to examine students' epistemic understanding of SI, but recent studies have consistently shown it to be effective for exploring science teachers' epistemic views of SI (e.g. Baykara et al., 2018; Cigdemoglu & Koseoglu, 2019; Faize, 2022; Ozer & Saribas, 2023). To this end, the VASI questionnaire as an instrument does not necessarily depend on whether the respondents are teachers or students. Hence, as recommended by Lederman et al., (2014a, 2014b), this study employed the VASI questionnaire as a reliable instrument to collect data. The VASI questionnaire consisted of eleven open-ended questions. These questions required the Bhutanese science teacher to provide subjective written responses. Each open-ended question targeted Bhutanese science teachers' specific epistemic aspects of SI. The eight epistemic aspects of SI and the corresponding questions of the VASI questionnaire are shown in Table 2.

The coefficient of reliability for the VASI questionnaire was determined by Faize (2022). The coefficient of reliability, in terms of internal consistency, was 0.795 (Cronbach's alpha). Thus, the index of reliability of the VASI questionnaire was within the acceptable range of reliability.

To ensure the accuracy of coding written responses gathered through the VASI questionnaire, semi-structured interviews were carried out with science teachers who have already responded to the VASI questionnaire. Additionally, the interviews also enriched researchers' qualitative understanding of the epistemic views of SI held by Bhutanese science teachers. The interview questionnaire contained eight open-ended questions and each question targeted one of the eight epistemic aspects of SI.

Table 2 SI aspects and the VASI items

SI aspects	Items in the VASI
1. Scientific investigations all begin with a question but do not necessarily test a hypothesis	1a, 1b, and 2
2. There is no single set and sequence of steps followed in all scientific investigations (i.e. there is no single scientific method)	1b and 1c
3. Inquiry procedures are guided by the question asked	5
4. All scientists performing the same procedures may not get the same conclusions	3a
5. Inquiry procedures can influence the conclusions	3b
6. Research conclusions must be consistent with the data collected	6
7. Scientific data are not the same as scientific evidence	
8. Explanations are developed from a combination of collected data and what is already known	4 7a and 7b

3.4 Data Collection

The VASI questionnaire was administered to over 305 Bhutanese science teachers. In the process of data collection, the study sought written informed consent from each science teacher. However, only 301 of them managed to respond to the VASI questionnaire. The VASI questionnaire was administered through an online survey mode designed using Google Forms. It was administered to the science teachers using their email addresses. In turn, science teachers who responded to the survey questionnaire rendered assistance in reaching out the VASI questionnaire to their colleagues. Moreover, some school principals and teachers majoring in other subjects also provided their assistance in identifying and reaching out the VASI questionnaire to their potential science teacher colleagues. The responses gathered by the VASI questionnaire were downloaded from Google Forms using Microsoft Excel Sheets.

After administering the VASI survey questionnaire, semi-structured interviews were carried out with 17 science teachers who had already responded to the VASI questionnaire. They are drawn in as the interviewees mainly based on their interests and willingness. As it happened, up-close face-to-face interviews were carried out in their respective schools either in school libraries or science laboratories. The interviewees were briefed about the rationale of the interviews and assured them to have their identities were concealed in the study reports. The interviews were recorded in the mobile phone voice recorder, however.

3.5 Data Analysis

Responses gathered through the semi-structured interviews were analysed based on a deductive content analysis approach. As for this, two researchers carried out the manual transcription of interviews recorded in the mobile phone voice recorder. The coding was carried out using eight SI aspects that were identified as the predetermined coding categories. As recommended by recent studies (e.g. Gyllenpalm et al., 2021; Lederman et al., 2014a, 2014b), findings from interviews were mainly used to understand participants' views of SI as well as to enhance the coding accuracy of subjective responses gathered through the VASI questionnaire. Hence, there are no findings reported from the interviews.

As implied in the foregoing section, the analysis of the VASI responses was carried out after the analysis of the interview data, however. To begin with, two researchers first attempted to establish a consensus in their coding processes. As for this, in line with the suggestion of Lederman et al., (2014a, 2014b), two researchers independently coded the first 60 (20%) respondents' VASI responses. The coding, by itself, was completed in two rounds, and in each round, a meeting was scheduled to discuss important matters, such as the quality of responses, coding processes, scoring techniques, and of course, the level of agreement. In the second meeting, however, two researchers met face-to-face and discussed about codes and responses. This enabled the resolution of remaining differences (if any), until an 80% inter-coding reliability was achieved. Subsequently, the rest of the VASI questionnaire responses were shared between the two researchers for coding, although a major portion of the VASI responses were coded by a principal researcher.

As can be seen, VASI responses were coded into three categories, including informed, mixed, and naive views. The responses that appeared congruent with the targeted responses for a given aspect of SI were coded as "informed" views, while responses that happened to be partially explained or not fully described in accord with the targeted responses were coded as "mixed" views. The responses that made no connection with the accepted views of SI aspects, and that did not provide evidence of congruence with the accepted views of SI aspects were coded as "naive" views. These coding methods were carried out as per the framework of analysis advocated by Eliyahu et al. (2020), Gyllenpalm et al. (2021), and Lederman et al., (2014a, 2014b). Finally, the categories of responses for each SI aspect were used to compute frequency in terms of percentage (%). Table 3 shows examples of Bhutanese science teachers' VASI responses categorised as naive, mixed, and informed views.

To conduct inferential statistics, Bhutanese science teachers' responses were scored as per the three coding categories. The views that were coded as "informed" were scored 2, while the views that were coded as "mixed" were scored 1. Scores, especially for the SI aspects represented by more than one item, were determined by computing composite scores (average). The responses that were coded as "naive" were awarded no points.

The observed data met the assumptions of being normally distributed in the Shapiro–Wilk test of normality. As such, a parametric test using an independent sample *t*-test was carried out to examine the effect of gender on Bhutanese science teachers' epistemic views of SI. The one-way ANOVA, on the other hand, was computed to examine the differences amongst the Bhutanese science teachers' epistemic views of SI based on academic qualification. The differences that existed based on academic qualification were further examined using the Tukey HSD post hoc test. The three-way ANOVA was carried out to examine individual and interaction effects of teaching subject, teaching experience, and school type on Bhutanese science teachers' epistemic views of SI aspects.

4 Results

4.1 Epistemic Views Across SI Aspects

Bhutanese science teachers' epistemic notions of SI aspects are reported in the following sections as:

Table 3 Categories of views surrounding SI aspects

SI aspects	Naive views	Mixed views	Informed views
Scientific investigations all begin with a question but do not necessarily test a hypothesis	"No, its not scientific since the person is just observing to collect data" "Scientific investigation is an experiment because it involves collection of data"	"It is scientific because the researcher would find something at the end through his observations"	"It is scientific as the person is collecting data through observations to answer the questions asked"
There is no single set and sequence of steps followed in all scientific investigations	"A person need to follow specific steps/procedures. For all scientific investigations, procedures are almost the same"	"Some investigation may follow more than one method. It may depend upon the nature research topic or investigation topic"	There can be many ways for investigation. Methods may differ depending on the characteristics that the researchers want to study and analyse"
Inquiry procedures are guided by the question asked	"Procedures for investigations vary in approach to draw true conclusions"	"Sometimes, procedures remain guided by the intentions to test the hypothesis"	" Investigations are always influenced by questions asked and the methods of investigation must answer the questions"
All scientists performing the same procedures may not get the same conclusions	"Scientists following the same procedures of investigations will get same results because they they follow same set of procedures to answer same questions"	"It depends on the types of investigations. Some scientific research yield same conclusions and others do not"	"Scientists performing same procedures of investigation get different results because they might have different interpretations"
Inquiry procedures can influence the conclusions	"If different procedures are followed to collect data for same question, the conclusion can be same"	"The conclusion may not be same. It totally depends on the quality of investigation and topic chosen to study"	"Conclusions differ when investigations take different procedures to address similar or same questions"
Research conclusions must be consistent with the data collected	"Conclusions need not be necessarily influenced by observations. It also depends on one's imagination as science value creativity and one's thinking"	"Conclusions may sometime be supported by data, although it often depends on one's interpretation, too"	" Conclusions for scientific investigations must be supported by and be based on findings and data"
Scientific data are not the same as scientific evidence	"All evidences are data but all data are not the evidences" "Data contain mixture of information while evidences contain only valid information"	"Date means all the information collected after observation and experimentation. Evidence means a specific and valid data to indicate the correctness"	"Data is a set of information collected on the subject. Whereas, evidence is a data generated as result or finding through statistical analysis"

Table 3 (continued)

SI aspects	Naive views	Mixed views	Informed views
Explanations are developed from a combination of collected data and what is already known	"Scientists use diagrams, observations, analysis, and data interpretations to check their hypothesis and to explain their conclusions"	"They use already available information found from previous studies for comparison" "Existing scientific theory must have supported their explanation"	"Explanations are based on a combination of collected data and previous knowledge"

o Aspect 1: Scientific investigations all begin with a question but do not necessarily test a hypothesis.

As shown in Table 4, more than one-third (44.1%) of Bhutanese science teachers held misconceived notions regarding scientific investigations. In one instance, these teachers strongly felt that questions are not very relevant for scientific investigation, and as such, scientific investigations often proceed without questions. Notably, this group of teachers also held little to no understanding of scientific experiments. While some of them equated scientific experiments to mere scientific investigations, many of them neither identified scientific experiments nor explained what constitutes scientific experiments correctly. Meanwhile, an almost equal proportion (46.9%) of Bhutanese science teachers held partially correct views. Despite being aware that scientific investigations start with questions, this group of teachers, nonetheless, fell short in justifying the critical roles played by questions in any field of scientific investigation. Concurrently, though they managed to recognise scientific experiments correctly, there was hardly anyone who held an accurate understanding of scientific experiments. Hence, they had a strong confusion between scientific experiments and scientific investigations.

Aspect 2: There is no single set and sequence of steps followed in all scientific investigations.

As shown in Table 4, slightly more than one-half (51.2%) of Bhutanese science teachers held incorrect views regarding the procedures of scientific investigations. They, for instance, strongly believe that scientific investigations must be carried out based on a specific set of experimental methods. As per them, all scientific investigations should contain stages that enable the observation of nature, asking questions, formulating and testing hypotheses, and drawing conclusions. In the meantime, slightly less than one-half (43.0%) of Bhutanese science teachers held partially correct views. In their responses, some science teachers felt that scientific investigations can follow more than one method but rarely managed to explain why procedures for scientific investigations differ even for the same research questions.

Aspect 3: Inquiry procedures are guided by the question asked.

As observed in Table 4, more than one-half (71.8%) of Bhutanese science teachers lacked the understanding of what guides the procedures for scientific investigations. As many happened to be confused, they expressed that procedures for scientific investigations are mainly guided depending on the situation, time, sample size, and the variable of interest. In the meantime, there were 22% of Bhutanese science teachers happened to hold partially correct views. This group of teachers, while recognising that scientific questions are guided by questions, did not elaborate as to why scientific investigations are commonly directed and influenced by questions. As anticipated, there were only 6.2% of Bhutanese science teachers who seemed to maintain correct views consistent with the understanding shared by scientific communities.

Aspect 4: All scientists performing the same procedures may not get the same conclusions.

Table 4 Distribution of VASI scores across the SI aspects

Aspects of SI	Naive	Mixed	Informed
1. Scientific investigations all begin with a question but do not necessarily test a hypothesis	44.1	46.9	9
2. There is no single set and sequence of steps followed in all scientific investigations	51.2	43.0	5.8
3. Inquiry procedures are guided by the question asked	71.8	22.0	6.2
4. All scientists performing the same procedures may not get the same conclusions	44.9	32.6	22.5
5. Inquiry procedures can influence the conclusions	55.2	36.8	8.0
6. Research conclusions must be consistent with the data collected	22.6	53.3	24.1
7. Scientific data are not the same as scientific evidence	69.6	23.1	7.3
8. Explanations are developed from a combination of collected data and what is already known	76.4	22.6	1.0

It was quite encouraging that nearly one-quarter (22.5%) of Bhutanese science held accurate views. As they appeared to be informed, they felt that with different interpretations, scientists following the same procedures do not arrive at the same conclusions. By contrast, nearly one-half (44.9%) of them still held misinformed notions, and as such, they reportedly believed that scientists could easily arrive at the same conclusions as long as scientific investigations were carried out using the same methods. As can be seen in Table 4, there were 32.6% of Bhutanese science teachers happened to maintain partial or mixed understanding. Although this group of teachers potentially seemed to have an understanding that conclusions often vary amongst scientific research, even with the same procedures of investigations, they did not elaborate correctly as to what influences scientists to arrive at differing conclusions. But rather, they held the typified notion that conclusions in scientific investigation are inherently influenced by the type of scientific investigations carried out.

Aspect 5: Inquiry procedures can influence the conclusions.

In this SI aspect, as well, slightly more than one-half (55.2%) of Bhutanese science teachers did not appear to maintain correct views. In their claims, they allegedly felt that scientists could arrive at the same conclusions despite different approaches employed for the scientific investigations. As seen in Table 4, it was noteworthy that 36.8% of Bhutanese science teachers held mixed understanding when they managed to express that scientists can have different conclusions depending on the methods of investigation. Nonetheless, there was rarely anyone who could explain how scientific investigations differ by the approaches to inquiry, especially in terms of data collection, operationalisation of variables, and the way variables are being measured and analysed.

Aspect 6: Research conclusions must be consistent with the data collected.

Unlike what was observed in the other SI aspects, Bhutanese science teachers' epistemic views surrounding this SI aspect appeared noteworthy and pleasing. This is because there were only 26.6% of them who did not seem to possess correct ideas about scientific conclusions, or for that matter how scientific conclusions are made using scientific data. By contrast, as shown in Table 4, more than one-half (55.3%) of Bhutanese held partially correct views when they managed to identify correct scientific conclusions. That said, they were extremely short of mature explanations surrounding their choice of a particular type of scientific conclusion. Encouragingly, almost one-quarter (24.1%) of Bhutanese science teachers held correct and consistent views. They, for instance, felt that science, while not always empirical in nature, is partially or wholly based on data collected through observations and investigations.

Aspect 7: Scientific data are not the same as scientific evidence.

As evident in Table 4, quite many Bhutanese science teachers appeared to be increasingly confused about what is scientific data and scientific evidence. As they did not seem to possess any indication of a mature understanding, 69.6% of them held unacceptable views of scientific data and scientific evidence. Simply put, some teachers from this group exemplified data as part of the evidence and defined evidence as either materials or procedures, whereas others adjudged data as a piece of information obtained based on evidence. Additionally, some teachers went on to consider evidence as a body of facts, information, or concrete descriptions;

and regarded data as numbers. As was the case, nearly one-fourth (23.1%) of Bhutanese science teachers held partially correct views. In their views, a few of them managed to give correct notions of scientific data, while others maintained correct views surrounding scientific evidence.

> Aspect 8: Explanations are developed from a combination of collected data and what is already known.

This epistemic aspect, as seen in Table 4, was by far the most difficult area of SI misunderstood by most Bhutanese science teachers. Take, for example, an overwhelming majority (70.6%) of them could not explain how scientific explanations are being developed using data and accepted forms of scientific knowledge. In this context, Bhutanese science teachers increasingly felt that scientific explanations are developed using beliefs, assumptions, logic, or interpretation and reasoning skills. As it could be seen, nearly one-fourth (22.6%) of Bhutanese science teachers held mixed views. As it happened, some of them managed to point out that scientific explanations are developed using data, while others claimed that scientific explanations are developed using previous or accepted versions of scientific knowledge. Hence, there was an almost negligible proportion (1%) of them who indicated to possessing a whole range of accurate views.

4.2 Epistemic Views with Demographic Variables

4.2.1 Across Gender

As shown in Table 5, Bhutanese male science teachers' epistemic mean score (*M*) of SI was 0. 38 ($SD=0.15$), while Bhutanese female science teachers' epistemic mean score (*M*) of SI was 0.41 ($SD=0.13$). As it could be seen, Bhutanese female science teachers' epistemic mean score of SI was slightly higher than the Bhutanese male science teachers' epistemic mean scores of SI. However, the independent sample *t*-test, as shown in Table 6, revealed no significant difference between the mean scores of Bhutanese male and female science teachers' epistemic views of SI ($t\,(299)=-1.85, p=0.07>0.05$).

4.2.2 Across Academic Qualification

As seen in Table 7, the highest mean for the epistemic views of SI was scored by Bhutanese science teachers with master's degrees ($M=0.43$, $SD=0.12$), while the lowest score was obtained by science teachers with certificate qualification ($M=.\ 37$, $SD=0.14$). The mean score (*M*) of science teachers with B.Ed. qualification was. 41 ($SD=0.12$), whereas the mean score (*M*) of science teachers with PGDE qualification was 0.39 ($SD=0.11$).

As illustrated in Table 8, the one-way ANOVA revealed Bhutanese science teachers' epistemic views of SI being significantly influenced by their academic qualification, (*F* (3,

Table 5 Descriptive statistics

	Gender	*N*	Mean	Std. deviation	Std. error mean
Scores	Male	157.0	0.38	0.15	0.04
	Female	144.0	0.41	0.13	0.02

Table 6 Independent sample *t*-test

		Levene's test for equality of variances		*t*-test for equality of means						
		F	Sig	*t*	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Scores	Equal variances assumed	0.15	0.71	−1.85	299	0.07	−0.031	0.022	−0.076	−0.251
	Equal variances not assumed			−1.84	222	0.06	−0.031	0.021	−0.079	−0.252

Level of significance: $*p < 0.05$.

Table 7 Descriptive statistics

Qualifications	Mean (*M*)	Std. deviation (*SD*)	*N*
B.Ed	0.41	0.12	92
PGDE	0.39	0.11	56
Masters	0.43	0.12	88
Certificate	0.37	0.14	65

Table 8 One-way ANOVA statistics

	Sum of squares	*df*	Mean square	*F*	Sig
Between groups	0.37	3	0.12	8.41	0.00
Within groups	4.31	297	0.01		
Total	4.68	301			

Level of significance: $*p < 0.05$.

297) = 8.41, $p = 0.00 < 0.05$). The Tukey HSD post hoc test, however, showed the significant differences existing only between the epistemic views of SI of science teachers possessing master's degree and teaching certificate qualification. As shown in Table 9, the differences between the epistemic views of SI were found to be in favour of science teachers with master's degree qualifications ($p < 0.05$).

4.2.3 Across Teaching Subjects, Teaching Experience, and School Type

The three-way multifactorial ANOVA revealed that there were no statistically significant differences amongst Bhutanese science teachers' epistemic views of SI based on school type (F (6, 196) = 0.14, $p = 0.23 > 0.05$, $\eta 2 = 0.01$), teaching subject (F (9, 196) = 1.91, $p = 0.31 > 0.05$, $\eta 2 = 0.16$), and teaching experience (F (8, 196) = 1.08, $p = 0.66 > 0.05$, $\eta 2 = 0.23$). Moreover, the test also showed that there were no statistically significant differences amongst the interaction effects of school type, teaching subject, and teaching experiences on Bhutanese science teachers' epistemic views of SI (F (23, 196) = 0.47, $p = 0.09 > 0.05$, $\eta 2 = 0.22$). The three-way ANOVA statistics is shown in Table 10.

5 Discussion

Findings from the study are discussed and interpreted in the following order as:

5.1 Epistemic Views Across the Aspects of SI

5.1.1 Questions for Investigations

As it was not so encouraging, many Bhutanese science teachers appeared to be naive to the idea that scientific investigations, regardless of any scope, are always preceded by questions. As it speaks, this notable lack of a correct view implies that Bhutanese science teachers, for some reason, have little to no understanding of how scientific investigations

Table 9 Tukey post hoc test

	(I) Qualifications	(J) Qualifications	Mean differences (I–J)	Std. error	Sig	95% confidence interval	
						Lower bound	Upper bound
Tukey HSD	B.Ed	PGDE	0.02	0.01	0.66	−0.07	0.03
		Masters	−0.02	0.01	0.66	−0.02	0.06
		Certificate	0.04	0.02	0.11	−0.09	0.01
	PGDE	B.Ed	−0.02	0.01	0.66	−0.03	0.07
		Masters	−0.04	0.01	0.11	−0.01	0.09
		Certificate	0.02	0.02	0.78	-0.78	0.04
	Masters	B.Ed	0.02	0.01	0.66	−0.06	0.02
		PGDE	0.04	0.01	0.11	−0.09	0.01
		Certificate	0.06	0.02*	0.00	−0.01	-0.01
	Certificate	B.Ed	−0.04	0.02	0.11	−0.01	0.09
		PGDE	−0.02	0.02	0.78	−0.04	0.78
		Masters	−0.06	0.02*	0.00	0.01	0.01

Level of significance: $*p < 0.05$.

Table 10 Three-way ANOVA

Source	Type III sum of squares	df	Mean square	*F*	Sig	Partial eta squared
Corrected model	0.99[a]	67	0.04	0.82	0.41	0.32
Intercept	4.38	2	3.38	111.33	0.01	0.51
School	0.12	6	0.01	0.14	0.23	0.01
Subject	0.20	9	0.03	1.91	0.31	0.16
Experience	0.26	8	0.06	1.08	0.66	0.23
Subject * Experience	0.22	13	0.02	0.67	0.34	0.10
Subject * School	2.1	8	0.04	1.01	0.06	0.63
Subject * Experience * School	0.22	23	0.02	0.47	0.09	0.22
Error	4.62	196	0.04			
Total	32.15	301				
Corrected total	6.30	300				

Level of significance: $*p < 0.05$.

are guided by questions nor an understanding of the critical roles played by questions in any area of scientific endeavour. Similarly, in the studies conducted by Baykara and Yakar (2020), Baykara et al. (2018), Cigdemoglu and Koseoglu (2019), Mesci et al. (2020), and Ozer and Saribas (2023), science teachers in Turkey displayed inherent difficulties in explaining that it is typical for science to begin with questions. Moreover, science teachers from the USA (e.g. Kite et al., 2021), Indonesia (Adisendjaja et al., 2017), and Portugal (e.g. Vasconcelos & Ribeiro, 2022) expressed the view that while it is necessary and customary for science to test the hypothesis, it is not always necessary to ask questions.

Indeed, any scientific investigation, no matter what, begins with questions but does not necessarily test hypotheses. Lederman et al., (2014a, 2014b), for instance, put that "science begins with questions" and "for scientific investigation to begin, there needs to be a question" (p. 68).

5.1.2 Procedures for Investigations

Not surprisingly, as expressed by Palestinian science teachers (e.g. Wahbeh & Abd-El-Khalick, 2014), Bhutanese science teachers reportedly ascribed to the notion of a scientific method in that scientists carry out investigations using the same sets of procedures. Practically, while scientists use several shared elements and perspectives, there is nothing such as a scientific method and there is no one-way approach to doing science. Perhaps, even for the same questions of interest, scientists employ different approaches to their investigations which are either descriptive, correlational, or experimental designs depending on the scope and nature of inquiry (Lederman et al., 2014a, 2014b). At the core, this finding is consistent with the findings of earlier studies conducted by Dorji et al. (2022), Jatsho and Dorji (2022) and Wangdi et al. (2019) in Bhutanese contexts, and it attests to the deep entrenchment of the step-by-step notion of doing science. As alluded to by Lederman et al., (2013a, 2013b) and Windschitl et al. (2008), Bhutanese science teachers' distorted notion of the scientific method must have been practically influenced by the way science experiments are presented in science textbooks, notebooks, and science practical manuals, and the way science experiments are conducted in schools and colleges in Bhutan.

Interestingly, consistent with the views of science teachers from the USA (e.g. Capps & Crawford, 2013; Kite et al., 2021) and Palestine (e.g. Wahbeh and Abd-El-Khalick (2014), Bhutanese science seemed to have a confusion between experiments and scientific investigations. As they happened to be quite ignorant, some of them reportedly equated or considered experiments as scientific investigations, while others allegedly claimed experiments to be only legitimate scientific investigations. Conceptually, experiments are different from scientific investigations, and as such, experiments carried out in science laboratories or elsewhere do not constitute a complete representation of scientific investigations. By and large, these findings appear to suggest that Bhutanese science teachers have almost no understanding of the occurrence of different forms of scientific investigations. Typically, but not necessarily, these findings in their rights seem to indicate science education in Bhutan being over-reliant on laboratory experiments at the expense of other scientific practices such as modeling, critiquing, and communication. Moreover, findings seem to suggest that experiments have a special place and status in the Bhutanese science education system. In practice, scientists use different forms of scientific investigation. While some use approaches that describe, classify, and attempt to find patterns, others construct inferential reasoning and conduct logical tests to examine causal relationships (Eliyahu et al., 2020; Lederman et al., 2014a, 2014b; NRC, 2012).

5.1.3 Conclusions for Investigations

The belief that scientists can easily arrive at the same conclusions with the same procedures was quite a misconception held by many Bhutanese science teachers. Given this, Bhutanese science teachers did not appear to possess a correct notion as to how inferences or conclusions are drawn. As can be seen, this finding is consistent with the reports of prior research conducted by Cavus-Gungoren and Ozturk (2021) in Turkey and Stylos et al. (2023) in Greece.

Normally, research inferences and conclusions are intrinsically influenced by a scientist's theoretical framework, what he or she considers as evidence, how data anomalies are handled, or how data are interpreted (Lederman et al., 2014a, 2014b). Furthermore, it is natural that conclusions are influenced by the way the variables are being measured, analysed, and operationalised, or how the data themselves are collected (Eliyahu et al., 2020). Hence, there is no guarantee that with the same procedures of investigation for the same questions of interest, scientists can yield the data necessary to arrive at the same conclusions.

5.1.4 Scientific Data and Evidence

Encouragingly, many Bhutanese science teachers believed that conclusions in science, as always, are drawn using empirical data. While this is true, science, however, is not lifeless, rational, or an orderly activity. As such, scientific knowledge, while being very much reliant on the observation or the investigation of the natural world, nevertheless involves a great deal of human endeavour, imagination, and creativity. Therefore, contrary to a common notion, the development of any explanations and construction of new ideas requires a great deal of creativity by scientists (Lederman, 2007; Lederman et al., 2002).

Conversely, Bhutanese science teachers, for the most part, remained almost completely devoid of the ideas maintained by the scientific communities regarding scientific data and scientific evidence. As they were far-removed and short of the required ideas, they failed to differentiate scientific data from scientific evidence. Consistent with this finding, a similar nature of confusion was observed amongst the population of pre-service science teachers in Greece (Stylos et al., 2023), Taiwan (Baykara & Yakar, 2020), and Turkey (Cavus-Gungoren & Ozturk, 2021). In sum, scientific data are observations made during investigations, while scientific evidence are patterns, themes, or relationships drawn after data analysis (Lederman et al., 2014a, 2014b).

5.1.5 Scientific Explanations

As it was noticed, Bhutanese science teachers appeared to be naive about how explanations or theories in science were being developed. While a few of them roughly managed to express partially correct views, almost all of them had little to no idea that scientific explanations are, indeed, developed by incorporating a significant body of evidence with a currently established body of scientific knowledge. Quite recently, a similar state of confusion was usually explicitly seen amongst the population of in-service science teachers (Mesci & Kartal, 2021) and pre-service science teachers (Ozer & Saribas, 2023) in Turkey.

Generally, as pointed out by Pakistani science teachers (Faize, 2022), scientific explanations are developed using evidence and a body of accepted or previous knowledge (NRC, 2012). Additionally, scientific knowledge is, oftentimes, built using creativity and imagination (Lederman et al., 2002), or is influenced by scientists' theoretical commitments, prior knowledge, beliefs, training, experiences, and expectations (Lederman, 2007).

5.2 Epistemic Views in Relation to Demographic Variables

5.2.1 Across Gender

The independent sample *t*-test revealed no significant difference between Bhutanese male and female science teachers' epistemic views of SI ($p > 0.05$). This appears to be supported by a growing body of current science education literature, and it suggests that Bhutanese science teachers' epistemic views of SI are not associated with gender. Contrary to this finding, a survey conducted by Shallow and Tadese (2021) in Ethiopia revealed science teacher's notions of SI being significantly influenced by gender. More recently, in a study by Garcia-Ruiz et al. (2021), Spanish male science teachers' epistemic views of SI were significantly better than their female counterparts.

5.2.2 Across Academic Qualifications

The one-way ANOVA revealed significant differences amongst Bhutanese science teachers' epistemic views of SI ($p < 0.05$) based on their academic qualifications. However, in the Tukey HSD post hoc test, this difference was observed only between science teachers with master's degrees and certificate qualifications in favour of a master's degree. While these findings seem to be noteworthy, going by its current scopes and inquiry, this study lacks an explanation as to why Bhutanese science teachers with master's degree qualifications held better views of SI. Theoretically, while science teachers with master's degrees or higher educational qualifications are often perceived to possess better subject content knowledge, there is no guarantee that they will possess more sophisticated and advanced epistemic views of SI. Comparably, as unveiled by Garcia-Ruiz et al. (2021) in Spain and Mesci and Kartal (2021) in Turkey, science teachers with master's or PhD backgrounds expressed more accurate views of SI than their counterparts with degree or certificate qualifications. In Germany, a study conducted by Strippel and Sommer (2015) reportedly observed German chemistry teachers with PhD qualifications much better in explaining that questions drive the whole journey of scientific investigations.

5.2.3 Across Teaching Subjects, Teaching Experience, and School Type

The three-way ANOVA test revealed Bhutanese science teachers' epistemic views of SI being independent of individual or combined effects of statistically significant effects of school types, teaching subjects, and teaching experiences ($p > 0.05$). This indicates that Bhutanese science teachers' epistemic views of SI is categorically not influenced by teaching subjects (irrespective physics, chemistry, or biology), teaching experiences in terms of numbers of years being in the service, or the school level (be it PSs, LSSs, MSSs, CSS, or HSSs). While there is no adequate prior literature on teaching subjects and school types, Shallow and Tadese (2021) observed the notions of SI being significantly influenced by work experiences in Ethiopia. In contradiction, senior science teachers in Turkey, as reported by Baykara et al. (2018), held inadequate epistemic views of SI compared to their novice colleagues, while in the USA, Crawford et al. (2010) documented young science teachers with more naive views of SI. As per Ajaja (2012) and Bruckermann et al. (2018), instead of the number of years being in the service, teachers' epistemic views of SI rather depend on the number of learning opportunities received by teachers in their in-service programmes and pre-service training modules.

5.3 Conclusions, Implications, and Limitations

This cross-sectional survey examined Bhutanese science teachers' epistemic views of SI**.** As was the case, Bhutanese science teachers held a range of unsatisfactory notions surrounding numerous aspects of SI. Though the intentions of the Bhutanese science curriculum desire Bhutanese science teachers to optimise science lessons around rich epistemic features of SI, a lack of adequate understanding would create unpleasant situations in classroom teaching (Schwartz & Lederman, 2002). Typically, science teachers cannot design lessons that provide adequate opportunities for the learners to understand NoS, how scientists work, and how scientific knowledge is developed and accepted. At the core, there will be a huge gap between the intentions of the science curriculum and the way the science curriculum in itself is being implemented in Bhutanese schools.

Because of the above possible implications, it appears more than necessary that the Ministry of Education at the helm take a lead role in organising in-service training programmes to enhance science teachers' professional capacities (Mesci et al., 2020). Particularly, professional development programmes can be organised to improve science teachers' perceptions of SI and to help them gain first-hand experience in carrying out quality classroom teaching (Elster et al., 2014; Seroussi et al., 2017). Moreover, it looks critical that the epistemic nature of SI is seamlessly integrated into the training modules offered by the colleges of education in Bhutan. Perhaps, this would be a perfect time to rightfully train pre-service teachers and make them ready to implement the aspects of SI accurately when they join the service (Garcia-Ruiz et al., 2021; Mesci et al., 2020).

This research recruited science teachers mainly based on convenience and snowball sampling procedures. At the same time, the sample size was somewhat not adequate and large enough to represent the whole population of Bhutanese science teachers. Further, the survey was carried out using an online survey mode. Given these, a future study may be conducted by recruiting samples who are representative and administering surveys by visiting schools in person.

Author Contribution Both authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Karma Dorji, while the data interpretation was performed by Pema Tshering. The first draft of the manuscript was written by Karma Dorji, and both authors commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

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Declarations

Ethics Approval This study was observational research. Hence, the ethics approval was not required, but the study sought informed consent from every participating biology teacher.

Consent to Participate Informed consent was obtained from all the biology teacher participants included in the study.

Competing Interests The authors declare they have no conflict of interest.

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