Pedagogical Beliefs of Pre-service Teachers towards Teaching Physical Science at the Secondary Level

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Abstract

The purpose of the study was to examine the pedagogical beliefs of pre-service science teachers about the nature of teaching and learning physical science, understanding how the physical science subject should be taught and characteristics of a good physical science teacher at the secondary level. Descriptive survey with mixed method approach was followed for data collection and analysis. 97 pre-service science teachers of RIE, Bhubaneswar were the participants of the study. The findings showed that pre-service science teachers had strong pedagogical beliefs towards the nature of teaching and learning physical science, were sensitive towards the effective use of pedagogy in teaching physical science and had knowledge about the characteristics of a good physical science teacher at the secondary level.

Conceptualisation of the Problem

Pedagogical beliefs are beliefs about teaching and learning. Pre-service teachers enter teacher education programmes with prior beliefs about teaching and ideas on pedagogical approaches. Different pedagogical beliefs may have significant influences on different approaches to the planning and conduct of lessons. Pedagogical beliefs of pre-service teachers are closely related to their learning experiences. Their pedagogical beliefs, practices and attitudes are important for understanding and improving

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educational processes. It's a big challenge for teacher educators to shift pre-service teachers away from traditional pedagogical beliefs towards constructivist ones (Lim and Chan, 2007). The teacher education programme, especially at the pre-service stage, plays a crucial role in facilitating teachers' transformation in their instructional practices by shifting their pedagogical beliefs. Many strategies have been recommended how to shift pre-service teachers away from traditional beliefs and guide them in adopting more constructivist instructional practices (Applefield, Huber and Moallem, 2001; Muijs and Reynolds, 2002). Pre-service teachers' beliefs about teaching are well established throughout many years in their educational observation. It occurs over the years as students where they accumulate ideas about what it takes to be an effective teacher and how students have to behave. Pre-service teachers learning pedagogy as an integral part of their teaching learning process. Teaching opportunities can reinforce the pre-service teachers' pedagogical beliefs, in this regard we need to provide ample opportunity for pre-service teachers to reconstruct their pedagogical beliefs.

Bandura (1986) has stated that beliefs represent the best indicator of why a person behaves, acts and makes decisions in a certain way. Pre-service teachers come to teacher education programmes with their own prior experiences, thoughts, values and beliefs which have an impact on their professional development (Chan, 1999). Teacher education programmes play an important role in the development of pre-service teachers' pedagogical beliefs about teaching and learning (Pajares, 1992; Hancock and Gallard, 2004). Their pedagogical belief about teaching and learning can be formed through the observations they make and the practices they perform over a long time period that begins the day a pre-service teacher starts their teacher education (Harwood et al., 2006). Several pedagogical research has indicated that pre-service teachers possess a vast array of complex beliefs about pedagogical issues. Accepting and appreciating the nature and role of these pedagogical beliefs is essential to understanding the choices and decisions these pre-service teachers will make. It has become widely accepted that the pre-service teachers' pedagogical beliefs play a crucial role in their teaching-learning practices (Handal and Herrington, 2003, Salmon and MacCyvers, 2001), whereas these pedagogical beliefs are established during teaching-learning process by selecting appropriate teaching methods, by choosing the subjects/ content, activities and learning experiences, by decision-making, and assessment in the classrooms (Borg, 2001). Hence, in order to change classroom teaching practices, pre-service teachers' pedagogical beliefs should be considered and need to continuously improve. (Hart, 2002).

Need and Justifications of the Study

There is no doubt that physical science teaching has a crucial role to play in shaping the future development of society. In this regard, the science teacher training is very important part for the future quality of physical science education. Nearly everyone now accepts the premise that pre-service teachers have an influence on the quality of science education. Each pre-service teacher holds a set of beliefs that determine priorities for pedagogical knowledge and how students acquire knowledge. Ertmer (2005), "who investigated teacher beliefs about teaching and learning, called these as pedagogical beliefs". Research focused on pedagogical beliefs in particular suggests that many pre-service teachers view teaching as telling or lecturing that is, directly transmitting information to a passive learner (Brookhart and Freeman, 1992; Holt-Reynolds, 1992; Richardson, 1996; Torff, 2003).

Pedagogical beliefs are the complex views of pre-service teachers' knowledge, skills and abilities, used in the reasoning, managing and ways of responding to the interactions of teaching and learning (Loughran, 2013). Researchers have widely recognised the importance of the professional experience in influencing pedagogical beliefs (Tondeur et al., 2016). The choice and the level of pedagogical expertise a pre-service teacher is able to get is directly influenced by the quality of that learning experiences, the teaching context, content and the pre-service teachers' ability to fully engage in reflective processes (Lee, 2005; Penso and Shoham, 2010). Several researchers have elaborated on the aspects of changing pedagogical beliefs (Endacott and Sturtz, 2015; Paakkari et al., 2015; Rossum and Hammer, 2010; Vosniadou et al., 2008; Wubbels, 1992). Changing pedagogical beliefs is a complex process, it requires an understanding of the purpose, content mastery and strong foundation in subject pedagogy to enable connections and influence teaching (Paakkari et al., 2015; Rossum and Hammer, 2010). As we know that teachers' pedagogical beliefs are important predictors of students' achievement because they actually shape the teachers' teaching learning practices. In this regard, we need to reshape pre-service teachers' pedagogical beliefs towards effective teaching learning practices. There is considerable evidence that the pedagogical beliefs of pre-service teachers strongly affect what and how they learn, and ultimately how they approach teaching in the classroom. Hence the investigators were interested to undertake the present study.

Objectives of the Study

1. To study the pre-service teachers pedagogical beliefs about the nature of teaching and learning physical science at the the secondary level.

2. To study the pre-service teacher's pedagogical beliefs about the way physical science should be taught at the secondary level.
3. To examine the pre-service teachers' beliefs about the characteristics of a good physical science teacher.

Research Questions

1. What are the pedagogical beliefs of pre-service teachers about the nature of teaching and learning physical science at the secondary level?
2. What are the pre-service teachers' pedagogical beliefs about the way physical science should be taught at the secondary level?
3. What are the beliefs of pre-service teachers about the characteristics of a good physical science teacher?

Methods and Procedure

Research design: The study was a descriptive survey research and mixed method were followed.

Participants: The present study was confined to science students studying in RIE, Bhubaneswar. There were 97 pre-service science teachers (B.Ed. and B.Sc.B.Ed.) of RIE, Bhubaneswar were the participants of the study.

Tools: Self developed questionnaire and rating scale (5-point likert scale) were used for the present study. Questionnaire consisted of a series of questions (short and long questions), and there were both open-ended and closed-ended questions were included.

Procedure of data collection: The data were collected with the help of questionnaire and rating scale (5-point likert scale). Researcher had administered questionnaire and rating scale to participants' respective class, and requested to fill them. During this period, the investigator was interacted with pre-service teachers.

Statistical techniques used: The data gathered were analysed by using both quantitative and qualitative analysis technique.

Delimitations of the Study

The study was limited to 97 pre-service science teachers (B.Ed. and B.Sc.B.Ed.) of RIE, Bhubaneswar. This was a group of diverse (i.e. social, cultural, economic, linguistic etc.) pre-service teachers. The study was focused on pedagogical beliefs of pre-service teachers' towards teaching physical science at the secondary level.

Data Analysis and Interpretation

Pre-service Teachers' pedagogical beliefs about the nature of teaching and learning physical science at the secondary level

Table 1

Pre-service teachers' pedagogical beliefs about the nature of teaching and learning physical science at the secondary level

Sl. No.	Items	PERCENTAGE (%)				
		SA	***A***	***UD***	***DA***	***SDA***
1.	Engaging in repeated practice for mastery of skills is a critical part of physical science learning	24.7	50.5	19.6	4.1	1.0
2.	Students learn physical science, when presented with problems, questions or situations	37.1	53.6	4.1	4.1	1.0
3.	Learners can learn physical science by themselves	6.2	20.6	36.1	29.9	7.2
4.	Students' questions and ideas direct some of the learning in the classroom	37.1	52.6	9.3	1.0	00
5.	Learning science is an orderly process; students learn by gradually accumulating more information about a topic over time	49.5	43.3	7.2	00	00
6.	Teachers are more responsible for students learning than the students	5.2	30.9	13.4	46.4	4.1
7.	Students know very little about science before they learn it in school	4.1	32.0	21.6	34.0	8.2
8.	Learning physical science through use of ICT stimulates learners engagement	33.0	48.5	9.3	6.2	2.1
9.	Effective use of Community resources nurtures learners creativity and curiosity	34.0	52.6	12.4	00	1.0
10.	As classrooms became more diverse, I believe that teaching profession is more challenging now	30.9	46.4	12.4	8.2	2.1

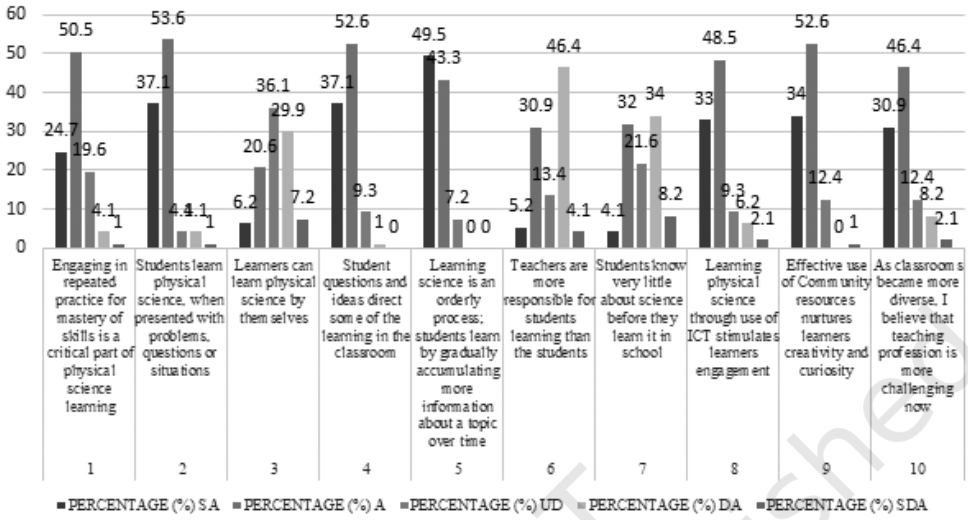

Fig. 1: Pre-service teachers' pedagogical beliefs about the nature of teaching and learning physical science at the secondary level

Figure 1 deals with the pre-service teachers' pedagogical beliefs about the nature of teaching and learning physical science at the secondary level. Most of the pre-service teachers (24.7% SA and 50.5% A) believed that engaging in repeated practice for mastery of skills is a critical part of physical science learning. They believed (37.1% SA and 53.6% A) that students learn physical science, when presented with problems, questions or situations. Some of the pre-service teachers (29.9% DA and 36.1% UD) were disagreed and undecided regarding the statement that learners can learn physical science by themselves. Most of the pre-service teachers (37.1% SA and 52.6% A) were agreed that students' questions and ideas direct some of the learning in the classroom. The pre-service teachers (49.5% SA and 43.3% A) believed that learning science is an orderly process; students learn by gradually accumulating more information about a topic over time. Mixed responses (32.0% A, 21.6% UD and 34.0% DA) were found from the participants in the statement that teachers are more responsible for students learning than the students. The pre-service teachers also showed mixed responses (32.0% A, 21.6% UD and 34.0% DA) regarding the statement i.e., students know very little about science before they learn it in school. Most of the participants (33.0% SA and 48.5% A) agreed that learning physical science through the use of ICT stimulates learners'

engagement. They had strong beliefs (34.0% SA and 52.6% A) that effective use of community resources can nurtures learners creativity and curiosity. Most of the pre-service teachers (30.9% SA and 46.4% A) believed that as classrooms became more diverse, the teaching profession is more challenging now.

From the study, it is noticed that participants had strong pedagogical beliefs about the nature of teaching and learning physical science at the secondary level. They understood the importance of pedagogy in effective teaching learning process. Pre-service teachers had sound understanding regarding how a children learn physical science more effectively. Participants of this study also understand the role of physical science at the secondary level and how important is physical science compared to other subjects.

Table 2
Pre-service teachers' pedagogical beliefs about the way physical science should be taught at the the secondary level

Sl. No.	Items	PERCENTAGE (%)				
		SA	***A***	***UD***	***DA***	***SDA***
1.	Physical science learning is enhanced when Students work in groups	24.7	71.1	4.1	00	00
2.	Learning is enhanced when students explain and demonstrate their ideas to others	70.1	28.9	1.0	00	00
3.	Students are more likely to understand a scientific concept if the teacher explain the concept in a way that is clear and easy to understand	60.8	37.1	2.1	00	00
4.	Teacher must prepare lessons and activities where students from diverse backgrounds can work together	66.0	29.9	4.1	00	00
5.	Active participation in learning enable students to learn physical science better	60.8	39.2	00	00	00
6.	Teachers should provide students with problem solving situations to investigate in small groups.	37.1	55.7	6.2	1.0	00
7.	There should be common assessment strategies for all students in physical science classrooms	15.5	30.9	15.5	28.9	9.3
8.	In physical science classrooms, students should be encouraged to ask questions, debate and challenge ideas while maintaining a climate of respect for what others have to say	62.9	24.7	8.2	2.1	1.0

9.	Observation and Experimentation should be included in lessons as a way to reinforce the scientific concepts	48.5	39.2	2.1	5.2	5.2
10.	Teachers should engage learners in situations that might bring about contradictions and then encourage discussions	24.7	60.8	5.2	8.2	1.0

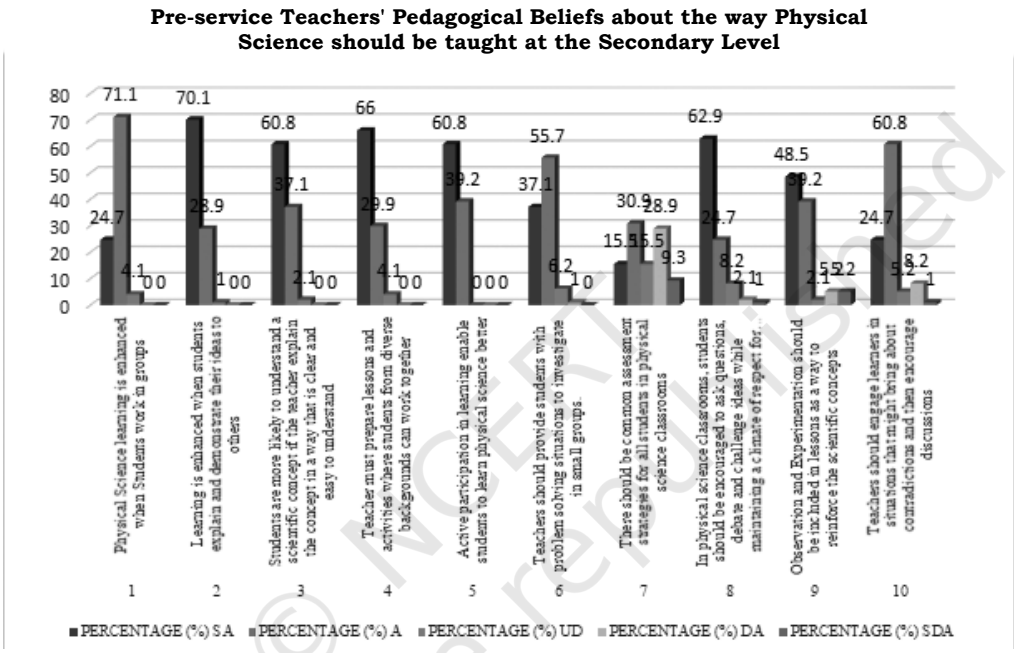

Fig. 2: Pre-service teachers' pedagogical beliefs about the way physical science should be taught at the secondary level

The Figure 2 deals with the pre-service teachers' pedagogical beliefs about the way physical science should be taught at the secondary level. Most of the pre-service teachers (24.7% SA and 71.1% A) believed that physical science learning is enhanced when students will work in groups. They had strong belief (70.1% SA and 28.9% A) that learning is enhanced when students explain and demonstrate their ideas to others. Pre-service teachers believed (60.8% SA and 37.1% A) that students are more likely to understand a scientific concept if the teacher explain the concept in a way that is clear and easy to understand. Most of the pre-service teachers (66.0% SA and 29.9% A) agreed the statement that teacher must prepare lessons and activities where students from diverse

backgrounds can work together. The participants of the study believed (60.8% SA and 39.2% A) that active participation in learning enable students to learn physical science better. They believed (37.1% SA and 55.7% A) that teachers should provide students with problem solving situations to investigate in small groups. There were mixed responses (15.5% SA, 30.9% A, 15.5% UD, 28.9% DA and 9.3% SDA) found from the participants regarding the statement, there should be common assessment strategies for all students in physical science classrooms. Most of the pre-service teachers (62.9% SA and 24.7% A) believed that in physical science classrooms, students should be encouraged to ask questions, debate and challenge ideas while maintaining a climate of respect for what others have to say. Most of the participants (48.5% SA and 39.2% A) agreed that observation and experimentation should be included in lessons as a way to reinforce the scientific concepts. They believed (24.7% SA and 60.8% A) that teachers should engage learners in situations that might bring about contradictions and then encourage discussions.

From the study, it is found that pre-service teachers had strong pedagogical beliefs about the way physical science should be taught at the secondary level. They had strong belief that teaching physical science through different activities, assignments, project work, field visit etc. had a considerable impact on learners' achievement. They had prior knowledge and understanding regarding the effective utilisation of learning resources as well as community resources and effective use of ICT in transacting physical science content. Participants of this study had strong beliefs regarding use of different approaches and strategies for effective teaching and learning physical science.

Pre-service teachers' beliefs about the characteristics of a good physical science teacher

From the responses, it is noticed that a good physical science teacher should have a sound understanding of the subject matter and knowledge of different pedagogical aspects. They must interact with learners in a friendly manner during teaching-learning process as well as outside the school environment to get the ideas of learners thinking process regarding physical science and try to optimise their level. They must encourage discussion and argumentation in physical science classrooms. They always help students to develop the habit of using different resources, i.e. textbook, reference books, class notes, periodicals, magazines, internet, etc. In the classroom process, they create joyful learning environment and always present learning tasks in a challenging way. They always actively involve every learner in teaching learning process. Apart from the personal characteristics of a good teacher, a physical science teacher

should be open-minded, free from prejudices and must be a creative person, who possessess scientific attitude, scientific temper and a keen aesthetic sense.

Best practices adopted in ideal physical science classrooms

Most of the participants revealed that in an ideal physical science classroom teacher should try to connect physical science content/knowledge with learners' prior learning experiences and their immediate learning environment. An ideal physical science classroom should be well equipped with scientific tools. The different learning needs of the learners must cater in the classroom process. The classroom management and transaction of content should be in such a way that every student will get the equal opportunity to clear their doubts. In the classroom process, teacher must use different approaches and strategies and utilise different learning resources to teach physical science content. In an ideal physical science classroom, teacher transact science knowledge in a joyful manner, where each and every learner take science learning without any kind of burden or hurdle. The relationship between teacher and student must be healthy in nature. Students should be given full freedom to express their ideas and creative thoughts. All above data showed that participants had strong pedagogical beliefs regarding an ideal physical science classrooms.

Major Findings

Pre-service teachers' pedagogical beliefs about the nature of teaching and learning physical science at the secondary level

- Most of the pre-service teachers (24.7% SA and 50.5% A) believed that engaging in repeated practice for mastery of skills is a critical part of physical science learning.
- They believed (37.1% SA and 53.6% A) that students learn physical science, when presented with problems, questions or situations.
- Most of the pre-service teachers (37.1% SA and 52.6% A) agreed that students' questions and ideas direct some of the learning in the classroom.
- There were mixed responses (32.0% A, 21.6% UD and 34.0% DA) found from the participants in the statement that teachers are more responsible for students learning than the students.
- Most of the participants (33.0% SA and 48.5% A) were agreed that learning physical science through use of ICT stimulates learners' engagement.
- They had strong beliefs (34.0% SA and 52.6% A) that effective use of community resources can nurture learners creativity and curiosity.

- Most of the pre-service teachers (30.9% SA and 46.4% A) believed that as classrooms became more diverse, the teaching profession is more challenging now.

Pre-service teachers' pedagogical beliefs about the way physical science should be taught at the secondary level

- Most of the pre-service teachers (24.7% SA and 71.1% A) believed that physical science learning is enhanced when students work in groups.
- Pre-service teachers believed (60.8% SA and 37.1% A) that students are more likely to understand a scientific concept if the teacher explain the concept in a way that is clear and easy to understand.
- Most of the pre-service teachers (66.0% SA and 29.9% A) agreed with the statement that teacher must prepare lessons and activities where students from diverse backgrounds can work together.
- There were mixed responses (15.5% SA, 30.9% A, 15.5% UD, 28.9% DA and 9.3% SDA) found from the participants regarding the statement, there should be common assessment strategies for all students in physical science classrooms.
- Most of the pre-service teachers (62.9% SA and 24.7% A) believed that in physical science classrooms, students should be encouraged to ask questions, debate and challenge ideas while maintaining a climate of respect for what others have to say.
- Most of the participants (48.5% SA and 39.2% A) were agreed that observation and experimentation should be included in lessons as a way to reinforce the scientific concepts.

Pre-service teachers' beliefs about the characteristics of a good physical science teacher

- A good physical science teacher should have a sound understanding of the subject matter and knowledge of different pedagogical aspects.
- They must interact with learners in a friendly manner during teaching-learning process as well as outside the school environment to get the ideas of learners thinking process regarding physical science and try to optimise their level.
- They must encourage discussion and argumentation in physical science classrooms.
- They always help students to develop the habit of using different resources, i.e. textbook, reference books, class notes, periodicals, magazines, internet, etc.
- In the classroom process, they create joyful learning environment and always present learning tasks in a challenging way.

- They always actively involve every learner in teaching learning process.
- A physical science teacher should be open-minded, free from prejudices and must be a creative person, who possess scientific attitude, scientific temper and a keen aesthetic sense.

Best practices adopted in ideal physical science classrooms

- Teacher should try to connect physical science content/ knowledge with learners' prior learning experiences and their immediate learning environment.
- An ideal physical science classroom should be well equipped with scientific tools.
- The different learning needs of the learners must cater in the classroom process.
- The classroom management and transaction of content should be in such a way that every student will get the equal opportunity to clear their doubts.
- In the classroom process, teachers must use different approaches and strategies and utilise different learning resources to teaching the physical science content.
- In an ideal physical science classroom, teachers transact science knowledge in a joyful manner, where each and every learner takes science learning without any kind of burden or hurdle.
- The relationship between teacher and student must be healthy in nature.
- Students should give full freedom to express their ideas and creative thoughts.

Discussion of Result

The major findings of the study have been presented above. The purpose of this research was to investigate pedagogical beliefs of pre-service teachers towards teaching physical science at the secondary level. The result of this study shows that pre-service teachers had strong pedagogical beliefs towards teaching physical science at the secondary level. They understood the importance of pedagogy and the role played by pedagogy in effective teaching learning process. Their pedagogical beliefs are important for understanding and improving educational processes. These pedagogical beliefs are closely linked to pre-service teachers' strategies for coping with upcoming challenges in their daily professional life and to their general well-being, and they shape students' learning environment and influence student motivation and achievement. The pre-service teachers' pedagogical beliefs are closely related to their prior learning experience (Hong and Chai, 2017). Pre-service teachers' pedagogical belief is the conception about teaching physical science at the secondary level. It incorporates pre-service teachers' roles, actions, and classroom activities. The objective

behind understanding pedagogical belief is that how pre-service teachers learn to teach, their views about teaching and how these views are implemented in actual classroom situations. The study found that pre-service teachers were aware about the different pedagogical aspects in teaching learning process of physical science at the secondary stage.

Educational Implications

It is hoped that this study will provide the baseline data for understanding pedagogical beliefs of pre-service teachers towards teaching-learning process. Knowing the pedagogical beliefs of pre-service teachers could have a huge impact on the work of curriculum reformers, policy makers and other educational administrators and leaders. That knowledge could inform them about how to think of the best ways to effect changes in teachers' pedagogical beliefs towards the goal of a successful curriculum reform. This study was intended to add to the body of knowledge on how pedagogical beliefs predict or contribute to the kinds of pedagogical instruction existing in an Indian context. The implication of this research is that pedagogical teaching in teacher education can be improved by a better understanding of how pedagogical beliefs evolve over the duration of the course. It is suggested that the professional experience will be helpful in building confidence and influencing possible changes in pedagogical beliefs of pre-service teachers. It is assumed that the exposure to professional experience, particularly when linked with specific coursework i.e. CWSNs education, behaviour management and method courses, can influence the pre-service teacher's pedagogical beliefs (Sheridan, 2016). This research signals the need for further exploration of pre-service teachers' developing pedagogical beliefs and the views they bring to teacher education. It is crucial to develop a broader understanding of the factors that influence the pre-service teachers' beliefs about pedagogy. This is particularly important in supporting reflection during and post the practicum experience and in reinforcing or challenging pre-conceived beliefs about teaching and learning. Future study is recommended to investigate individual belief systems so as to further enhance our understanding of how teacher education programmes contribute to pedagogical beliefs. Understanding how best to support the pre-service teachers' pedagogical development in teacher education is central to producing quality teachers and improving student outcomes.

Conclusion

Pre-service teachers' pedagogical beliefs about physical science teaching are highly personalised construct that are emerged by their prior learning experiences, interactions with colleagues, teachers, and their immediate environments. This

research was focused on pedagogical beliefs of pre-service teachers towards teaching physical science at the secondary level. According to key theorists, pedagogical beliefs are shaped by own experiences and align closely with beliefs about knowledge, how students learn and how teachers teach (Fajet, Bello, Leftwich, Mesler, and Shaver, 2005; Ryan, Carrington, Selva and Heally, 2009). Researchers have recognised the importance of the professional experience in influencing pedagogical beliefs. The choice and level of pedagogical expertise, a pre-service teacher is able to acquire is directly influenced by the quality of that experience, the teaching context and the pre-service teachers' ability to fully engage in reflective processes. In contemporary, era an important task of physical science education is making physical science more relevant to students, more easily learned and remembered, and more reflective of the actual practices of physical science. There is a strong belief emerged through researches that prospective physical science teachers need high quality training and pedagogical skills. The process of changing pedagogical beliefs and understanding how beliefs change, as the pre-service teachers progress through their degree, will assist teacher educators in supporting pre-service teachers' learning. Pre-service teachers' pedagogical beliefs is considered to be central to improving teachers' professional practices. In this regard, there is a need to reconstruct pedagogical beliefs of pre-service teachers and provide them adequate pedagogical skills.

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