JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

https://doi.org/10.33225/jbse/19.18.19

THE IMPACT OF A SCIENCE METHODS COURSE ON FEMALE PRE-SERVICE TEACHERS' BELIEFS WITHIN A SAUDI-ARABIAN CONTEXT

Amani K. Hamdan Alghamdi,
Sun Young Kim

Abstract. *This research examines the impact of a science methods course on the beliefs of female pre-service teachers (PSTs) in Saudi Arabia. Forty-seven female PSTs enrolled in a diploma of education programme at Imam Abdulrahman Bin Faisal* University (IAU) *took a 16-week science methods course aimed at promoting their beliefs about their own self-efficacy, science teaching strategies, and science content knowledge (SCK). The PSTs completed a 30-item questionnaire on science teaching beliefs (five- point Likert Scale) both before and after taking the course. Data analysis revealed that the PSTs' beliefs regarding their own self-efficacy changed after the course (statistically significant t=2.792, p 0.01) with scores indicating increased beliefs. Although increases were also observed for beliefs regarding science teaching methods and strategies and science content knowledge, they were very slight and not statistically significant. Overall, mean scores fell within the 'neither agree nor disagree' category for all three themes, ranging from 2.98 to 3.24. As one of the first studies in Saudi Arabia on PSTs' science teaching beliefs, this research filled a gap in the existing literature. Grounded in the moderate scores for all three themes, recommendations for future science education course design are tendered as are suggestions for future research.*

Keywords: *pre-service teachers, science teachers' beliefs, self-efficacy, teaching strategy, teachers in Saudi Arabia.*

Amani K. Hamdan Alghamdi
Imam Abdulrahman Bin Faisal University, Saudi Arabia
Sun Young Kim
Chosun University, South Korea

Introduction

For many years, science educators have focused on science education reforms in order to engage students in the discourses and practices of argumentation in science subjects (Erduran & Jimenez-Aleixandre, 2008; Sampson & Blanchard, 2012; Zembal-Saul, 2009). It has been assumed that when students engage in well-structured discourse, they are also involved in metacognition. As a result of free-association drawn from their constructive experiences, their sense of intuitiveness is fostered, and they develop a better understanding of science concepts (Berland & Reiser, 2009; Erduran & Jimenez-Aleixandre, 2008). Numerous case studies have provided empirical evidence of the positive impact of argumentation on students' learning in science education (Lemke, 1990; McNeill & Krajcik, 2011; Venville & Dawson, 2010). However, the successful execution of a pedagogical revolution that promotes the concepts of argumentation in science education among students does not simply involve the development of knowledge; it is also about empowering in-service and pre-service science teachers by giving them the necessary knowledge, skills and competencies to teach science through argumentation (Simon, Johnson, & Johnson, 2008).

Effective pedagogies and their successful execution by teachers are a core component in strengthening the implementation process of argumentation in science education. Fostering teachers' belief in their own abilities to "organize and execute the courses of action" that are required to produce argumentation in science education is one way to promote this concept (Bandura, 1997, p. 3). Dewey (1933) referred to thought as being synonymous with belief, defining the latter as "something beyond itself by which its value is tested; it makes as assertion about some matter of factors or some principle or law" (p. 6). Dewey (1933) simplifed the necessity of belief because

> …it covers all the matters of which we have no sure knowledge and yet which we are sufficiently confident of to act upon and also the matters we now accept as certainly true, as knowledge, but which nevertheless may be questioned in the future. (p. 6)

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Richardson (1994) described beliefs as one's understandings of the world and the way it functions or should function. These beliefs may be held consciously or unconsciously, and they guide a person's practice. Science teachers possess beliefs regarding their professional practice, with Lumpe, Czerniak, Haney, and Beltyukova (2012) commenting on the critical nature of these motivational beliefs. But research indicates that acquiring new beliefs is difficult. For example, Pajares (1992) distinguished between early-held beliefs and newly acquired ones, explaining that the former ones are combined with one's belief structure, and become difficult to change. Therefore, these early-held beliefs greatly influence one's perceptions and how one addresses new information. As a result, newly-obtained beliefs are more "vulnerable," although they become "robust" over time (Pajares, 1992, p. 317). Pajares has also argued that beliefs are difficult to replace and noted that an individual can retain a belief that is derived from incomplete or incorrect knowledge, despite sufficient evidence to the contrary.

Studies have suggested that engaging teachers in active learning activities has a significant role in changing their beliefs and practices. In mathematics education, for example, Nelson and Hammerman (1996) found that activities can challenge teachers "to confront their old ideas about the nature of mathematics, learning, and teaching with new data, ideas, and experiences" (p. 5). Mansour (2009) introduced different sources of teachers' beliefs, explaining that some beliefs stem directly from the culture, while others come from experiences. Mansour further noted that teachers' experiences have a significant impact on their beliefs regarding the process of teaching and learning. According to Mansour, other sources of teachers' beliefs include "personality factors, prior learning or teaching experiences, teacher education, teaching contexts, an apprenticeship through observation, and related reading of either research findings or other materials" (2009, pp. 36, 37).

Bransford, Brown, and Cocking (2000) identified a barrier that restricts teachers from rethinking their subject matter and thus changing their beliefs. They explained that:

> …learning involves making oneself vulnerable and taking risks, and this is not how teachers often see their role ... teachers generally are accustomed to feeling efficacious – to knowing that they can affect students' learning – and they are accustomed to being in control. When they encourage students to actively explore issues and generate questions, it is almost inevitable that they will encounter questions that they cannot answer – and this can be threatening. (p. 195)

Bransford et al. (2000) also suggested that it is very important to assist teachers to feel comfortable in the role of learner by providing them with expertise in the subject matter and with developed technology that grants them broader access to the expertise of other professionals.

The Impact of Science Methods Courses for Pre-service Science Teachers

In teacher preparation programmes, science methods courses play the most influential role in helping pre-service teachers (PSTs) to establish their own teaching strategies and build a positive perception of science and science teaching (Bursal, 2008). Through such courses, PSTs have opportunities to connect theory and practice and integrate their teaching and learning perspectives (Anderson, 1997). Other studies have argued that science methods courses are a good means of increasing efficacy in science teaching (Cantrell, Young, & Moore, 2003; Kim, 2012; Palmer, 2006). PSTs who possess a good sense of their own efficacy in science teaching will progress well as teachers (Appleton & Kindt, 2002). In addition, when teaching science, such teachers make more use of inquiry methods (Anderson et al., 2004). Cross (2009) argued that the beliefs held by math teachers regarding the practise of teaching are more than one-dimensional. He maintained that research has redefined and categorized science teachers' beliefs into three dimensions: science teaching efficacy, science teaching strategies, and science content, elaborated in the following sections.

Self-efficacy in Science Teaching

Self-efficacy is a powerful predictor of performance that is used interchangeably with self-confidence (Watters & Ginns, 2000). Bandura (1997) defined self-efficacy as "the beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Bandura then described four main sources of self-efficacy: *mastery experiences*, in which a particular situation is successfully dealt with; *vicarious experiences*, which refers to situations in which people compare their own abilities with those of others who have modelled

https://doi.org/10.33225/jbse/19.18.19

the desired behaviour; *verbal persuasion*, which occurs when individuals receive positive feedback from their peers; and *physiological and affective states*, which refers to individuals' personal levels of fear, anxiety and stress.

In a similar sense, teachers' self-efficacy refers to their belief that they have the ability as an individual to create positive change in students' learning (Gibson & Dembo, 1984). A lack of confidence impacts a teacher's classroom behaviour and teaching. Appleton and Kindt (2002) have found that new teachers with little belief in their own abilities seldom use hands-on activities in teaching science, using instead reading and writing as teaching strategies. Bursal (2008) has also argued that teachers with low self-efficacy rely on the use of teacher-directed instruction and avoid science experiments and other inquiry activities.

In order to increase science teaching efficacy, pedagogical knowledge is a prerequisite, including understanding both the use of appropriate science teaching strategies, and content knowledge. According to Appleton (1995), a constructivist science methods course increased teachers' confidence. Furthermore, Settlage (2000) has found that pre-service elementary teachers' self-efficacy increased when they were given instructions about the learning cycle. Furthermore, science content knowledge (SCK) has been shown to be one of factors that affects PSTs' confidence and self-efficacy (Schoon & Boone, 1998).

Science Teaching Strategies

The current focus in science teaching involves promoting inquiry-based instruction and engaging students in reasoning (National Science Teachers Association [NSTA], 1998). Inquiry process skills, which include observing, classifying, measuring, communicating, predicting, inferring and experimenting, help students to engage in meaningful learning. Science teaching reforms position science teachers as facilitators who enable students to be actively involved in examining and solving real-world problems (Plevyak, 2007). The NSTA (2003) has stated that inquiry-focused teachers prepare to teach through inquiry, understand the processes of multiple methods of inquiry, and engage students in appropriate inquiries based in a scientific manner on their observations, data, and inferences. In this sense, one of the roles of a pre-service teacher preparation programme is to provide ideal contexts that allow PSTs to develop insights into science teaching strategies.

Science Content in Science Teaching

It is critical that science teachers understand both science content and the nature of science as a way of knowing. The NSTA has stated that "teachers of science understand and can articulate the knowledge and practices of contemporary science. They can interrelate and interpret important concepts, ideas, and applications in their fields of licensure; and can conduct scientific investigations" (2003, p. 4). SCK is considered to be a requirement in order for teachers to develop inquiry-based science pedagogy or pedagogical content knowledge in science (Santau, Maerten-Rivera, Bovis, & Orend, 2014). Davis (2004) has argued that teachers with adequate SCK will use authentic inquiry in their teaching more often.

However, many studies have reported that science teachers lack adequate content knowledge, with this deficiency resulting in lower-quality teaching (Kind, 2009). In addition, the literature indicates that elementary science teachers possess the same science misconceptions as their students (Bursal, 2012). In order for teachers to implement reform-based science teaching, the development of SCK, or, *what* science to teach, is essential, along with pedagogical content knowledge, or, *how* to teach (Santau et al., 2014). When teachers possess sufficient SCK, they will be better prepared to plan and implement inquiry lessons and better able to answer students' questions in a way that connects with students' prior experience (Luera & Otto, 2005).

Pre-service Science Teacher Education in the Saudi Arabian Context

Saudi Arabia was founded in 1932. As the birthplace of Islam, this country holds considerable religious significance; it also possesses a great deal of petroleum-based wealth. Reforming higher education in Saudi Arabia (Hamdan Alghamdi & Alsalouli, 2013) has been at the centre of attention in recent years. In 1989, the Ministry of Education (MOE) established 18 teacher colleges, with goals that included the preparation of new student teachers and the provision of professional development for in-service teachers. PSTs in these teacher colleges must complete general academic courses, courses in professional education, and additional credit hours in courses on their major areas of study (Ministry Agency of Teachers' Colleges as cited in Hamdan Alghamdi, 2015). Almost

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

all teacher education programmes in Saudi Arabia are structured in a similar way and involve two semesters of theoretical courses and eight to 10 weeks of practicum in the second semester. Depending on their field of study (whether BA or BSc), the PSTs attend micro-teaching seasons, take methods courses (e.g., science, math, religion, literature, social studies) and teach their various subjects in schools for eight to 10 weeks.

Research Problem and Questions

Based on a review of the literature associated with science teachers' education in general and science teachers' education in Saudi Arabia in particular, it appeared that little is known about the beliefs these teachers hold about science. Few studies have examined the belief system of PSTs from the perspective of a science methods course, and there seems to be a lack of focus on how teachers' beliefs about science are formed. Research in this area is necessary because there is an increasing demand for preparing science teachers, improving their teaching skills, and increasing their understanding of the nature of science.

The beliefs and perspectives of pre-service and in-service science teachers play a critical role in shaping their learning. This research attempted to better understand teachers' perspectives and the influence of a science methods course on such perspectives. In particular, this research examined the impact of teachers' beliefs regarding their own self-efficacy, methods and strategies for teaching science, and the content and nature of science. The study was guided by the following research questions:

Research Question 1: What science teaching beliefs are currently held by female Saudi-Arabian PSTs studying for a post-graduate diploma in education at Imam Abdulrahman Bin Faisal University (IAU)?
Research Question 2: What impact does a science methods course have on the beliefs of these female PSTs?

Research Methodology

Science Methods Course Context

This research involved female PSTs (i.e., teacher candidates) who were enrolled in a science methods course titled "Science Teaching in the 21st Century" within their diploma of education programme. This course covered half a year (i.e., one 16-week semester) and provided two credits (total 32 contact hours per semester). It required the PSTs to spend two hours in their practicum and three hours in the classroom per week. According to the schedule, this course addressed science teaching (Table 1) before the practicum. The course introduced the PSTs to science concepts that might arise during their practicum, provided them with an understanding of how to develop SCK using creative and critical thinking, and taught them how to promote an understanding of SCK through problem solving. Furthermore, the PSTs were given opportunities to apply scientific and critical thinking in the context of teaching science. Within a teaching context, the PSTs were encouraged to use constructivist ways of teaching, such as the "Five E's" model (Engage, Explore, Explain, Elaborate, Evaluate) and to reflect both on how learners use scientific concepts and how teachers plan and evaluate concepts. Overall, the course focused on promoting PSTs' self-efficacy, their science teaching methods and strategies, and their SCK in order to allow them to develop adequate pedagogical knowledge of and positive beliefs about science teaching.

Table 1. Content of the 16-week science methods course.

Week	Content
1	Requirements for preparing a science teacher
2	Planning for science education
3	Evolution of concepts in science: how to acquire it, how to develop a concept, and how to promote it through problem solving
4	Scientific thinking: the concept of thinking, creative thinking and critical thinking

https://doi.org/10.33225/jbse/19.18.19

Week	Content
5	Applications of scientific and critical thinking in teaching science (part 1)
6	Applications of scientific and critical thinking in teaching science (part 2)
7	Applications of teaching and learning theories in science teaching
8	Constructivism in science education: the "Five E's" model
9	Constructivism in science education: deduction methods
10	Constructivism methods in teaching science: the induction method
11	Basic rules of science and the scientific way of thinking (how learners use scientific concepts and how the teacher plans and evaluates concepts): basic concepts and skills in science, discovery and exploration.
12	Basic science skills: observation, sensory use, graphics, comparison, classification, measurement, expression of results, reasoning, prediction, asking default questions, understanding the relationship between objects, identifying and controlling variables, and using scientific tools to obtain information
13	Assessment of learning outcomes in the science curriculum
14	Models of activities: methods and methods of science education (part 1)
15	Models of activities: methods and methods of science education (part 2); reading and libraries, scientific exhibitions, trips and scientific visits, associations and scientific clubs
16	Models of activities: methods and methods of science education; radio and press school, lectures and scientific seminars

Sample

Potential respondents were informed of the research study through an informative letter and were asked to participate. They were given the right to refuse participation or withdraw from the research if desired, with no consequences. They were ensured of confidentiality and informed that ethical measures would be taken. For example, their responses were not recorded under their names, so the results had no impact on their course marks or final grades in the diploma of education programme. Ultimately, data were collected from 47 female participants enrolled in the diploma of education programme at IAU, ranging in age from 26–44 (reflecting the lack of access to male counterparts). For clarification, education in Saudi Arabia is gender segregated so female professors (i.e., authors of this study) have access to female students and are not allowed to teach male students.

Instrument and Procedures

The researchers developed a data-collection instrument – a questionnaire in the form of a science beliefs scale – and used it to collect data about PSTs' beliefs regarding their science teaching efficacy, science teaching strategies and science content. The questionnaire, titled "Science Teaching Beliefs," was constructed according to the following three steps.

1) **Identifying the themes of the questionnaire.** A review of the existing literature on this topic revealed a wide range of different measures that have been used to examine science teaching beliefs. For example, Ambusaidi and Al-Baloushi (2012) and Bakir (2016) both examined teaching beliefs using three approaches: a direct (explicit) approach, a discovery approach and a conceptual approach. On the other hand, Sahin, Deniz, and Topçu (2016) adopted three rationales for beliefs; namely, knowledge beliefs, beliefs regarding learning methods and techniques, and teachers' beliefs regarding learning concepts. Saylan, Armagan, and Bektas (2016) have identified more detailed rationales for science teachers' beliefs, which included simple knowledge and real knowledge beliefs, beliefs about how the quick assimilation of science occurs, and beliefs about the innate abilities of a learner that cause learning to occur. Within the same detailed orientation of beliefs, Alabdulkareem (2016) has adopted a typology of beliefs

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

divided into five dimensions: instruction, teaching, teaching objectives, key teaching practices, and learners' error-correction strategies. In contrast, other studies, such as that by Ibrahim (2012), focused on the qualitative aspect of teachers' beliefs, including science teachers' beliefs regarding observation, inference, the laws of science, scientific theories, and the nature of scientific knowledge. This qualitative perspective is consistent with Al-Jazaeri's (2009) research, which addresses teachers' beliefs by focusing on the nature of science, scientific knowledge, instruction, and learning.

After reviewing the orientation of these previous studies, the researchers chose to examine science teachers' beliefs within the following three themes:

- *Theme 1: Beliefs regarding their own self-efficacy*
- *Theme 2: Beliefs regarding science teaching methods and strategies*
- *Theme 3: Beliefs regarding science content knowledge*

This structure covers the components that were investigated by the above-mentioned existing studies but re-classifies them into three themes. For example, the components of instruction, teaching and teaching objectives (Alabdulkareem, 2016) was merged into *Theme 2: Beliefs regarding science teaching methods and strategies*. Similarly, the components of simple and real knowledge of science (Saylan et al., 2016) and the nature of science (Ibrahim, 2012; Al-Jazaeri, 2009) were merged into *Theme 3: Beliefs regarding science content knowledge*. In addition, the three themes within the chosen typology are compatible with the simple educational experience of the study population – namely, the experience of female PSTs studying for a post-graduate diploma in education in the Eastern province in Saudi Arabia.

2) **Building the questionnaire items.** In the questionnaire, each theme comprised 30 items that were graded by the respondents using a 5-point Likert scale as follows:

- 5: Strongly agree
- 4: Agree
- 3: Neither agree nor disagree
- 2: Disagree
- 1: Strongly disagree

The 30 items (which were not posed as questions) were appropriately phrased to ensure that they were understandable to the respondents. The higher the rating to each questionnaire item, the more closely the respondents' beliefs aligned with the desired pedagogical perspective, that being "constructivist." Furthermore, the 30 items focused on real and relevant issues involving beliefs that must be a concern for science teachers.

3) **Verifying the validity and reliability of the questionnaire.** The content of the questionnaire was verified by having four professors in the field of curricula, teaching methods and science assess the instrument in terms of the following criteria: the accuracy of the wording, clarity of drafting, and linking of each item to a single theme among the three main themes. The instrument was then modified based on the experts' observations. It should be mentioned here that the questionnaire was constructed and validated after reading and analysing the international literature on PSTs' beliefs.

Also, Cronbach's alpha was calculated, and the parameter value was found to be .81 based on the 30 statements (items) within the questionnaire. This value indicates that the questionnaire is stable and applicable to the community targeted in the research. Table 2 clearly shows that the correlation coefficient values was positive and statistically significant at the .05 level, which is an indication of instrument internal consistency.

https://doi.org/10.33225/jbse/19.18.19

Table 2. Correlation coefficient between the three themes in the questionnaire and the overall degree of respondents' beliefs.

Item	Theme	Beliefs regarding their own self-efficacy	Beliefs regarding science teaching methods and strategies	Beliefs regarding science knowledge	Total
1	Beliefs regarding their own self-efficacy				
2	Beliefs regarding science teaching methods and strategies	.550*			
3	Beliefs regarding science knowledge	Decline from .381*	.397*		
4	Total	.767*	.891*	.699*	

** Mean significance at the level of (.05)*
*** Mean significance at the level of (.01)*

Data were collected before the science methods course, and then collected again after the course for comparison.

Data Analysis

To collect data for the first research question, the respondents were asked to complete the questionnaire prior to taking the abovementioned course titled "Science Teaching in the 21st Century" (see Table 1). Using the questionnaire, data were gathered on the PSTs' beliefs regarding their own self-efficacy, science teaching methods and strategies, and SCK. The researchers calculated both the respondents' average response per item and their responses for all items in the questionnaire using a 5-point Likert scale, which ranged from 1 (strongly agree) to 5 (strongly disagree). The average response was calculated by first calculating the range according to the following relationship:

$$\text{Range} = \text{Number of categories} - 1$$

The value of the range is 4. The length of the category was specified using the following equation:

$$\text{Length of category} = \text{Range}/\text{Number of categories}$$

The value of the category length is 0.80. Thus, the categories used to interpret the values of the average response for each belief item on the questionnaire were specified as follows:

- *Average ranging from 4.21–5.00:* Beliefs that the research group strongly agrees with, on average
- *Average ranging from 3.41–4.20:* Beliefs that the research group agrees with, on average
- *Average ranging from 2.61–3.40:* Beliefs that the research group neither agrees nor disagrees with, on average
- *Average ranging from 1.81–2.60:* Beliefs that the research group disagrees with, on average
- *Average ranging from 1–1.80:* Beliefs that the research group strongly disagrees with, on average

A factor analysis was not carried out because the three themes were not directly interrelated, per insights from the literature review. However, a *t* test was applied due to the interrelation of the independent variables. The internal consistency of the questionnaire was verified by calculating the correlation coefficient between the three themes and the "overall agree" using an exploratory sample of 25 PSTs within the diploma of education programme at IAU. The results of the correlation coefficient calculation are provided in Table 2. Data were analyzed using SPSS Statistics software.

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Research Results

Table 3 summarizes the overall results obtained when 47 Saudi female PSTs enrolled in the diploma of education at IAU completed the questionnaire *prior* to taking the course titled "Science Teaching in the 21st Century" (see Table 1). With an average score of 3.07 (neither agree nor disagree), the respondents' ratings of the three themes in the questionnaire were ordered as follows. Theme 3 (science knowledge) had the highest rating, with an average of 3.18. Theme 1 (self-efficacy) had an average rating of 3.08 and Theme 2 (teaching methods and strategies) had the lowest rating, with an average score of 2.95. All ratings fell within the neither agree nor disagree category, with scores ranging from 2.95–3.18. Also, the PSTs in this research held similar beliefs regarding each of the three themes, with no considerable or clear difference relative to self-efficacy, teaching methods and strategies, or science content knowledge.

Table 3. General average ratings for the three themes associated with PSTs beliefs about teaching science.

Item	Theme	Mean	Mean (%)	Category of mean
1	Beliefs regarding their own self-efficacy	3.08	62	Neither agree nor disagree
2	Beliefs regarding science teaching methods and strategies	2.95	59	Disagree
3	Beliefs regarding science knowledge.	3.18	64	Neither agree nor disagree
General mean ratings for Themes 1, 2 and 3 by female pre-service science teachers		3.07	61	Neither agree nor disagree

The following section provides a detailed account of the results for each of the three themes per the first research question, which was concerned with their beliefs *before* completing the science methods course (see Table 1).

Theme 1: Beliefs Regarding Their Own Self-efficacy (Pre-enrolment)

Table 4 profiles the results for Theme 1, the PSTs' beliefs regarding their own self-efficacy as science educators assessed before taking the course. First, the general average score for theme 1 was 3.08 out of a total value of 5, reflecting the neither agree nor disagree category. Second, none of the items within the first theme fell within the category of strongly agree. Respondents rated four items (40%) as agreed (items 1 through 4), three items (30%) as neither agree nor disagree (items 5 through 7), and three items (30 %) as disagree (items 8 through 10).

Table 4. Ordered average ratings for 10 items in Theme 1 (pre- and post enrolment).

	Theme 1 - Beliefs regarding their own self-efficacy	Before the course		After the course	
		Mean	Category of mean	Mean	Category of mean
1	Achieving apparent improvement in the level of learners is attributed to the effort exerted by the teacher in teaching sciences.	4.17	Agree	4.34	Strongly agree
2	Accurately implementing scientific experiments is a skill to be mastered by a science teacher.	3.89	Agree	4.15	Agree
3	Implementing the images related to science inside the classroom affects the learners' understanding and comprehension.	3.70	Agree	3.89	Agree
4	Linking science concepts to real-life applications is a simple task for a science teacher.	3.55	Agree	3.81	Agree
5	Difficulties related to working out the applications and problems of teaching science are attributed to a science teacher's lack of skills.	2.98	Neither agree nor disagree	3.55	Agree

https://doi.org/10.33225/jbse/19.18.19

	Theme 1 - Beliefs regarding their own self-efficacy	Before the course		After the course	
		Mean	Category of mean	Mean	Category of mean
6	Developing the high-order thinking skills related to teaching science is difficult.	2.79	Neither agree nor disagree	2.79	Neither agree nor disagree
7	Motivating learners to study science content is difficult for a science teacher.	2.64	Neither agree nor disagree	2.34	Disagree
8	It is difficult to manage the classroom while explaining science because of discussions and carrying out activities.	2.51	Disagree	2.53	Disagree
9	Overcoming the learners' learning difficulties related to the study of science is not an exhausting activity for the science teacher.	2.45	Disagree	2.61	Neither agree nor disagree
10	Developing the learners' attitudes towards studying sciences is achieved at a weak rate.	2.15	Disagree	2.40	Disagree
	General mean	3.08	Neither agree nor disagree	3.24	Neither agree nor disagree

Theme 2: Beliefs Regarding Science Teaching Methods and Strategies (Pre-enrolment)

Table 5 profiles the results for Theme 2 – beliefs regarding science teaching methods and strategies before completing the science methods course. The overall average rating for this theme was 2.95 out of 5 (neither agree nor disagree). Three items (30%) were rated as strongly agree or agree (items 1, 2 and 3). Three were rated as neither agree nor disagree (items 4, 5 and 6). Two items were rated as disagree (items 7 and 8) or strongly disagree (items 9 and 10), four in total.

Table 5. Ordered average ratings for the 10 items in Theme 2.

	Theme 2 - Beliefs regarding science teaching methods and strategies	Before the course		After the course	
		Mean	Category of mean	Mean	Category of mean
1	The impact of life applications on the learners' understanding of science is clear.	4.30	Strongly agree	4.15	Agree
2	Giving the learner the opportunity to build his/her own knowledge through studying science is important to achieve meaningful learning.	4.13	Agree	4.17	Agree
3	Assimilating and understanding the laws of the science subject is achieved by inferring the specific example of the laws.	3.72	Agree	3.57	Agree
4	Providing the learners with knowledge and skills prior to introducing scientific concepts clearly affects their assimilation.	3.23	Neither agree nor disagree	3.38	Neither agree nor disagree
5	Individualizing learning is an important requirement in teaching science because of the clear variation in the levels of learners.	3.17	Neither agree nor disagree	3.34	Neither agree nor disagree
6	Depending on group work s will clearly affect the learners' assimilation and understanding.	3.13	Neither agree nor disagree	3.32	Neither agree nor disagree
7	Teaching science through indirect experiences is most useful for saving time.	2.30	Disagree	2.15	Disagree

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Theme 2 - Beliefs regarding science teaching methods and strategies		Before the course		After the course	
		Mean	Category of mean	Mean	Category of mean
8	Real learning of science occurs through the teacher assuming the major role of explaining the lesson because of the poor and low level of the learners.	2.19	Disagree	2.06	Disagree
9	A teacher implementing the scientific experience by himself or herself wastes much time without achieving a tangible result.	1.79	Strongly disagree	1.77	Strongly disagree
10	Giving the learners the opportunity to try self-learning in science is not clearly useful.	1.57	Strongly disagree	1.91	Disagree
General mean		2.95	Neither agree nor disagree	2.98	Neither agree nor disagree

Theme 3: Beliefs Regarding Science Content Knowledge (Pre-enrolment)

Still focused on the first research question, Table 6 profiles the results for Theme 3 – beliefs regarding science content knowledge, before taking the course. The overall average rating for Theme 3 was 3.18 out of 5 reflecting the neither agree, nor disagree category. No item was rated as strongly agree, but two items (20%) were rated as agree (items 1 and 2). The majority (60%, *n*=6) of items were rated as neither agree nor disagree (items 3, 4, 5, 6, 7 and 8). Two items were rated as disagree (items 9 and 10).

Table 6. Ordered average ratings for the 10 items in Theme 3.

Theme 3 - Beliefs regarding science content knowledge		Before the course		After the course	
		Mean	Category of mean	Mean	Category of mean
1	The focus of science textbooks on the application of life skills and classroom activities is more important than theoretically elaborating on the topics.	4.17	Agree	4.32	Strongly agree
2	Parents believe in the difficulty of the science subject content.	3.91	Agree	3.83	Agree
3	Precisely identifying learners' learning difficulties of science is a complex task because of the nature of science content.	3.34	Neither agree nor disagree	3.06	Neither agree nor disagree
4	Teaching practical skills is easier than teaching scientific concepts.	3.34	Neither agree nor disagree	3.34	Neither agree nor disagree
5	Implementing classroom activities related to science is easier than implementing them in other courses.	3.32	Neither agree nor disagree	3.13	Neither agree nor disagree
6	More students tend to study science subjects rather than theoretical courses.	3.23	Neither agree nor disagree	3.36	Neither agree nor disagree
7	Teaching science is more difficult than teaching other subjects.	2.79	Neither agree nor disagree	2.91	Neither agree nor disagree
8	Building scientific tests to measure learners' achievement in science is a simple task due to the diversity of science content.	2.72	Neither agree nor disagree	2.94	Neither agree nor disagree
9	Reading the science content textbooks is a simple task for students and occurs without suffering.	2.57	Disagree	2.57	Disagree
10	Preparing the teaching aids of science-related subjects is more difficult compared with other subjects.	2.40	Disagree	2.57	Disagree
General mean		3.18	Neither agree nor disagree	3.20	Neither agree nor disagree

https://doi.org/10.33225/jbse/19.18.19

Results for Research Question 2 (Comparing pre- and post-enrolment)

To verify the effectiveness of the science methods course (see Table 1) in modifying the science teaching beliefs held by female pre-service science teachers at IAU in Saudi Arabia, the questionnaire administered before the course was re-administered after they had completed the course.

Theme 1: Beliefs Regarding Their Own Self-efficacy after Completing the Course

Table 7 shows the results of a *t* test comparing the average ratings for the 10 items in Theme 1 before and after the course. With $t = 2.792$, it is evident that there is a significant difference between the pre- and post-course averages regarding beliefs associated with self-efficacy (with 46 degrees of freedom and a significance level of .01). A detailed comparison was then performed in order to infer the impacts of the course on the participants' beliefs in relation to their own self-efficacy when teaching science. These results, outlined in Table 4, clearly demonstrate a change in the responses for virtually all the items in Theme 1, the exception being item 6, "Developing high-order thinking skills associated with teaching science is difficult." Of the nine item scores that did change, four changed categories (items 1, 5, 7, and 9). PSTs either gained more certainty (moving from **neither agree or disagree** to **agree** or **disagree**, items 7 and 5 respectively and moving from **agree** to **strongly agree** for item 1) or lost certainty (changing from **disagree** to not sure (**neither agree nor disagree**) (item 9).

Table 7. *t*-test results comparing Theme 1 item ratings before and after completing the course.

Application	Number of participants	Mean	*SD*	*df*	*t* value	*p*
Before course	47	30.82	3.749	46	2.792	.008
After course		32.40	3.411			

Theme 2: Beliefs Regarding Science Teaching Methods and Strategies After Completing the Course

Table 8 shows the results of a *t* test comparing the average ratings for the 10 items in Theme 2 before and after the course. The t value ($t = .347$) is not statistically significant at 46 degrees of freedom and a significance level of .05. Thus, there are no statistically significant differences between the pre- and post-course averages regarding beliefs related to science teaching methods and strategies. However, a minuscule change (increase) occurred from an average rating of 29.53 in the first application to 29.82 in the second application. A detailed comparison was then performed in order to infer the impacts of the course on the respondents' beliefs in relation to science teaching methods and strategies (see Table 5). There was an increase in average numerical ratings for five (50%) items (items 2, 4, 5, 6 10) but only one item changed categories, with item 10 moving from **strongly disagree** to **disagree**.

Table 8. *t*-test results for comparing Theme 2 item ratings before and after completing the course.

Application	Number of participants	Average of the sum of the ratings	*SD*	*df*	*t* value	*p*
Before course	47	29.53	5.025	46	.347	.730
After course		29.82	3.583			

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Theme 3: Beliefs Regarding Science Content Knowledge after Completing the Course

Table 9 shows the results of a *t* test comparing the average ratings for the 10 items in Theme 3 before and after the course. A t value of t = 0.357 is not statistically significant at 46 degrees of freedom and a significance level of .05. Thus, there were no statistically significant differences between the pre- and post-course averages regarding beliefs related to science content knowledge. However, a change is noticeable from an average rating of 31.80 in the first application to 32.04 in the second application. A detailed comparison was then performed in order to infer the impacts of the course on the participants' beliefs in relation to their beliefs regarding science content knowledge (see Table 6). There was an increase in numerical scores for five (50%) of the SCK belief items (items 1, 6, 7, 8 and 10) but only one item changed categories, with item 1 moving from **agree** to **strongly agree**.

Table 9. *t*-test results for comparing Theme 3 item ratings before and after completing the course.

Application	Number of participants	Average of the sum of the ratings	*SD*	*df*	*t* value	*p*
Before course	47	31.80	3.468	46	.375	.709
After course		32.04	3.764			

Results: Overall Impact of the Science Methods Course on PSTs' Science Teaching Beliefs

Table 10 provides the results of a *t* test comparing the average ratings the PSTs provided for the questionnaire's 30 items as a whole, before and after the course. A t value of t = 1.336 indicates no statistically significant differences between the pre- and post-course averages regarding beliefs related to science teaching in general (at 46 degrees of freedom and a significance level of .05). Nonetheless, an overall increase in the ratings on the questionnaire items prior to the course may be seen relative to the ratings given afterwards, increasing about two points from 92.17 to 94.27.

Table 10. *t*-test for comparing overall results before and after PSTs took the course.

Application	Number of participants	Average of the sum of the ratings	*SD*	*df*	*t* value	*p*
Before course	47	92.17	8.947	92	1.336	.188
After course		94.27	7.930			

Discussion

The discussion section begins with the import of the results for question one (organized by the three themes of self-efficacy, teaching methods and strategies, and science content knowledge). This question focused on the PSTs' beliefs *before* completing the science methods course (see Table 1). Then, the discussion turns to the results for question two, which was focused on the effectiveness of the science methods course in modifying the beliefs held by female PSTs at IAU in Saudi Arabia. In short, before taking the course, the PSTs presented beliefs characterized as neither agree nor disagree (mean= 3.08), indicating a mental stance of uncertainty about their self-efficacy, their beliefs about how to teach science and science content. *After* taking the course, the overall score was still within the neither agree nor disagree category. The PSTs' scores for self-efficacy improved statistically but not so for science teaching methods or science content. The course was somewhat effective with room for improvement.

https://doi.org/10.33225/jbse/19.18.19

Theme 1: Beliefs Regarding Self-efficacy (Pre-enrolment)

Table 4 profiles the results for Theme 1, the PSTs' beliefs regarding their own self-efficacy as science educators assessed before taking the course. On average, they indicated ambivalence around this issue, with a general average of 3.08 (neither agree nor disagree). The PSTs in this study had spent one year on post-graduate studies (only one semester for this 16-week course), meaning their teaching experiences were limited. A general self-efficacy score of 3.08 reflects this inexperience. These results are supported by earlier studies that reported first-level PSTs having lower self-efficacy than the more experienced fourth-level PSTs (Aslan, Tas, & Ogul, 2016; Uyanik, 2016). Overall results could suggest that these Saudi female PSTs lacked confidence regarding their efficacy as science teachers. It could be disempowering to feel incapable of producing a desired result when teaching science (i.e., low self-efficacy). Teachers with higher levels of efficacy believe they can control, or at least strongly influence, student achievement and motivation (Tschannen-Moran, Hoy, & Hoy, 1998).

In particular, three specific items scored as neither agree or disagree (items 5, 6 and 7). These pertained to difficulties around (a) working out the applications and problems (activities) of how to teach science, (b) developing students' higher order thinking skills, and (c) motivating learners to study science. Not being sure about whether these tasks will be difficult speaks to their immaturity as educators and their perceived skill sets. The more experienced the science teacher, the higher their self-efficacy (Aslan et al., 2014; Uyanik, 2016). Feeling inadequate in improving student motivation and performance (item 7) would lower self-efficacy because these two factors are powerful motivators for teacher behaviour and efficacy (Tschannen-Moran et al., 1998).

The significance of this result can be further interpreted using a recent Spanish study. Arce, Bodner, and Hutchinson (2014) compared the viewpoints of a "conventional" group of teachers with those orientated towards developing and upgrading their science teaching methods ("correctional" teachers). Their research showed that ideal science teaching practices (item 5) are those that are centred on the involvement of learners in both scientific and discovery activities, which inherently develop learners' high-level thinking skills (item 6), as they involve an examination of the real-life applications of science (item 4); hence, such activities motivate learners to study science (item 7).

None of the ten items for Theme 1 scored strongly agree but four scored agree (items 1, 2, 3 and 4). Together, these items reflect a distinct sense of competency on the part of the teachers. They agreed that their teaching efforts influence student academic improvement as does implementing images related to science when teaching. They agreed that it is easy to link science concepts to real life and that teachers must know how to accurately implement science experiments. One interpretation of these results is that most of the items scored as agree pertain to a focus on the learner rather than the teacher. This interpretation is compatible with existing studies that show a positive correlation between a science teacher's ability to make the learner the focal point and their belief in their own self-efficacy in teaching. Bakir (2016) pointed out that discovery teaching in science (i.e., experiments, real-life applications, and imagery, items 2, 3 and 4) is more acceptable for students than direct teaching or conceptual teaching. And, Aydogdu and Peker (2016, p. 20) asserted that "there is a relationship between the science teachers' beliefs … with regard to their teaching efficiency and the teaching activities which are learner-centred, and which are practiced inside the classroom."

The respondents disagreed with three items related to self-efficacy (items 8, 9 and 10). The PSTs disagreed that they were ineffective in developing learners' attitudes towards studying science; in other words, they felt they were effective. They did not think it was difficult to carry out classroom management activities while facilitating discussions and other activities. But they did feel that overcoming learners' learning difficulties is exhausting. It might be naïve for PSTs to perceive classroom management and developing students' attitudes towards studying science as easy tasks. This might be an instance of misplaced self-efficacy given that first-level PSTS have been found to have lower self-efficacy than more experienced fourth-level PSTs (Aslan, Tas, & Ogul, 2016; Uyanik, 2016).

Theme 2: Beliefs Regarding Science Teaching Methods and Strategies (Pre-Enrolment)

Table 5 profiles the results for Theme 2, the PSTs' beliefs regarding science teaching methods and strategies assessed before taking the course. First, the respondents gave an overall average rating of 2.95 out of 5 for this theme. At first glance, the numerical value 2.95 indicates that they generally rated items under this theme in the disagreement category. But this apparent negative finding is contradicted when the items are reframed from their original wording. The four items rated disagree or strongly agree (items 7, 8, 9 and 10), in concert with the three

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

rated agree and strongly agree (items 1, 2 and 3), actually represent the PSTs' inclination to value student-centred, constructivist learning.

Students explicitly agreed that (a) life applications have a visible impact on learners (item 1), (b) it is important to allow students the chance to build their own knowledge (item 2) and (c) students can assimilate and learn science concepts if they experience the chance to make inferences (item 3). Reframing disagree and strongly disagree items reveals, indirectly, that PSTs felt (d) teaching science thorough indirect experiences does not save time, (e) teacher-centered education does not ensure real learning (item 8), (f) students do learn when teachers implement science experiences (item 9), and (g) facilitating self-learning is useful (item 10).

Items scored as strongly agree or agree (items 1, 2 and 3) may be examples of teaching strategies that reflect constructivist thinking, which is beyond conventional teaching techniques. Sahin et al. (2016) revealed a correlation between the constructivist conception of science teaching and PSTs' epistemological beliefs regarding science content, which are reflected in their teaching methods and strategies. They concluded that epistemological beliefs and conceptions of learning are important factors in PSTs' conceptualizations of teaching science (see also Saylan et al., 2016). Bursal (2012) reported that positively developing teachers' beliefs towards science teaching can occur through qualitative training in the main skills of science, including the key skills of inquiry and simple practical experiments.

The researchers consider the items scored as neither agree nor disagree (items 4, 5, and 6) to be closely related to a PST's skill in diversifying the techniques of teaching science for individualized or group activities. These PSTs may be unable to agree or disagree on these particular items because they lack teaching experience and need more training. Alabdulkareem (2016) has reported that science teachers' beliefs about key concepts were closely related to science teaching strategies such as instruction, teaching, teaching objectives, key teaching practices, and learners' error-correction strategies. All of these strategies are affected by the science teachers' beliefs about science teaching methods.

As a general observation, Wong (2016) showed that two-year training provided to science teachers through an online post-graduate programme caused positive and tangible modifications in teachers' beliefs regarding the effective teaching of science and how teaching is centred on the learner. The science teachers in his study underwent positive changes in their beliefs, changes that were unaffected by the number of years of experience. This finding implies that effective and planned training is a very important factor in convincing Saudi pre-service science teachers to adjust incorrect or affirm vacillating beliefs regarding effective teaching strategies.

Theme 3: Beliefs Regarding Science Content Knowledge (Pre-enrolment)

Table 6 profiles the results for Theme 3, the PSTs' beliefs regarding science content knowledge, assessed before taking the course. The general overall rating for this theme was 3.18 out of 5, meaning neither agree nor disagree. Sixty percent (*n*=6) of the items scored in this category. Being in a state of ambivalence about their beliefs around science content knowledge is not surprising given that the PSTs had yet to take the science methods course titled "Science Teaching in the 21st Century" (see Table 1). Ambivalent means uncertain due to mental conflict. At this stage, they appeared to not have adequately examined their beliefs around science content knowledge.

In particular, the scores for items 3 through 8 ranged from 2.72-3.34, meaning the PSTs were not sure if they agreed or disagreed with these statements. Issues captured within these items pertained to the *ease* of (a) identifying students' learning difficulties vis-à-vis science content (item 3), (b) teaching science concepts relative to practical skills (item 4), (c) implementing science classroom activities (item 5), (d) teaching science compared to other subjects (item 7), and (e) creating assessment tools and tests (item 8). PSTs were also not sure about whether more students study science than theoretical courses (item 6). Not knowing their stance on such fundamental aspects of science content knowledge has the potential to handicap future science teaching.

In more detail, science content knowledge (SCK) has been shown to affect PSTs' confidence and self-efficacy (Schoon & Boone, 1998). Furthermore, we consider that rating these six items as neither agree nor disagree indicates that the PSTs are vacillating around their beliefs of whether science content knowledge is difficult to teach, learn and assess. Discussing the notion of accuracy of beliefs about science content knowledge, Tarmo and Bevins (2016) showed that science teachers hold common inaccurate beliefs about the nature and content of science. They concluded that these 'inaccurate' beliefs can negatively affect teaching science practices. We hold that 'ambiguous' beliefs can also have negative consequences.

https://doi.org/10.33225/jbse/19.18.19

Some of our results can be explained somewhat using Ambusaidi and Al-Baloushi's (2012) work. They performed research within an Arabian environment in the Sultanate of Oman involving candidate teachers who were to be employed as science teachers. They reported that candidate teachers' belief in conceptual and direct teaching ranked higher than their belief in discovery teaching, because conceptual teaching is theoretical in nature and thus exempts the teacher from exerting much teaching effort (see also Bakir, 2016). The PSTs in our study were not sure about the ease of teaching science concept knowledge (items 4, 5, and 7), perhaps because of its complex nature (item 3). Yet, puzzlingly, they agreed that science textbooks should eschew theory and focus on life skills applications (item 1, Table 6) (i.e., eschew conceptual teaching).

Two items were scored agree (items 1 and 2). Respectively, the PSTs agreed that it is more important for science textbooks to cover topics by focusing on the application of life skills instead of theoretically elaborating on topics. They also believed that parents appreciated the difficultly of science content and knowledge. Along similar lines of thought, the PSTs disagreed that it was easy for students to read the science content in textbooks (item 9) and they did not believe it was easy to prepare science-related teaching aids (item 10).

By way of explanation, science teachers form their beliefs as a result of societal factors, and such factors make each society unique. Regarding science-related beliefs, Ozfidan, Cavlazoglu, Burlbaw, and Aydin (2017) reported differences between science teachers' beliefs in the United States and Turkey. Accordingly, the beliefs of the PSTs in this research may, well be attributed to societal viewpoints on the difficulty of science content. Also, the belief that the knowledge taught in a science class is difficult, and that parents firmly hold this belief, may reflect negatively on students' futures because it may hinder their learning and influence any progress in choosing science streams and professions.

The ratings for items 9 and 10 (disagree) imply that respondents considered it difficult to communicate using the language of SCK, whether in students' reading or in the use of teaching aids that convey and translate scientific concepts. This result could be attributed to the PSTs' lack of experience with academic science content from a pedagogical perspective. They had not yet taken the science methods course (see Table 1). This result aligns with Sahin et al.'s (2016) work. They performed a forecasting study with primary education science teachers in Turkey and reported that epistemological beliefs were key predictors of science teachers' beliefs regarding SCK, along with their beliefs about the methodology and concepts of science learning.

General Comments on Research Question One (Pre-enrolment)

Per Table 3, the fact that there was no considerable or clear difference between beliefs held for self-efficacy, teaching methods and strategies, or science content knowledge can be attributed to the respondents' lack of teaching experience, such that their perspective on science-related beliefs is formed more through their learning experiences as science students in their first degree than through their experiences as pre-service science teachers (Diploma in Education). Since the respondents had only spent one year on post-graduate study (i.e., in teacher education program), their self-efficacy was still not high enough. The low score for beliefs regarding science teaching methods and strategies is acceptable from a logical standpoint, given that these beliefs are technical and require specialized study. The PSTs in this research are in need of a science methods course.

These observations align with findings from existing studies indicating that the initial beliefs of PSTs – before they complete academic or qualitative programmes focused on the professional preparation of a pre-service science teacher – are inaccurate or unexamined and likely based on personal conceptions. In fact, this generalization also applies to many in-service science teachers. Saylan et al. (2016) reported a correlation between the epistemological beliefs of PSTs and their conceptions of the learning environment. Epistemological beliefs form from several sources including: simple knowledge and real knowledge of science, how quickly science assimilation occurs, and the innate capabilities and faculties of the learner and their impact on science learning. This viewpoint is consistent with Yenice's (2015) findings. He showed, through a forecasting study, that the key rationales held by PSTs include a belief that science learning depends on trial and error, the abilities of learners, and the nature of the science content. It is the researchers' opinion that all of these beliefs position success in science teaching as relying on variables for which the PSTs do not bear clear responsibility.

The discussion now shifts to address the import of any changes in Saudi female PSTs' beliefs about science teaching self-efficacy, methods, and content as a result of completing a science methods course (see Table 1), part of the Diploma of Education at the Imam Abdulrahman Bin Faisal University (IAU).

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Theme 1: Changes in Beliefs about Their Own Self-Efficacy After Completing the Course

There was a statistically significant difference between the pre- and post-course averages regarding beliefs associated with their own self-efficacy. This result is supported by previous research that confirmed science methods courses as a viable means for increasing efficacy in science teaching (Cantrell et al., 2003; Kim, 2012; Palmer, 2006). The only self-esteem belief item that did not change dealt with developing students' high-order thinking skills (item 6, Table 4). The PSTs still felt uncertain about whether it would be difficult for them to develop this skill set in students. Santos (2017) maintained that PST science education has largely disregarded critical thinking, opting instead for an emphasis on a traditional pedagogy. In contrast, the science methods course used in our research study intentionally incorporated critical thinking, with three weeks out of 16 set aside for this topic (see Table 1). It could be argued that a change in this belief would require science teachers to have more teaching experience and confidence in their teaching performance. It could also mean they need more or different instruction on how to instil critical thinking skills or more convincing of its merit. Demir (2015) affirmed that training teacher candidates in critical thinking is necessary if they are to appreciate its merits and apply it when teaching.

Of the nine Theme 1 item scores that did change, four changed categories. PSTs gained more certainty about the role their skill level plays in teaching science and they indicated that it is not as difficult to motivate students to study science as they formally believed. They also increased their belief that improvement in learning can be attributed to their teaching efforts. But they lost certainty around beliefs about how exhausting it is to overcome learners' learning difficulties. These four items tended to focus on the concept of difficulty, which means something requires a lot of effort to achieve, deal with or understand. Assessing the level of difficulty of a task before actually experiencing it is a challenge.

From another perspective, although results revealed tangible development between the pre- and post-course assessment of PSTs' beliefs about their own self-efficacy, this development could be attributed to the respondents considering that they had attained a proper level of teaching experience after the course, perhaps with a degree of exaggeration. This interpretation aligns with Saka, Bayram, and Kabapinar's (2016) work with final-year Marmara University teacher candidates, wherein they proposed that beliefs regarding high self-efficacy could be misplaced. This possibility should be considered in future research and course design.

Theme 2: Changes in Beliefs about Science Teaching Methods and Strategies After Completing the Course

Regarding beliefs about science teaching methods and strategies, there was an increase in average score ratings for half of the items (n=5) (items 2, 4, 5, 6 and 10 in Table 5) (not statistically significant). This moderate score increase may reflect the short duration of the course (16 weeks), as the development of beliefs associated with teaching methods and strategies requires deep academic learning and considerable classroom experience. The amount of time teachers spend in professional development courses and programs can impact their learning and teaching (Lumpe et al. 2012). But acquiring new beliefs is difficult (Pajares (1992), perhaps explaining the only moderate increase in beliefs, with most currently still held in disagreement.

The five items in question (with most scored as disagree) reflected at best nominal increases and were focused on both (a) the *effectiveness* of providing learners with knowledge and skills before the lesson, using group work, and enabling self learning; and (b) the *importance* of individualized learning, and providing learners with opportunities to build their own knowledge. Failing to appreciate the importance of these teaching strategies implies that these Saudi PSTs had not yet fully embraced the constructivist pedagogy, as is recommended by Simon et al. (2008). The constructivist science pedagogy can increase teachers' confidence in their teaching ability (Appelton, 1995).

Only one of these five items changed categories. The PSTs articulated lessening disagreement on the usefulness of giving learners self-learning opportunities, moving from strongly disagree to disagree. In effect, they still did not believe that it was useful to engage in this teaching strategy. However, movement away from strong disagreement on this belief is encouraging because research shows that self-directed learning is a key component of effective science learning. The NSTA (2003) believes science educators should use inquiry-based teaching strategies, which includes students engaging in self-learning.

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Theme 3: Changes in Beliefs about Science Content Knowledge After Completing the Course

Regarding beliefs about science content knowledge, nominal score increases were observed for half (n=5) of the items (items 1, 6, 7, 8 and 10 in Table 6) with most of these registering the sentiment of neither agree nor disagree (not statistically significant). The PSTs became slightly more uncertain about the difficulty of teaching science, preparing teaching aids, and creating assessment tools. As noted, assessing the level of difficulty of a task before actually experiencing it is a challenge. This may explain why they are still uncertain about their beliefs about these aspects of science content knowledge.

Only one belief item about science content knowledge changed categories, with item 1 moving from agree to strongly agree. Students became even more convinced that it was important for science textbooks to focus on the application of life skills and classroom activities rather than theoretically elaborate on science topics. This result implies that these Saudi PSTs favoured applied approaches to teaching instead of theoretical and conceptual. Eschewing the latter short changes students' understanding of science concepts since learning best happens with a combination of conceptual and practical (experiential) learning. To quote Duit and Tesch (2010), when teaching science, "*hands-on* needs to include *minds-on*" (p. 26). This includes textbooks.

From another perspective, their strengthened belief around textbooks may reflect an insufficiently developed scientific perspective required to accurately assess science textbooks. In particular, there is a strong epistemological structure among the concepts, facts, relationships and practical applications of SCK, which has been shown to affect PSTs' confidence (Schoon & Boone, 1998), in this case perhaps creating a false sense of confidence when it comes to assessing textbooks. Direct classroom experience is required in order to understand this structural relationship, and the PSTs in this research sample may not yet have sufficient experience to critically judge textbook resources.

Conclusions and Recommendations

Results for Theme 1 (beliefs regarding their own self-efficacy) were statistically significant. Respondents' scores indicated an increase in beliefs about their own self-efficacy after taking the course, although PSTs' scores still fell within the neither agree nor disagree category. Although increases were also observed for Theme 2 (beliefs regarding science teaching methods and strategies) and Theme 3 (beliefs regarding science content knowledge), they were slight and not statistically significant. General scores before and after the course fell within the neither agree nor disagree category for these themes as well. Two themes were found to be not statistically significant – science teaching methods and science content knowledge. Respectively, future science education course planners can be encouraged that in-service training can modify PSTs' beliefs about effective teaching methods. Teacher candidates' beliefs regarding the epistemological (knowledge) structure of science can also be modified through short-term micro-teaching.

Because teaching requires pedagogical content knowledge and knowledge of teaching strategies, it is imperative that science methods courses provide PSTs with learning opportunities to develop this aspect of practice. While respecting this imperative, the overall results of this study imply that it was difficult to establish a considerable and significant modification in Saudi female PSTs' beliefs over a short period of time. It may be that Saudi female PSTs require more or different instruction before they begin teaching science. Curriculum planners and PST instructors should take this into account when redesigning the course for future cohorts. Especially, they need to engage in evidence-based course development and heed best practices. And, longitudinal studies are encouraged so as to track science teachers' beliefs and actual practice in full-time employment. This recommendation applies to both male and female PSTs, with the latter the focus of our research.

As one of the first studies in Saudi Arabia on female PSTs' beliefs regarding science education, this research addresses a gap in the existing literature. The results and aforementioned recommendations are relevant to science education curriculum theorists, researchers, specialists and practitioners.

References

Alabdulkareem, S. (2016). The impact of science teachers' beliefs on teaching science: The case of Saudi science teachers. *Journal of Education and Learning*, *5*(2), 233-249.

Alghamdi Hamdan, A., & Alsalouli, M. (2012). Saudi elementary school science teachers' beliefs about teaching science in the new millennium. *International Journal of Science and Mathematics Education*, *11*(2), 501-525.

https://doi.org/10.33225/jbse/19.18.19

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Al-Jazaeri, K. (2009). Science teachers' beliefs at the second school stage in Damascus about the nature of science and scientific knowledge. *Proceedings of the Second Scientific Conference at the Educational Sciences College in Jerash University (Role of Arab Teacher in the Knowledge Flow Age)* [pp. 454-493]. Jordan, Jerash: College of Educational Sciences, Jerash National University.

Ambusaidi, K., & Al-Balushi, M. (2012). A longitudinal study to identify prospective science teachers' beliefs about science teaching using the draw-a-science-teacher-test checklist. *International Journal of Environmental and Science Education*, *7*(2), 291-311.

Anderson, R. D. (1997). The science methods course in the context of the total teacher education experience. *Journal of Science Teacher Education*, *8*(4), 269-282.

Andersen, A. M., Dragsted, S., Evans, R. H., & Sørensen, H. (2004). The relationship between changes in teachers' self-efficacy beliefs and the science teaching environment of Danish first-year elementary teachers. *Journal of Science Teacher Education*, *15*(1), 25-38.

Appleton, K. (1995) Student teachers' confidence to teach science: Is more science knowledge necessary to improve self-confidence? *International Journal of Science Education*, *17*, 3, 357-369.

Appleton, K., & Kindt, I. (2002). Beginning elementary teachers' development as teachers of science. *Journal of Science Teacher Education*, *13*(1), 43-61.

Arce, J., Bodner, M., & Hutchinson, K. (2014). A study of the impact of inquiry-based professional development experiences on the beliefs of intermediate science teachers about "best practices" for classroom teaching. *International Journal of Education in Mathematics, Science and Technology*, *2*(2), 85-95.

Aslan, D., Tas, I., & Ogul, G. (2016). Pre- and in-service preschool teachers' science teaching efficacy beliefs. *Educational Research and Reviews*, *11*(14), 1344-1350.

Aydogdu, B., & Peker, M. (2016). Science and mathematics teaching efficacy beliefs of pre-school teachers. *Universal Journal of Educational Research*, *4*(11), 2541-2550.

Bakir, S. (2016). What are their beliefs? What is their approach in practice? What is the profile of their science teachers and professors? *International Journal of Environmental and Science Education*, *11*(5), 587-602.

Bandura, A. (1997a). *Self-Efficacy: The Exercise of Control*. New York: Freeman.

Bandura, A. (1997b). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191-215.

Berland, L. K., & Reiser, B. J. (2009). Making sense of argumentation and explanation. *Science Education*, *93*(1), 26-55.

Bransford, J. D., Brown, A.L., & Cocking, R. R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience, and School.* Washington, DC: National Academy Press.

Bursal, M. (2008). Changes in Turkish pre-service elementary teachers' personal science teaching efficacy, beliefs and science anxieties during a science method course. *Journal of Turkish Science Education*, *5*(1), 99-112.

Bursal, M. (2012). Changes in American pre-service elementary teachers' efficacy beliefs and anxieties during a science methods course. *Science Education International*, *23*(1), 40-55.

Cantrell, P., Young, S., & Moore, A. (2003). Factors affecting science teaching efficacy of pre-service elementary teachers. *Journal of Science Teacher Education*, *14*(3), 177-192.

Cross, D. I. (2009). Alignment, cohesion, and change: Examining mathematics teachers' belief structures and their influence on instructional practices. *Journal of Mathematics Teacher Education*, *12*(5), 325-346.

Davis, E. A. (2004). Knowledge integration in science teaching: Analysing teachers' knowledge development. *Research in Science Education*, *34*(1), 21-53.

Dede, H., Yilmaz, A., & Ilhan, N. (2017). Investigation of the self-efficacy beliefs of pre-service science teachers in terms of following and using the innovations in the field of education. *Journal of Education and Training Studies*, *5*(2), 21-30.

Demir, S. (2015). Evaluation of critical thinking and reflective thinking skills among science teacher candidates. *Journal of Education and Practice*, *6*(18), 17-21.

Dewey, J. (1933). *How We Think: A Restatement of the Relation of Reflective Thinking to the Educational Process*. Lexington, MA: Heath.

Duit, R., & Tesch, M. (2010, July 25-31). On the role of the experiment in science teaching and learning: Visions and the reality of instructional practice. *Proceedings of the 7th International Conference on Hands-on Science* (pp. 17-30). Rethymno, Crete.

Erduran, S., & Jimenez-Aleixandre, M. P. (Eds.). (2008). *Argumentation in Science Education.* New York, NY: Springer.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, *76*(4), 569.

Alghamdi, A. H. K., & Azam, S. (2018). Differentiation in a Saudi pre-service science teacher program. *Journal of Baltic Science Education, 18*(3), 1-35.

Hamdan Alghamdi, A. K. (2013). Pre-service teachers' preferred methods of assessment: A perspective from Saudi Arabia. *Australian Journal of Teacher Education*, *38*(4), 1-25.

Ibrahim, B. (2012). Science teachers' beliefs in the UNRWA schools in Jordan about the nature of science and their relationship to some variables. *Arab Educational Magazine for Education*, *Tunisia*, *32*(1), 71-97.

Kazempour, M. (2014). I can't teach science! A case study of an elementary pre-service teacher's intersection of science experiences, beliefs, attitude, and self-efficacy. *International Journal of Environmental and Science Education*, *9*(1), 77-96.

Kim, S. Y. (2012). Pre-service biology teachers' learning to teach science through science methods courses. *Journal of the Korean Association for Science Education*, *32*(9), 1427-1442.

Kind, V. (2009). Pedagogical content knowledge in science education: Perspectives and potential for progress. *Studies in Science Education*, *45*(2), 169-204.

https://doi.org/10.33225/jbse/19.18.19

Lemke, J. L. (1990). *Talking Science: Language, Learning and Values*. Westport, CT: Ablex.
Lieberman, A., & Grolnick, M. (2005). Educational reform networks: Changes in the forms of reform. In M. Fullan (Ed.), *Fundamental Change*. New York: Springer.
Luera, G. R., & Otto, C. A. (2005). Development and evaluation of an inquiry-based elementary science teacher education programme reflecting current reform movements. *Journal of Science Teacher Education*, *16*(3), 241-258.
Lumpe, A., Czerniak, C., Haney, J., & Seltyukova, S. (2012). Beliefs about teaching science: The relationship between elementary teachers' participation in professional development and student achievement. *International Journal of Science Education, 34*(2), 153-166.
Mansour, N. (2009). Science teachers - beliefs and practices: Issues, implications and research agenda. *International Journal of Environmental & Science Education*, *4*(1), 25-48.
McNeill, K. L., & Krajcik, J. (2011). *Claim, Evidence and Reasoning: Supporting Grade 5-8 Students in Constructing Scientific Explanations*. Boston, MA: Pearson Education.
National Science Teachers Association (1998). NSTA position statement: The national science education standards: A vision for the improvement of science and learning. *Science Scope*, *65*(5), 32-34.
National Science Teachers Association (2003). Standards for science teacher preparation. *Faculty Publications: Department of Teaching, Learning and Teacher Education*, *86*.
Nelson, B. S., & Hammerman, J. K. (1996). Reconceptualizing teaching: Moving toward the creation of intellectual communities of students, teachers, and teacher educators. In M. W. McLaughlin & I. Oberman (Eds.), *Teacher learning: New policies, new practices* (pp. 3-21). New York: Teachers College Press.
Nilsson, P., & Loughran, J. (2012). Exploring the development of pre-service science elementary teachers' pedagogical content knowledge. *Journal of Science Teacher Education*, *23*(7), 699-721.
Ozfidan, B., Cavlazoglu, B., Burlbaw, L., & Aydin, H. (2017). Reformed teaching and learning in science education: A comparative study of Turkish and US teachers. *Journal of Education and Learning*, *6*(3), 23-30.
Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, *62*(3), 307-332.
Palmer, D. H. (2006). Sources of self-efficacy in a science methods course for primary teacher education students. *Research in Science Education*, *36*(4), 337-353.
Plevyak, L. H. (2007). What do pre-service teachers learn in an inquiry-based science methods course? *Journal of Elementary Science Education*, *19*(1), 1-12.
Richardson, V. (1994). The consideration of beliefs in staff development. In V. Richardson (Ed.), *Teacher Change and the Staff Development Process: A Case of Reading Instruction* (pp. 90-108). New York: Teachers College Press.
Sahin, E., Deniz, H., & Topçu, M. (2016). Predicting Turkish pre-service elementary teachers' orientations to teaching science with epistemological beliefs, learning conceptions, and learning approaches in science. *International Journal of Environmental and Science Education*, *11*(5), 515-534.
Saka, M., Bayram, H., & Kabapinar, F. (2016). The teaching processes of prospective science teachers with different levels of science-teaching self-efficacy belief. *Educational Sciences: Theory and Practice*, *16*(3), 915-941.
Sampson, V., & Blanchard, M. R. (2012). Science teachers and scientific argumentation: Trends in views and practice. *Journal of Research in Science Teaching*, *49*, 1122-1148. doi:10.1002/tea.21037.
Santau, A. O., Maerten-Rivera, J. L., Bovis, S., & Orend, J. (2014). A mile wide or an inch deep? Improving elementary pre-service teachers' science content knowledge within the context of a science methods course. *Journal of Science Teacher Education*, *25*(8), 953-976.
Santos, L. F. (2017). The role of critical thinking in science education. *Journal of Education and Practice, 8*(20), 159-173.
Saylan, A., Armagan, F., & Bektas, O. (2016). The relationship between pre-service science teachers' epistemological beliefs and preferences for creating a constructivist learning environment. *European Journal of Science and Mathematics Education*, *4*(2), 251-267.
Schoon, K. J., & Boone, W. J. (1998). Self-efficacy and alternative conceptions of science of pre-service elementary teachers. *Science Education*, *82*(5), 553-568.
Settlage, J. (2000). Understanding the learning cycle: Influences on abilities to embrace the approach by pre-service elementary school teachers. *Science Education*, *84*(1), 43-50.
Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15,* 4-14.
Simon, S., Johnson, S., & Johnson, S. (2008). Professional learning portfolios for argumentation in school science. *International Journal of Science Education*, *30*(5), 669-688.
Tarmo, A., & Bevins, S. (2016). Pre-service science teachers' epistemological beliefs and teaching reforms in Tanzania. *Cogent Education*, *3*, 1.
Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*(2), 202-248.
Uyanik, G. (2016). Investigation of the self-efficacy beliefs in teaching science and attitudes towards teaching profession of the candidate teachers. *Universal Journal of Educational Research*, *4*(9), 2119-2125.
Venville, G. J., & Dawson, V. M. (2010). The impact of a classroom intervention on grade 10 students' argumentation skills, informal reasoning, and conceptual understanding of science. *Journal of Research in Science Teaching*, *47*, 952-977.
Watters, J. J., & Ginns, I. S. (2000). Developing motivation to teach elementary science: Effect of collaborative and authentic learning practices in pre-service education. *Journal of Science Teacher Education*, *11*(4), 301-321.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Wong, S. (2016). Development of teacher beliefs through online instruction: A one-year study of middle school science and mathematics teachers' beliefs about teaching and learning. *Journal of Education in Science, Environment and Health*, *2*(1), 21-32.

Yakar, Z., & Turgut, D. (2017). Effectiveness of lesson study approach on pre-service science teachers' beliefs. *International Education Studies*, *10*(6), 36-43.

Yenice, N. (2015). An analysis of science student teachers' epistemological beliefs and metacognitive perceptions about the nature of science. *Educational Sciences: Theory and Practice*, *15*(6), 1623-1636.

Zembal-Saul, C. (2009). Learning to teach elementary school science as argument. *Science Education*, *93*, 687-719.

Received: *August 02, 2018* Accepted: *December 23, 2018*

Amani K. Hamdan Alghamdi	BSc–BEd, MA Ed, PhD, Associate Professor, College of Education, Curriculum and Pedagogy, Imam Abdulrahman Bin Faisal University, Saudi Arabia. E-mail: akhalghamdi@iau.edu.sa
Sun Young Kim	Ph.D, Associate Professor, College of Education, Department of Biology Education, Chosun University, Gwangju, South Korea. E-mail: sykim519@chosun.ac.kr; mhsysj@gmail.com

https://doi.org/10.33225/jbse/19.18.19