INTRODUCTION

Pre-service teachers’ school years or prior learning experiences may influence their pedagogy beliefs as they undergo professional preparation (Thomas et al., 2001). Teaching science requires an understanding of how to teach the content, that is, student teachers need sufficient pedagogical content knowledge (PCK) to be effective practitioners. PCK development includes learning about strategies and approaches, from reflective classroom experience (Bartholomew et al., 2011). However, the specific ways in which school years’ learning might influence developing pedagogic competencies of trainee pre-service science teachers are less well known. It might be that school years learning underlies how teachers under preparation appreciate alternative pedagogies; these preconceptions may be difficult to change even with extensive educational courses and teaching experience (Lotter, 2004). However, Lotter alerts that without adequate support, pre-service teachers may revert back to the way they were taught instead of trying to incorporate new teaching techniques if they are uncomfortable or uncertain about their abilities. Consequently, Hoover (1996) emphasizes that teachers teach as they are taught, not as they are told to teach. Nonetheless, attempts to identify and harness positive school years’ learning experiences to support current teaching practices would make for effective science teaching. This study sought to determine how pre-service science teachers’ secondary school education could be used as prior knowledge to improve and enhance their science teaching efficacy beliefs.

RELATED LITERATURE AND THEORETICAL FRAMEWORK

Constructivism represents one of the big ideas in education. Its implications for how teachers teach and learn to teach are enormous. If efforts in reforming education for all students are to succeed, then we must focus on students. Prior knowledge need not be only knowledge of the content, although that is the most critical type of knowledge to monitor. Knowledge of popular culture or current events can be used to great advantage as well in the same ways (Svinicki, 1994).

In as much as beginning a class with a review of what was done before helps activate prior knowledge, students entering teacher education programs can use their experiences to strengthen old information with the new one they acquire during their training. This is because learning of new knowledge is dependent on what is already known. In other words, knowledge is constructed first by observing and recognizing events (Novak and Gowin, 1984). For pre-service teachers to learn meaningfully, they must relate new knowledge to their relevant prior knowledge. It is thus imperative that appropriate teaching methods and strategies are utilized in the classrooms. This is in support of Ausubel’s (1968) statement, “The most important thing is to determine this and teach them accordingly” (p. vi). It is thus important to acknowledge and recognize the knowledge that students bring to class and move from what they know towards what they do not know. There is no tabula
Lekhu and Matoti: Pre-service teachers' reflections of secondary science education

Conceptual design of the interrelationship between prior-knowledge, students’ reflection, teacher training, and self-efficacy beliefs.

Student teachers confront their understanding in light of what they encounter in the new learning situation. If what they encounter is inconsistent with their current understanding, their understanding can change to accommodate new experience. Third, if student teachers must apply their current understandings in new situations to build new knowledge, then lecturers must engage students in learning, bringing student teachers’ current understandings to the forefront. Lecturers can ensure that learning experiences incorporate problems that are important to student teachers, not those that are primarily important to lecturers and the educational system. Fourth, if new knowledge is actively built, then time is needed to build new knowledge experiences, how these experiences line up against current understandings, and how these experiences were used as prior learning experiences. This study focused on pre-service science teachers’ reflections of secondary school science education prior learning experiences, and how these experiences were used as prior learning experiences, and how these experiences were used as prior learning experiences. This study focused on pre-service science teachers’ reflections of secondary school science education prior learning experiences, and how these experiences were used as prior learning experiences. This study focused on pre-service science teachers’ reflections of secondary school science education prior learning experiences, and how these experiences were used as prior learning experiences. This study focused on pre-service science teachers’ reflections of secondary school science education prior learning experiences, and how these experiences were used as prior learning experiences. This study focused on pre-service science teachers’ reflections of secondary school science education prior learning experiences, and how these experiences were used as prior learning experiences. This study focused on pre-service science teachers’ reflections of secondary school science education prior learning experiences, and how these experiences were used as prior learning experiences.

Relationship between Constructs of the Study

A conceptual design of the study linking prior knowledge, teaching efficacy, knowledge to improve and enhance their science teaching, student teachers’ reflection, teacher training, professional identity, and self-efficacy beliefs.

Student teachers confront their understanding in light of what they encounter in the new learning situation. If what they encounter is inconsistent with their current understanding, their understanding can change to accommodate new experience. Third, if student teachers must apply their current understandings in new situations to build new knowledge, then lecturers must engage students in learning, bringing student teachers’ current understandings to the forefront. Lecturers can ensure that learning experiences incorporate problems that are important to student teachers, not those that are primarily important to lecturers and the educational system. Fourth, if new knowledge is actively built, then time is needed to build new knowledge experiences, how these experiences line up against current understandings, and how these experiences were used as prior learning experiences.

Figure 1: Conceptual design of the interrelationship between prior-knowledge, students’ reflection, teacher training, and self-efficacy beliefs.

Various studies have been carried out on pre-service elementary teachers’ reflections of secondary school pre-service science teachers influence on teaching efficacy. Flores (2015; Otero and Nathan, 2004) and a few on secondary sciences education experiences (Hudson et al., 2010; Hudson and Kidman, 2008; Finson et al., 2006). According to McGee and Cooper (2010) in their study on secondary sciences education experiences, there is evidence that supports the view that new teachers have a positive impact on their students’ learning while student teachers implement the practices they have learnt during their initial teacher education programs (Bartholomew et al., 2011).

Aim of the Study

The study aims to investigate the following research question:

Research Question

1. Are there any significant differences between male and female pre-service teachers’ reflections of secondary school science education experiences, and how these experiences were used as prior knowledge to improve and enhance their science teaching?

Hypotheses

Hypothesis 1: Male and female pre-service teachers’ reflections of secondary school science education experiences, and how these experiences were used as prior knowledge to improve and enhance their science teaching, are not significantly different.

Hypothesis 2: Male and female pre-service teachers’ reflections of secondary school science education experiences, and how these experiences were used as prior knowledge to improve and enhance their science teaching, are significantly different.

Various studies have been carried out on pre-service elementary teachers’ reflections of secondary school pre-service science teachers influence on teaching efficacy. Flores (2015; Otero and Nathan, 2004) and a few on secondary sciences education experiences (Hudson et al., 2010; Hudson and Kidman, 2008; Finson et al., 2006). According to McGee and Cooper (2010) in their study on secondary sciences education experiences, there is evidence that supports the view that new teachers have a positive impact on their students’ learning while student teachers implement the practices they have learnt during their initial teacher education programs (Bartholomew et al., 2011).
They also self-reported their demographics. Further requested to write a narrative on how they will use their high school experiences to improve on their future practice. The measure includes questions on recall of memories about science teaching and learning while they were still learners. This study was adapted from Hudson et al. (2010). The students completed an open-ended questionnaire survey. The benefits of participating in the study were explained to the participants. The respondents were also assured of the confidentiality of their responses. The data was analyzed using MS Excel and GraphPad software. Cronbach’s alpha was used to compute the reliability of the instrument. The students completed the study. Sixty-two percent (62%) of the students were males and 38% were females. Thirty percent (30%) of the students were under 22 years old, while 68% were above 22 years, the remaining 2% did not indicate their age.

### METHODOLOGY

#### Research Design

This study used a non-experimental, descriptive, and exploratory quantitative design to determine how pre-service science teachers’ prior learning experiences influence their perceived professional development. The statement of the full scale were categorized into five themes, namely: Teachers’ approaches targeting learners’ interests, selection of topics, and teaching practices. Table 1-6 present the descriptive and inferential statistics for the study variables.

#### Instrument

The students completed an open-ended questionnaire survey on remembering their secondary school science learning experiences. This study was adapted from Hudson et al. (2010). The students were males and 38% were females. Thirty percent (30%) of the students were under 22 years old, while 68% were above 22 years, the remaining 2% did not indicate their age.

#### Data Collection Procedures

The close structured questionnaires were administered during a physical science didactics class in the presence of the researcher. The students were males and 38% were females. Thirty percent (30%) of the students were under 22 years old, while 68% were above 22 years, the remaining 2% did not indicate their age.

#### Data Analysis

Microsoft Excel and GraphPad software were used to analyze the data. Descriptive statistics (frequencies, means, and standard deviations) as well as inferential statistics (Mann–Whitney U) were computed to characterize how pre-service teachers’ prior learning experiences influence their perceived professional development.

#### Ethical Issues

Permission to conduct the study was sought from and approved by the institution. Participation in the study was voluntary. The students were males and 38% were females. Thirty percent (30%) of the students were under 22 years old, while 68% were above 22 years, the remaining 2% did not indicate their age.

#### Participants and Setting

Respondents were a convenience sample of 85 students enrolled for a 4-year undergraduate Bachelor of Education degree, in the Natural Sciences Programme at a university of 200 students. Of these, 60 students who majored in physical sciences completed the study. The students were males and 38% were females. Thirty percent (30%) of the students were under 22 years old, while 68% were above 22 years, the remaining 2% did not indicate their age.

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There is no significant difference between male and female teachers' approaches targeting learners' interest.

Science teaching practice

There is no significant difference between male and female teachers' affective domain. Teachers' lesson plans with practical and usable knowledge were ranked the highest prior to learning influences (M = 4.36), while letting learners' activities without explanation were ranked the lowest (M = 2.13).

A Mann–Whitney test was used to evaluate the hypothesis that male respondents would score higher, on the average, than female respondents on teachers' science teaching practices. The results of this test were greater for males (Mdn = 16.5) than females (Mdn = 10.5), U = 40, ρ = 0.1902.

The results of the test show that there is no significant difference between males and females on the teachers' science teaching practices.

### Table 2: Teachers' science teaching practices

| Item                                                                 | Whole group | Males | Females |
|---------------------------------------------------------------------|-------------|-------|---------|
| Mean Rank               | Rank        | Mean Rank | Rank | Mean Rank | Rank |
| Taught the lesson without too many explanations                    | 2.96 10     | 3.00 20 | 3.23 19 |
| Facilitated group work with my peers                               | 3.93 7      | 4.06 11 | 4.00 12.5 |
| Constructed science lessons that had practical and usable knowledge | 4.36 1      | 4.58 1  | 4.08 10  |
| Provided hands-on science experiences                              | 4.20 4      | 4.32 6.5| 3.92 15  |
| Presented opportunities for me to copy lesson notes from the board | 3.70 8      | 3.68 16 | 4.23 9   |
| Let me do the science activity without explaining the reason       | 2.13 11     | 2.00 22 | 2.08 21  |
| Let me experiment and discover concepts for myself                 | 3.62 9      | 3.95 14 | 3.54 17.5|
| Corrected me when I was not correct                                | 4.33 2      | 4.47 2.5| 4.31 8    |
| Took me on science excursions (e.g., museum, and planetarium)     | 4.27 3      | 4.47 2.5| 4.00 12.5|
| Told me I was wrong when I was wrong                               | 4.17 5      | 4.39 4  | 4.38 5    |
| 6K RZGHPKRZWRUHRFRUGVFHOFUHVXOWVLQDVFLHQWLFDFZD\1.98 6 | 4.32 6.5 | 3.54 17.5 |

Average: 3.93 3.76

Mann–Whitney U p-value: 0.1902

### Table 3: Teachers' selection of topics

| Item                                                                 | Whole group | Males | Females |
|---------------------------------------------------------------------|-------------|-------|---------|
| Mean Rank               | Rank        | Mean Rank | Rank | Mean Rank | Rank |
| Organized science activities that involved dissection              | 4.00 1      | 4.22 1 | 3.62 7.5 |
| Conducted lessons that included interactivity with animals         | 2.62 6      | 2.79 11 | 2.31 12  |
| Provided a wide selection of science topics                        | 3.82 4      | 4.11 3  | 3.77 6    |
| Conducted lessons that included interactivity with plants          | 3.27 5      | 3.26 9  | 2.85 10   |
| Demonstrated circuitry                                             | 3.94 2      | 4.17 2  | 3.62 7.5  |
| Taught me about life cycles                                       | 3.85 3      | 4.05 4  | 3.92 5    |

Average: 3.77 3.35

Mann–Whitney U p-value: 0.17384

### Table 4: Teachers' affective domain

| Item                                                                 | Whole group | Males | Females |
|---------------------------------------------------------------------|-------------|-------|---------|
| Mean Rank               | Rank        | Mean Rank | Rank | Mean Rank | Rank |
| Was enthusiastic about teaching science                              | 4.13 2      | 4.05 3  | 4.00 4.5 |
| Had a positive attitude towards science                             | 4.11 3      | 4.53 1.5| 4.00 4.5 |
| Organized lessons that required use of science equipment            | 4.22 1      | 4.53 1.5| 3.92 6    |

Average: 4.15 4.39 3.97

Mann–Whitney U p-value: -
A Mann–Whitney test was used to evaluate the hypothesis that male respondents would score higher, on the average, than female respondents on the selection of topics. The results of this test were greater for males (Mdn = 16.5) than females (Mdn = 10.5), U = 40, ρ = 0.1902. The results of the test show that there is no significant difference between males and females on the selection of topics.

### Teachers’ affective domain

Teachers organized lessons requiring the use of science equipment were ranked the highest prior learning influences (M = 4.22), while their positive attitude toward science was ranked the lowest (M = 4.11). Male students’ average mean score (M = 4.39) was high in this category compared to female students who scored a mean of 3.97.

### Teachers’ articulation of concepts

Secondary school teachers perceived prior school experiences to influence their concepts that explained abstract science concepts in simple terms was ranked the highest (M = 4.33) and the concepts that articulated clearly the purposes for the science lesson ranked the lowest (M = 3.95). The male students ranked the higher than females in all the three items of this category.

### Table 5: Teachers’ articulation of concepts

| Item | Whole group | Males | Females |
|------|-------------|-------|---------|
| 9    | 7DONHGDERXWWKHFVLOFHRQFHSVWNLQOGHLDUO | 4.17 | 3.62 |
| 10   | Explained abstract science concepts in simple terms | 4.58 | 4.54 |
| 13   | Articulated clearly the purposes for the science lesson | 4.32 | 3.92 |

### Table 6: Summary of descriptive statistics on the five categories

| Category                     | Whole group Mean | Whole group SD | Whole group Rank | Males Mean | Males SD | Males Rank | Females Mean | Females SD | Females Rank |
|------------------------------|------------------|----------------|------------------|------------|---------|------------|--------------|------------|--------------|
| Targeting learners’ interest | 3.59             | 1.14           | 4                | 3.78       | 0.92    | 6          | 3.43         | 0.56       | 9            |
| Selection of topics          | 3.58             | 0.96           | 5                | 4.39       | 0.29    | 1          | 3.97         | 0.05       | 4            |
| 7DFKHNWUHFWDHLYGMPDLQ4.15    | 1.11             | 0.60           | 1                | 5.49       | 1.11    | 4          | 4.72         | 0.66       | 8            |
| Concepts from teachers       | 4.10             | 1.10           | 2                | 4.36       | 0.31    | 3          | 4.03         | 0.47       | 3            |
| Science teaching practice    | 3.79             | 1.11           | 3                | 3.93       | 0.79    | 5          | 3.76         | 0.66       | 8            |

### Open-Ended Questions Analysis

The followings are the themes that emerged from open-ended questions.

**Theme 1: Positive science teaching experiences**

Themes that emerged from the pre-service teachers’ most memorable learning experiences include performing experiments, attending science expos and taking excursions as stated below:

- “We attended a science expo where I gained knowledge about how science is part of our daily lives”
- “We performed color change experiment with indicators. It was exciting to observe color changes, a successful experiment reminding us of rainbow.”

**Theme 2: Negative science education experiences**

The pre-service teachers also indicated some bad memories they had in their secondary school learning of science. These included being taught by incompetent and not so enthusiastic teachers. The following excerpts emphasized how the science teacher could play a role in discouraging students toward science:

- “My teacher was not eager to make science interesting; there was no difference between science and English classes.”
- “I realized that science is around us and it is fascinating. Teachers were unable to answer some of my questions due to my curiosity”

The most prevalent bad memory was lack of hands-on laboratory activities where they were forced to either do...
observations or watch videos of experiments. In some instances, pre-service teachers were exposed to hazardous situations that were also due to lack of proper supervision in the laboratory.

“When the Science learning facilitator from the Department of Education visited our school and performed a practical experiment. I was so embarrassed because the scientific names of apparatus used were not familiar to me”

“The teacher tried to conduct an experiment without the correct procedure... everything almost got burned down.”

Theme 3: Improvements toward science education

Pre-service teachers who had positive experiences gave all the credit to their secondary school teachers. They will continue to inspire their learners by being passionate, enthusiastic, and motivated:

“I was highly inspired by my teacher who had best ways of introducing lessons using concepts from other learning areas that learners mastered, for example, Reproduction.”

“She would always come to class prepared, knowing what to do with all the energy. She always had interest in how learners are coping with the subject.”

“Science teachers give their all when it comes to educating children about the world they live in; they go beyond boundaries to ensure quality education”

Those who had negative experiences would improve the teaching and learning of science by teaching learners thoroughly, explaining abstract concepts, and correcting learners when they are wrong, and presenting them with opportunities to do practical work. The following excerpts show how some pre-service teachers felt that their own teachers did not give the teaching of science its well-deserved attention:

“I’ll put my learners first, not to summarize lessons rushing off to complete the syllabus”

“Science was never fun, so I’ll make it fun and understandable at the same time. I’ll expose my learners to hands-on practical activities and organize science excursions.”

While only 33% of the pre-service responded “yes” to this question, a remarkable 67% of the pre-service teachers preferred not to teach the way that they were taught for various reasons addressed in the previous question.

“NO! Telling without doing is not science. Working in groups where we all did not understand a concept, or rely on one person who might have an idea”

“Yes! Teaching strategies used by my teacher were the best and produced the best results; I’ll then focus on slow but working learners and groom them.”

DISCUSSION

The results showed that pre-service teachers’ professional identity based on students’ gender was found, while male student teachers showed higher ranks than the female student teachers. In a study focusing on the development of students’ professional identity based on students’ gender was found, while male students tend to attach more importance to discipline in the classroom, their female counterparts focus more on student involvement (Lamote and Engels, 2010).
and Stephens (2000) that teacher educators need to learn much more about the “identity baggage” that student teachers bring with them into the professional arena. Much of this “baggage” has been acquired by student teachers during the formative stages of their lives. During their training, the transition from personal self to professional identity calls for a much closer understanding of the matrix of complex, contradictory, and FRP5OHVPQWDLTJHQGDFWQKDLQXSHFHWKHPDNL (Samuel and Stephens, 2000). On the contrary, in their study examining pre-service teachers’ previous experiences and visions about their future teaching, Gurbuzturm et al. (2009) UHYDHOGWLVJQLD\DQWDVVFRDLWRQEOHWHQHSQSHLQXSHFHWKHPDNL visions about their future teaching and their views about their previous education experiences only at primary level. These 5QGLQJ\VVXJHWWKDWUSUHVHYLFHWHDFKHUVJ\D\HQFHWKHPDNL their secondary school or university teachers’ practices in terms of shaping their visions for future practice (Gurbuzturm et al., 2009).

7KHaGQLQJVVXJHWWKDWDSUHVHYLFHWHDFKHUVJ\D\HQFHWKHPDNL 6\DVRQHIWKLHGLQHQLVHFDFWHJRULHVSDV\QJLQURHOLQKWGHYHORSPHQWIRISURHVRLQRDGLHQLWQLQHQLWZLKVHWKHLQVRIWHXWGXEDXJKWHWWLQY where students had more positive and positive memories for WKH\X\EHFWV\WH\ISODQGQHWRHDFK+DXJ\KWHWWLQY trainers in constructivist professional development sessions should model learning activities that teachers can apply in their own classrooms. It is not enough for trainers to describe new ways of teaching and expect teachers to translate from talk to DF\FWLRLWLP\PRUHHHLFWLYHWRHQDJ\D\HQFHWKHPDNL will lead to new actions in classrooms (Hoover, 1996). This in turn will enhance their vicarious experience as a source R\HV\FDFZKLFKZLOEXLOGWK\VH\OH\FDFIE\HOLH service teachers.

The category on teachers’ articulation of concepts was scored second highest (mean = 4.10, SD = 1.00). This score is in agreement with the open-ended question that required the respondents to indicate how they can use their own experience to improve the teaching and learning of science. Respondents SHUFLHYGKFVHFLQHQWHREHYHULG\FV\WXWQDGDEWUWLZLKVHWGCDW\WSDLUWHDFKHUVZXRQOGXHDLVLPWH concepts to help them understand better. That is the main reason why most of the prospective teachers want to promote mastery learning by demystifying abstract science concepts and G\HDOLQJ\D2DWLKW\SHUFL\LQWSK\WDFKLOVWDF\FLQXHOLH only meant for smart learners. This undertaking is in line with RQHRIWKH\RI\XDULQVXUFHVFHR\FDFPVD\W\H|H as shown in the excerpt below:

“To master science, learners should be able to believe in their own understanding abilities and have sound curiosity about acquiring knowledge about the universe”

In mastering experience, one’s direct experiences help in the successful performance of tasks which reinforces RSWLPLWLVHF\OVXUFHR\FDF\SHUFL\LQW\\OVXUDW\WHU\|HRIQUPD\LQWRQISUFLVHFLYHUH\FDFIE\FDFPVD\W\H|H to Tschannen-Moran et al. (1998). The perception that a SHUFL\UPDFHDFKHUV\VXWDF\DFQDUH\VHL\FDFIE\HOLH and provide the source for the belief that future performances in a similar vein will also be successful (Cantrell and Young, 2003). The respondents are also in support of promoting Q\RW\ROQV\WKH\V\OH\FDF\EX\W\DOV\ZR\LQO\IFR\VXHT\DX\D the outcome expectancy dimension that is concerned about Q\R\DH\WH\FDFIE\HOLH. According to McGee and Cooper (2010) in Bartholomew et al. (2011), there is evidence that supports the view that new teachers have a positive impact on their students’ learning when student teachers implement the practices they have from their secondary school or university teachers’ practices in their undergraduate science content courses provided poor instructional models of reform-based science teaching and that were of little value in preparing them as science teachers (Simmons, 2016).

As prospective teachers, respondents want to make sure that they do not leave learners with unanswered questions and ensure that they correct their learners when they are wrong. They want to motivate and inspire their learners to love science not to ridicule them and make them feel that they DF\FWLRLWLP\PRUHHHLFWLYHWRHQDJ\D\HQFHWKHPDNL science. Motivation is one source of science excursion (mean = 4.27). This exposure to the “real world” of science made them realize that science is not only for smart learners. Their negative attitude was as a result of lack of resources and proper infrastructure, teachers who lacked knowledge and seemed less interested in teaching science. This is supported by the lowest scored item 14 (I think I would remember science if my teacher let me do the science activity without explaining the reason) which resulted in their worst memory with mean = 2.13. Likewise, Simmons mentioned that most pre-service teachers reported that their undergraduate science content courses provided poor instructional models of reform-based science teaching and that were of little value in preparing them as science teachers (Simmons, 2016).
view of human motivation which assumes that individuals improve their performance (Argyris and Schön, 1974 cited in Osterman, 1990).

three progressive stages in beginning teacher development as where pre-service teachers only have vague ideas about teaching and their ideas stem from their own experiences, followed by “concern with self” where they are concerned with issues of their own adequacy as teachers in dealing with classroom control and the ability to teach the subject matter (Lotter, 2004). The two dimensions cannot be generalized. Hence, a need for further research in other teacher education areas of specialization includes technology, computer science, languages, and social sciences. Consequently, this research would have implications on professional identity and self-efficacy. This research has

learners’ interest, teachers’ affective domain, teachers’ articulation of concepts, selection of topics, and teaching practices have both positive and negative impact on the teachers’ forming of professional identity. Pre-service teachers with negative secondary school learning experiences will use their own school years’ learning experiences and teacher training to build and develop positive professional identity and self-efficacy. This research has

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