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Research Article

Developing Female Pre-Service Teachers' Mathematics Self-Efficacy by Integrating History of Mathematics into Teaching During Lesson Study

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Abstract: History of Mathematics (HOM) was incorporated into peer teaching during lesson study as a strategy to augment the mathematics self-efficacy of female pre-service teachers in Ghana. An overview of studies on methodological approaches to integrating the history of mathematics into the teaching and learning process was presented. Mathematics Self-efficacy Scale and Grade Descriptor Grid were used to assess 12 female pre-service teachers' confidence level and performance, respectively, during lesson study. Results revealed that pre-service teachers exhibited a moderate self-efficacy level as well as moderately good performance in lesson instruction. A web-based questionnaire completed by participants revealed that integrating HOM into lessons has the potential to improve teachers' self-efficacy. The impact of the study included: change of pre-service teachers' perception about teaching mathematics, a positive attitude towards mathematics, broadened conceptual knowledge, and exposure to the multiplicity of problem-solving approaches. It was recommended that innovative pedagogical strategies should be adopted to enhance females' self-efficacy towards teaching mathematics. Also, teachers need to participate in lesson study as a professional collaboration which can improve their pedagogical knowledge. Further studies should investigate the relationship between prospective female teachers' self-efficacy and their mathematics achievement.

Keywords: History of Mathematics (HOM), self-efficacy, lesson study, pre-service teachers, prospective mathematics teachers, mathematics education

1. Introduction

The enrolment of females to teach mathematics in a teacher education program in Ghana has been on the decline for the past three decades and this has attracted the attention of many researchers. Mathematics is deemed as a difficult discipline at all levels of education which creates lots of anxiety for learners. According to Yarkwah (2020), the trend of female students' enrollment and participation in mathematics in Ghana is on the decline and the country has made great strides to make greater progress in the immediate future to bridge the gap of gender disparity towards Science

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Technology Engineering and Mathematics (STEM).

Education researchers have dedicated much effort to aid in developing a meaningful curriculum that will foster the participation of more females. This is because about 73% of practicing teachers at the basic schools in Ghana are females but less than 40% teach mathematics and science (Yarkwah, 2020). Meanwhile, the nation needs an education system staffed with females who can promote creativity, critical thinking and problem-solving skills which are essential pre-requisites to excel in a 21st-century economy. In keeping this vision, Ghana's education landscape has undergone a set of ambitious and wide-ranging reforms, including the teacher education sector. The teacher education reforms are designed to ensure that the country's pre-tertiary classrooms are staffed with well-trained, skilled, inspirational and motivated teachers.

A key pillar of the teacher education reform is the shift from a Diploma in Basic Education to a new 4-year Bachelor of Education (B. Ed.) Degree in Basic Education. The Teacher Education Curriculum for the new Basic Education Degree provides Ghanaian teachers with the essential practical competencies, skills, knowledge and values that will enable them to deliver high-quality education. Initial teacher education is the foundation upon which the basic education system is constructed, meanwhile, the enrollment of females at this level, especially in mathematics studies, is very minimal. This has led to many tertiary institutions to reviewing their admission requirements by offering special entry arrangements for females who opt for STEM courses.

Incorporating innovative strategies in teaching mathematics increases learners' motivation and creates a more positive attitude towards the subject. One of the new strategies which are uncommon among mathematics educators in Ghana is the integration of History of Mathematics (HOM) into mathematics topics. The National Council of Teachers of Mathematics encourages the integration of HOM into the teaching of mathematics because of its numerous benefits to learners. This has the capacity to raise humanistic ideas of mathematical knowledge, provides indicators to guide mathematics teaching and fosters mathematical thinking (NCTM, 2000).

As mathematics educators put much effort into developing students' mathematical literacy and knowledge, it is expedient to build their self-efficacy which will go a long way to alleviate the mathematics anxiety. Mathematics self-efficacy is commonly defined as an individual's beliefs and perceptions regarding their mathematics abilities. This study aimed at developing female pre-service teachers' self-efficacy in mathematics during a lesson study where HOM was incorporated in lesson instructional designs and teaching.

This work is in five sections. Section one entails the introductory background to the topic, statement of the problem, purpose of the study, significance of the study and research questions. Section two and three capture the review of related literature and methodology respectively. Section four consists of analysis and findings while section five looks at the summary, conclusion and recommendations.

1.1 *Research problem*

The low interest of females in the study of Science Technology Engineering and Mathematics (STEM) courses as asserted by Freeman (2004); Jacobs and Simpkins (2005); Fletcher (2009); Griffith (2010); El Yacoubi (2015) is depicted at Agogo Presbyterian Women's College of Education. 12 out of 413 students which are approximately 3% selected mathematics as their area of specialization as prospective teachers. Analyzing comments and reports in Students' Reflective Journal (SRJ) after two years of studying mathematics and participating in the Supported Teaching in Schools (STS) program, it was unveiled that 88% of these pre-service teachers lack the confidence in handling mathematical topics in the Basic School Curriculum.

The low confidence of females towards mathematics is also exemplified in several studies which include Ma and Kishor (1997); Casey et al. (2001); Odogwu and Lawal (2018). Teachers are expected to use every relevant subject to develop pupils' mathematical and scientific literacy since confidence in numeracy and other scientific skills is a precondition to success across the national curriculum. Teacher educators on the other hand employ few teaching and learning activities that would encourage the use of inquiry and discovery methods in their teaching. This was replicated by pre-service teachers during their first teaching practicum. It was observed that pre-service teachers lacked confidence and creativity during lesson delivery.

Studies (Randhawa et al., 1991; Ma & Kishor, 1997; Ma & Xu, 2004; Siegle & McCoach, 2007) have identified self-efficacy as a good predictor of teachers' knowledge base, decisions, goals, confidence and effort in their lesson instructions. If the self-efficacy of these female pre-service teachers is nurtured and developed via innovative

pedagogical approaches like lesson study whiles incorporating historic resources in their teaching, they will exhibit mastery of the mathematical content and methodologies (Slykhuis et al., 2015). According to Mendoza et al. (2016), if pre-service teachers are developed professionally via lesson study, they will learn to collaborate with each other and create the awareness of new pedagogical approaches. Bridging the gap of gender apathy in selecting mathematics-related courses leads to the road of achieving the fifth Sustainable Development Goal (SDG) which calls for gender equity and equality. This study will explore how incorporating HOM will make an impact on pre-service teachers' mathematics self-efficacy during mathematics lesson study at Agogo Presbyterian Women's College of Education.

1.2 *Purpose of the study*

The main purpose of this study was to investigate how incorporating HOM in pre-service teachers' teaching practicum can aid mathematics students of Agogo Presbyterian Women's College of Education to develop their self-efficacy during lesson study.

1.3 *Research questions*

This study was guided by the following questions:

1. What are the levels of pre-service teachers' self-efficacy in lesson preparation, lesson development and presentation during lesson study?

2. How are pre-service teachers' self-efficacy enhanced through incorporating history of mathematics into lessons study?

1.4 *Significance of the study*

Findings from this study could be used as premises to predict prospective mathematics teachers' mathematics self-efficacy, readiness, capabilities, attitudes and performance in teaching basic school mathematics. The integration of HOM into lessons will broaden the teacher knowledge base by exposing teachers and learners to personalities behind the evolution, discovery and development of some mathematics topics and materials that can be used in teaching those topics.

2. Literature review

2.1 *History of mathematics*

Recently there has been a big offer for encouraging young people to pursue careers in STEM fields due to its global prolificacy. Slykhuis et al. (2015) ascertained that HOM is a critical force that needs to be infused within the instruction of the STEM fields especially mathematics. This is because no other subject loses more than mathematics by any attempt to dissociate it from its history. Many teachers rarely talk about the history that leads to the discovery of algebra, geometry, number as well as the use of other content areas like the Cartesian plane and relevant mathematical materials such as Napier Rods. Teacher educators need to draw on historical and contemporary narratives to position historic issues in mathematics education. This attempt will have much impact and influence pre-service teachers' lesson preparation and reflect in their teaching.

Integrating the History of Mathematics as a new pedagogical practice especially into Mathematics Education (ME) has gained international recognition. Its interest for classroom practices as well as research study area is described as the History and Pedagogy of Mathematics (HPM) perspective as stated in studies (Clark et al., 2016; Fauvel, 1991; Radford et al., 2016; Barbin, 2012; Huntley & Flores, 2010; Clark, 2012; Duong et al., 2019; Fried, 2014a; Fried, 2014b). This assertion is believed to have led the International Conference of Mathematics Education (ICME) in 1996 to launch a 4-year ICME Study on the relations between HOM and Mathematics Education. Proceedings of the 2016 ICME, according to Radford et al. (2016), aimed at bringing together (1) researchers in mathematics education who are interested in the history of mathematics and mathematical thinking; (2) mathematics teachers at all levels who are eager for deeper knowledge on how to embed HOM in pedagogy to arouse young learners' interest in the

subject; (3) historians of mathematics who wish to talk about their research; (4) mathematicians who want to learn about new possibilities of teaching their discipline; and (5) all those with an interest in the history of mathematics and pedagogy (p. 1). This throws much light on the existence, emergence and relevance of HOM as a study area for both mathematics educators and teachers. Integrating HOM in classrooms fosters the use and relevance of mathematics at all levels; promotes a deeper understanding of the way mathematics evolves, and the forces which contribute to this evolution. Additionally, it ensures how to relate the teaching of mathematics to the development in a way that assists the improvement of instruction and development of curricula. All the aforementioned lead to promoting awareness of the history of mathematics as a significant part of the development of cultures (Fasanelli & Fauvel, 2006, p. 2).

The Ghanaian standard base curriculum recognizes the value of History as a study discipline and maintains that history provides the opportunity to explore the past with the aim of understanding factors that have shaped our world. And history deals with important past activities of people so that we understand how we acquired our identity and culture. As an academic discipline, history helps learners to develop imaginative abilities and critical thinking skills because it teaches them to analyze, evaluate and interpret past events carefully in order to make informed decisions that provide clear guidelines for everyday life and interactions of people in society according to the National Council for Curriculum and Assessment (NaCCA, 2019). One of the visions of the common goal programs for education in Ghana is a big push for getting more Ghanaian young people to pursue careers in Science, Technology, Engineering, and Mathematics (STEM) fields (NTECF, 2019) since STEM has been the buzzword for several years. The knowledge of the history of mathematics would foster this goal as a motivating factor for young learners by learning about the innovation of mathematical personalities who discovered several mathematical concepts that are currently in use at several fields of study.

The genetic principle of "fundamental biogenetic law: Ontogeny and Phylogeny" propounded by (Polya, 1965) requires that each learner retraces the main steps in the historical evolution of the subject under study in order to be effective. The genetic principle has proven to be singularly effective with respect to planning mathematical lessons. It can be argued that a child's ability to acquire mathematical knowledge is enhanced if its presentation is examined in the light of the historical acquisition of such knowledge. This may not be directly in line with the original principle, but it could be asserted that ordering instructional materials for effective teaching of mathematics topics requires an examination of the history of relevant mathematical ideas. Incorporating historical resources in the teaching of mathematics enhances the impact of the application of the inside and outside mathematics by offering descriptions and explanations to developments of the subject. Therefore, it is opined "*... that both history and heritage are legitimate ways of handling mathematics of the past; but muddling the two together, or asserting that one is the subordinate of the other is not,*" (Grattan-Guinness, 2004, p. 1, 165). The history of mathematics as a teaching tool can help teachers to achieve the elusive objective of teaching for meaning and understanding.

Clark (2012) revealed that for prospective mathematics teachers (PMTs), the mathematical knowledge for teaching (MKT) framework provides clarity on ways in which studying the history of mathematics informs knowledge of mathematics topics they would soon teach. According to Clark (2019), research conducted before 2000 in the field of history in mathematics education primarily focused on:

(a) Anecdotal reports of interventions used with students.

(b) Historical research on topics that could serve as the focus of classroom instruction.

(c) Survey research, including research on students' or teachers' attitudes and beliefs related to the history of mathematics.

A classic example of empirical research examined focused on the effects of studying mathematics history on attitudes of college algebra students toward mathematics. According to Clark (2019), the authors found a significant increase in the attitude (particularly since the attitudes of the treatment group increased and those of the control group decreased). However several limitations were identified, including the notion that the teacher effect may have been significant. The above motivated this study to focus on determining how incorporating HOM in mathematical topics for female pre-service mathematics teachers will develop their self-efficacy to teach. This is because the researchers believe and perceive that pre-service teachers who exhibit high mathematics self-efficacy via incorporating HOM will develop a positive attitude and interest in teaching mathematics better. The basis for this perception is that infusing new forms of educational strategies and reforms has implications on learners' attitude and interest (Papadakis et al., 2018; 2021). The National Council of Teachers of Mathematics (NCTM) and National Council for Accreditation of Teacher Education

(NCTM/NCATE, 2003) require all prospective mathematics teachers to "Demonstrate knowledge of the historical development" of number and number system, of Euclidean and non-Euclidean geometries, algebra, calculus, discrete mathematics, statistics and probability, measurement and measurement systems, and knowledge about contributions from diverse cultures" (NCTM/NCATE, 2003, p. 4). In order for students to appreciate the role of mathematics, they need to obtain varied experiences which are scientifically related to the historical evolution of the subject (NCTM/NCATE, 2003, p. 5-6).

The relevance of introducing the integration of HOM to Ghanaian prospective teachers is that certification requirements for secondary schools teachers in America, Europe and Asia include offering a course in HOM (Katz, 1998). This depicts the widespread of HOM in mathematics education in other jurisdictions. The lack of research reports on HOM in Ghana motivated the necessity to adapt the history of mathematics to this study.

2.2 *Teachers' self-efficacy*

Self-efficacy simply refers to one's belief in his or her ability to execute behaviors necessary to produce specific performance attainment by reflecting the confidence in their capacity to exert control over self-motivation and social environment (Bandura, 1986). Bandura's theory on self-efficacy as applied to teaching reveals that teachers are motivated to perform better by adopting best practices if they are confident enough to be successful. This assertion has been emphasized by several educationists including Ahmad et al. (2010) as well as Chen (2010). Maninger and Anderson (2007) established that in this case, prospective female teachers' self-efficacy in applying innovative pedagogical approaches in their classroom is based on their readiness and total preparation towards their expertise in that particular field of study. Self-efficacy is a good predictor of prospective teachers' performance and success in teaching mathematics as well as the use of technology in teaching (Wong et al., 2012). From the above, aiding female mathematics teachers to develop their self-efficacy through the incorporation of the history of mathematics has the potential to enhance their capacity and confidence in innovative pedagogical transformations in their lesson preparation, lesson development and lesson presentation when teaching mathematics.

According to Bandura (1986), self-efficacy could be developed through mastery of experiences, vicarious experiences, verbal persuasion as well as the emotional and psychological states of the individual. Therefore, if prospective female mathematics teachers are trained well by knowing the historical developments of mathematical concepts, understanding of historic mathematical problems and their solutions as well as knowing stories or anecdotes of mathematical discoveries and the personalities behind them, they would tend to be intrinsically interested in the course they pursue and perform well by teaching it efficiently.

Bandura (1997) opines that self-efficacy is specific to the context and must be measured appropriately. For example, students might feel confident that they can correctly solve systems of linear equations but lack confidence in their abilities to prove a geometric theorem. In this situation, asking the students to rate their confidence in mathematics generally could result in misleading responses. Bandura also suggested that self-efficacy should be measured close to the time that the task would take place. This proximity helps students to make more accurate judgments about their abilities than otherwise. With these guidelines for measuring self-efficacy in mind, it is crucial to understand how researchers typically measure mathematics self-efficacy.

2.3 *Lesson study*

Murata et al. (2012) identified the lesson study as a collaborative teacher professional development which provides teachers with the opportunity to develop their knowledge through peer participation. Murata (2011) opined that during lesson study, lessons are collectively observed and teachers reflect on observations of their own lessons. Teachers share what they had noticed or what had seemed important with their colleagues, implying a level of personal reflection. Through individual interviews, teachers also suggest a further level of personal reflection where they had brought practices of lesson study into their teaching. Adding to the advancement of teachers' pedagogical knowledge base, lesson study enhances teachers' lesson preparation, lesson development and lesson delivery. Lesson study is of much relevance to basic school teachers because it builds confidence in teaching new curriculum and all teachers participating in the research are exposed to awareness of more teaching and learning approaches.

Mendoza et al. (2016) investigated the impact of integrating HOM into teaching the Cartesian plane during

Mathematics Lessons study for college students. Positive feedback from participants revealed that integrating HOM and applying real-life situations in teaching mathematics proved its positive effects in transferring knowledge among learners. It was revealed that prospective teachers appreciated the integration of HOM into the topic and developed the sense of purpose of the Cartesian coordinate plane in real-life. The study made the following recommendations:

1. To make Lesson Study a way of life of the teaching community where educational institutions should provide a timetable which can address its rigorous process;

2. Teachers should recognize and support learner's ability to construct knowledge by making lessons higher-order;

3. Teachers need to integrate HOM into teaching Mathematics lessons to develop a sense of purpose of studying the subject among the learners;

4. Teachers can use HOM as a teaching strategy that can make a smooth transition of their lessons from the motivational phase towards the lesson proper.

In general, the authors proposed a research and development system for improving teaching practices that shape the collaborative practice of Lesson Study and integration of HOM.

2.4 *Theoretical framework*

The theoretical framework of this study fostered pre-service teachers' beliefs about their abilities to effectively complete tasks assigned through motivation. Applying motivation as a framework in the history of mathematics could result in either developing mathematics self-efficacy or alleviating mathematics anxiety. Motivation is defined as an individual's tendency to instigate and sustain goal-directed behaviors (Pintrich & Schunk, 2002). When it comes to learning mathematics, it is often assumed that highly motivated college students are more likely to achieve and perform at higher levels than less motivated students. It is assumed that college students' motivation to learn mathematics is related to their levels of mathematics self-efficacy and anxiety. Specifically, it is also assumed that college students who feel more confident than their peers in their abilities to incorporate the history of mathematics might have less anxiety about mathematics, are more likely to be motivated to learn and, therefore, succeed in mathematics (Middleton & Spanias, 1999). Therefore, using motivations to target students' goal orientation related to successfully understanding the material, learning new skills, or mastering tasks shall yield the desired result.

3. Methods

A mixed method approach was adopted since this study had to analyze both qualitative and qualitative data. According to Creswell and Plano (2011), mixed methods enable a greater level of understanding through a sequential or simultaneous and rigorous integration of qualitative and quantitative data in order to compensate for any inherent weakness.

3.1 *Instruments*

A generalized self-efficacy scale was adapted from Schwarzer and Jerusalem (1995) to suit this study. The scale had 10 items with internal reliability of Crouchbach's alpha between 0.76 and 0.90 respectively. After reviewing previous research on mathematics self-efficacy, it was identified that three main domains are involved with studying mathematics self-efficacy: solving mathematics problems, using mathematics in everyday tasks, and obtaining good grades in performing mathematical activities or course work. This study focused on the latter two domains and, therefore, asked participants to rate their confidence in regards to mathematics tasks and related teaching activities. Grade Descriptor Grid (GDG) was used to assess the performance of participants during lesson study. This is a tool cited in the National Teaching Standards (NTS) and the National Teacher Education Assessment Policy (NTEAP) to use its rubric for assessing pre-service teachers' teaching practice during teaching practicum of their Initial Teacher Education Programme. It assesses students' lesson plan, subject matter knowledge for the lesson taught, the evaluation process for the lesson taught as well as students' professional ethics during the lesson delivery. Pre-service teachers are always required to enter lesson reflections by evaluating all lessons observed or taught in Student Reflective Journal (SRJ). Because the SRJ isn't meant for only mathematics, it was modified to suit only the teaching and learning of

mathematics. The SRJ was then translated into a web-based questionnaire to gather participants' views on incorporating historic resources in their teaching during lesson study.

3.2 *Participants*

Twelve (12) pre-service mathematics teachers of Agogo Presbyterian Women's College of Education pursuing a 4-year Bachelor of Education in Mathematics & Agriculture were conveniently and purposively selected for the study. The participants had earlier enrolled and completed a Nature of Mathematics course coordinated by the University of Cape Coast, Ghana.

3.3 *Data collection and analysis*

3.3.1 *Participants' lesson preparation, lesson development and lesson presentations*

The participants were required to develop a well-planned lesson for the study considering how HOM could be embedded in topics selected from the Junior High School mathematics curriculum. Tutors in the mathematics department were assigned to direct, guide, supervise and assess participants' lesson plans as well as ensure whether their selected topics conformed to the levels they were expected to teach.

As part of the assessment modes students were expected to:

1. Select one of these strands (Number, Algebra, Geometry and Measurement) and identify a topic that could be taught using historic resources and materials at the Junior High School level for a PowerPoint presentation.

2. Develop a well-planned lesson using STS template for lesson preparations focusing much on lesson starter, development and plenary stages. Most of the students used songs as starters for their lesson but for the sake of this study, participants were encouraged to substitute historic anecdotes or short stories related to their topics as starters instead of the usual songs which were at times unrelated to the lesson.

3. Deliver a presentation of the prepared lesson for panel supervision. Two tutors from the mathematics department were assigned to monitor and assess the lesson using the GDG.

4. Complete Students' Reflective Journal for the lesson delivered. Participants were expected to enter reflections of this presentation into their regular SRJ.

5. Complete the web-based questionnaire items for the study. This was the last phase of the assessment where participants were tasked to complete the online questionnaire.

The purpose of the web-based questionnaire was to direct participants to identify the existence of historic elements enshrined in the basic school mathematics curriculum. During instructional design for the lesson study, participants were expected to identify and record the following elements;

(i) Historic contents in the basic school mathematics curriculum.

(ii) Historic materials and methodologies employed in classrooms.

(iii) Historic anecdotes for lessons introduction.

Descriptive statistics (composite means) were calculated to group participants under the levels of self-efficacy (low self-efficacy = 0 – 2.4, moderate self-efficacy = 2.5 – 3.4 and high self-efficacy = 3.5 – 5.0).

4. Results

Table 1. Pre-service teachers' self-efficacy levels towards lesson preparation, development and delivery/presentation

Lesson Phases	Mean Scale Value	Standard Deviation	Efficacy Level
Lesson Preparation	2.8	2.2	Low
Lesson Development	4.0	1.0	High
Lesson Delivery/Presentation	3.3	1.7	Moderate

Table 1 shows that participants attained a higher mean value of 4.0 depicting a higher efficacy level where they developed lesson with tutors than individual lesson preparation and delivery with mean scores of 2.8 and 3.3 respectively.

Table 2. Pre-service teachers' self-efficacy levels on use of historic resources

Questionnaire Constructs	Mean Scale Value	Efficacy level
Identifying historic contents in curriculum	3.1	Moderate
Applying historic materials and methodologies	2.9	Moderate
Incorporating historic anecdotes for lessons introduction	3.3	Moderate

From Table 2, although mean scores revealed moderate efficacy levels, participants had a higher mean value of 3.3 incorporating anecdotes for lesson introduction than identifying contents in curriculum and applying historic materials and methodologies which attracted mean values of 3.1 and 2.9 respectively.

Table 3. Pre-service teachers' performance in lesson preparation, lesson development and lesson presentations

NTS Grade	Mark Bands	NTS Descriptor: applied in relation to the expectations	Number of Participants
Outstanding	80+ 75-79	Much of the quality of student teachers' performance over time is outstanding and never less than very good	2
Good	70-74 65-69	The quality of student teachers' performance over time is never less than good;	8
Requiring Improvement	60-64 55-59 50-54	The student teachers' performance over time requires improvement to be consistently good	1
Inadequate	0-49	Student teachers' performance does not meet the Minimum level of Practice required by the NTS.	1

From Table 3, the GDG showed that for the 13 participants, 2 had an outstanding performance in teaching, 8 exhibited good performance, while 1 required improvement and 1 participant inadequately performed.

5. Discussions

5.1 *Pre-service female mathematics teachers' self-efficacy levels*

According to Table 1, the Self-efficacy of female pre-service mathematics teachers towards lesson preparation, development and delivery/presentation was moderate. This suggests the possibility of considering innovative pedagogical strategies and tools like incorporating related historic resources could have a positive influence on prospective teachers' lesson design. Results from Table 4 below revealed that incorporating historic-related resources in mathematics lessons has the potential of developing prospective teachers' self-efficacy as depicted and asserted by

Mendoza et al. (2016).

Table 4 Pre-service teachers' perceived efficacy on teaching mathematics

Questionnaire Items	Mean Scale Value	Standard Deviation
I perceive that females can equally handle maths lesson as males do.	4.1	0.9
I am good to select and apply relevant Historic Materials and Methodologies in my lesson.	4.2	0.8
My performance on teaching mathematics requires improvement.	3.0	2.0
Female mathematics teachers serve as my role models.	4.0	1.0
Searching for historic development of math topics in curriculum helps me get more knowledge and skills to teach well.	4.4	0.6
Starting mathematics lessons with maths anecdotes fosters learner's interest.	3.3	1.7
I perceive all maths lessons could be linked to a historic anecdote.	1.8	3.2
I perceive mathematics lesson preparations need no further research online apart from curriculum materials.	3.3	1.7
Teaching mathematics and using technology for lesson presentation/delivery is challenging.	3.7	1.3
Teaching maths involves mere manipulation of figures.	2.8	2.2

Table 4 shows mean values for the questionnaire items on participants' perceived mathematics self-efficacy after the lesson study.

5.2 *Impact of incorporating related historic resources to mathematics lessons*

The study revealed that all participants were able to identify related mathematics anecdotes to the topics chosen from the four strands in the basic school curriculum. Question and answer sessions during the PowerPoint presentation unveiled that incorporating related historic resources like anecdotes and methodologies in lessons enriched pre-service teachers' inquiry and the culture of mathematical research. This is related to Furner et al. (2016) who claim that; providing interesting mathematical anecdotes arouses learners' interest and shapes their perception positively towards inquiring more into the subject. The culture of research was developed since surfing the internet for historic facts revealed lots of mathematical information about the development of mathematical concepts, problems and solutions. This made participants learn from each other during the lesson study and observation process. The preparation of PowerPoint slides on the history of mathematical strands informed participants of the need to integrate ICT into mathematics lesson preparation and classroom presentation. Results of the Grade Descriptor Grid showed that the performance of female pre-service mathematics teachers was good. Finally, after analyzing entries of the Students' Reflective Journal of participants, it was established that pre-service teachers have ascertained that the teaching of mathematics requires adequate preparations on the part of the teacher. Thus teachers have an essential role in ensuring the accuracy and consistency of judgements of learners' progress, achievement and final attainment.

6. Conclusion

In answering the research questions for the study:

1. What are the levels of pre-service teachers' self-efficacy in lesson preparation, lesson development and presentation during lesson study?

Findings showed pre-service teachers exhibited a moderate self-efficacy level in the three phases of lesson design. The study revealed that female pre-service teachers possess the confidence and pedagogical content knowledge to teach some basic school mathematics topics. This was displayed in their lesson preparation, lesson development and lesson presentation.

2. How are pre-service teachers' self-efficacy enhanced through incorporating the history of mathematics into lessons study?

Participants performed moderately well by integrating HOM into lesson instruction. The impact of incorporating HOM in lessons included: change of pre-service teachers' perception about teaching mathematics, a positive attitude towards mathematics, broadened conceptual knowledge and exposure to the multiplicity of problem-solving approaches. Pre-service teachers' self-efficacy was identified to have the confidence using their phones, laptop and other digital devices in searching and selecting appropriate mathematical tasks as lesson starters unlike formally relying on textbooks and local songs which were at times unrelated to lessons.

Although the belief that mathematics is a masculine discipline has led to a low female enrollment especially at the teacher education level, this research revealed that female pre-service teachers possess moderate self-efficacy in teaching mathematics. Therefore, the few enrolled females in mathematics education who have the hope and potential to teach mathematics at basic schools need to be enriched with innovative pedagogical strategies and skills to build their confidence in handling mathematics contents. Enhancing female pre-service mathematics teachers' self-efficacy will propel them to higher heights to bridge the gap of gender disparity towards the subject. This will also create the opportunity for females to serve as role models for young learners.

The study, therefore, recommends that teachers explore ways mathematics can relate its history and appropriately infuse those strategies into planning lessons and classroom teaching. Teachers should make cultural connections into the math curriculum and expose learners to more historic math manipulatives during lesson instruction.

It is also recommended that further research dives into the relationship between female prospective teachers' self-efficacy and their mathematics achievement.

Practicing mathematics teachers is encouraged to enroll in professional development sessions and in-service training on the use of lesson study in collaborative teaching. Stakeholders in mathematics education should devise mechanisms to encourage females to pursue and participate in mathematics education programs at all levels of education.

Conflict of interest

The authors declare no competing financial interest.

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