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RESEARCH ARTICLE

Article Info

Received:

August 3, 2022

Accepted:

October 25, 2022

Published:

November 20, 2022

Keywords

Attitude
Innate Characteristics
Mathematics Achievement
Preservice Teachers
Self-Concept
Self-Efficacy

Suggested Citation:

Dua, C. C. R., Mancera, A. C., Solis, Y. J. R., Pentang, J. T., & Bautista, R. M. (2022). Preservice teachers' self-concept, self-efficacy, and attitude: Its implications to mathematics achievement. *Studies in Technology and Education*, 1(1), 1-13.

PRESERVICE TEACHERS' SELF-CONCEPT, SELF-EFFICACY, AND ATTITUDE: ITS IMPLICATIONS TO MATHEMATICS ACHIEVEMENT

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Abstract

This correlational study investigated the relationship between preservice teachers' math self-concept, self-efficacy, and attitude with their math achievement. Participants were chosen using stratified random sampling from BEd and BSEd mathematics majors (n = 117). From the findings, preservice teachers had moderate to high math self-concept, self-efficacy, and attitude. These variables were statistically correlated with each other and with math achievement. The inclusion of training programs for developing the preservice teachers' math self-concept, self-efficacy, and attitude, as well as designing curricula that engage and encourage them to do mathematics and problem-solving, must be considered among teacher education institutions.

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INTRODUCTION

Many countries are confronting the issue of a lack of qualified teachers. The decreasing number of qualified teachers threatens the student's learning and the teacher's effectiveness (Garcia & Weiss, 2019). Align with the concerns expressed on the critical issues. Including teaching and preservice teacher training preparation in the teacher education curriculum benefits teaching. It is the essential component of every preservice teacher that needs to experience it (Kelly, 2019) because it dramatically impacts their teaching career and student outcomes. Practice teaching is not enough preparation for preservice teachers. Therefore, teacher education institutions establish teaching and training preparation programs to fully equip preservice math teachers and produce high-quality teachers (Pentang, 2019; Pentang et al., 2022). The training preparation of preservice teachers can be influenced by three innate characteristics: math self-concept, self-efficacy, and attitude.

Self-concept

The self-concept of preservice teachers can influence their input, especially in teaching mathematics. Self-concept is a critical moderator that affects both cognitive and affective aspects of oneself (Vinney, 2018). It has an impact on how they teach mathematics in the classroom. The self-concept of preservice teachers deals with how they express their feelings in mathematics, how they interact with mathematics, how to make decisions and how they act in certain situations, particularly when mathematics is involved. Numerous theories about self-concept have the same beliefs, with social interaction being the most critical factor in the formation of self-concept. It emerges during childhood and the early stages of adulthood and is acquired rather than innate (Ackerman, 2018). These theories imply that in the early stages of human development, it is essential to introduce and create a positive mathematics self-concept so that a person will carry positive views while growing. The active participation and involvement of preservice teachers in mathematics develop a positive math self-concept that may be used in teaching mathematics. These theories also help preservice teachers further understand the vital role of self-concept in learning and teaching mathematics.

Self-efficacy

Self-efficacy is a factor that has a crucial effect on the cognitive aspects of preservice teachers, particularly in mathematics courses (McCampbell, 2015). The mathematical self-efficacy of preservice teachers plays a vital role in doing and teaching mathematics. The belief of preservice teachers in their ability to solve various mathematical problems may affect the actual teaching of mathematics and the student's learning outcomes. These can affect their ways of executing mathematics problems. It also identifies the amount of effort preservice teachers expend in performing specific mathematical tasks and how they handle negative situations (Phan, 2012). Consequently, the high math self-efficacy of preservice teachers has positive effects on doing and teaching mathematics, while low math self-efficacy tends to cause difficulties in performing mathematics.

Attitude

Attitude is another factor related to the preservice teachers' behaviors toward mathematics (Jain, 2014). Besides, preservice teachers' attitude affects how they react or respond when doing mathematics. Preservice teachers' attitudes can be negative or positive. As a result, the negative attitude of preservice teachers can lead to negative behavior and a positive one to positive behavior. Hence, preservice teachers should

possess a positive attitude towards mathematics to enrich their interest in teaching mathematics. In that case, preservice teachers show good behavior when teaching mathematics. The importance of this aspect is observable in the actual encounters of a mathematics course, whether in solving or teaching situations.

Study Objectives

A strong sense of mathematical self-concept, self-efficacy, and the attitude of preservice teachers positively influenced their achievement in teaching mathematics. Preservice teachers with a positive math self-concept, math self-efficacy, and math attitude are said to be effective and productive in teaching. The study investigated the implications of these three variables toward mathematics achievements. Hopefully, the findings will help preservice teachers develop strategies for improving their mathematics performance. Additionally, this research may aid in developing such methods for an appropriate instructional process. It may give preservice teachers various knowledge to help them assess their proficiency in dealing with mathematics.

Generally, this study aims to determine the math self-concept, self-efficacy, and attitude of the preservice teachers and its implications for mathematics achievement. Specifically, the study was able to:

1. describe the preservice teachers' math self-concept, self-efficacy, and attitude levels;
2. investigate the significant relationship among the preservice teachers' math self-concept, self-efficacy, and attitude; and
3. explore the significant relationship between the preservice teachers' math self-concept, self-efficacy, and attitude toward math achievements.

LITERATURE REVIEW

Math Self-Concept

Self-concept refers to how individuals view themselves and "how they think about, evaluate or perceive themselves" (Jordan, 2020). It influences how we look in our body, express our feelings and emotions, interact with others, draw inferences and respond in certain situations (Maddux & Kleiman, 2022). Self-concept is related to academic performance (Caasi & Pentang, 2022), and mathematical self-concept is one of the mediating factors influencing students' mathematics achievements (Timmerman et al., 2017). It refers to people's views on mathematics (Erdogan, 2014). A student's math self-concept is essential to education and is related to effective learning. Longitudinal studies show that mathematics self-concept and achievements are significantly related over time (Hannula et al., 2014), while cross-sectional studies show that math self-concept and mathematics achievement have significant gender and cultural differences (Han, 2019).

Math self-concept can be positive for learners who like or love mathematics and unfavorable for those who struggle with this subject. A positive self-concept can make the learners feel more capable, which results in good performance and affects students' achievement (Caasi & Pentang, 2022). Thus, a low math self-concept indicates that the individual is unequipped and cannot cope with the demands of different real-life math problems. As preservice teachers, math self-concepts should be positive because they represent a substantial improvement for the teachers and an advancement in teaching itself, and teachers' positive math self-concepts will positively affect students' achievement in mathematics is greatly influenced by teachers' attitudes toward teaching the subject (Takunyaci, 2021). Their self-concept is an important factor influencing their professional

capability (Beudels et al., 2021). Preservice teachers often struggle with challenges relating to their self-concept, ideas about teaching, and perceptions or attitudes about teaching programs and the profession (Moen & Green, 2014).

Math Self-Efficacy

Self-efficacy relates to a learner's perception of the abilities required to perform to a standard and achieve academic goals (Santos et al., 2022). It is an emotional factor affecting preservice teachers' mathematics achievements (Masitoh & Fitriyani, 2018). Self-efficacy belief significantly impacts achievement in academic settings (Hayat et al., 2020), where preservice teachers with higher self-efficacy can experience more satisfaction in mathematics due to well-developed cognitive domains than students with low self-efficacy (Betoret et al., 2017). Still, math self-efficacy may differ based on learning styles (Santos et al., 2022).

In mathematics, self-efficacy refers to students' self-belief in their ability to perform various mathematical tasks (Macmull, 2019). Therefore, preservice teachers' math self-efficacy deals with their beliefs that they can successfully solve different mathematics tasks and problems (Watson, 2015). Other experiences in mathematics can influence their math self-efficacy. A negative experience in mathematics leads to lower math self-efficacy, and positive mathematics experiences can lead to higher math self-efficacy (Yildiz & Özdemir, 2019). Individuals with high math self-efficacy are more interested in learning mathematics, whereas those with low self-efficacy may avoid mathematics tasks (Skaalvik, 2015). Active participation and performing mathematics tasks or problems lead to a high level of math self-efficacy and high mathematics achievements (Arifin et al., 2021). Therefore, it is suggested that teachers in the teacher education program may be doing more to aid in developing preservice teachers' mathematical self-efficacy (McGuire, 2016).

Math Attitude

Teachers with a positive attitude toward mathematics can teach math problems well, and the learners can easily understand the lesson (Bacsal et al., 2022; Ibañez & Pentang, 2021). They inspire students to have positive beliefs about mathematics. The math attitude of preservice teachers can also affect future learners' perspectives. Having a positive attitude in preservice teachers reflects on what their students acquire, which causes them to achieve high mathematics achievements. "Teacher's attitudes, biased against historically marginalized groups, predict lower achievement in mathematics" (Battey et al., 2021). Therefore, having biased views and dealing with students is not conducive to having high student achievements in mathematics.

Attitude toward learning is an essential factor that may influence performance (Bacomo et al., 2022; Capuno et al., 2019). Attitudes significantly impact the mathematics achievement of learners. A positive attitude is associated with higher achievements, while a negative attitude appears to be poor performance (Kennedy, 2019; Bacomo et al., 2022). It is feasible that you will succeed in mathematics if you have a favorable attitude toward the subject. When you have a positive outlook on mathematics, you will have a high possibility of achievement. "Students who (a) enjoy studying math and participating in mathematics-related activities, (b) believe that learning math will result in a positive outcome, (c) believe in their math abilities are more likely to have a high mathematics achievement" (Hwang & Son, 2021).

METHODOLOGY

Research Design and Participants

This study used descriptive-correlational research to determine the preservice teachers' math self-concept, math self-efficacy, and math attitude and their implications on mathematics achievement. A sample of 117 preservice teachers from a State University in West Philippines enrolled in the Bachelor in Elementary Education (BEEd), and Bachelor in Secondary Education (BSEd) programs with a mathematics major participated in this study. They were chosen as participants based on their area of specialization through stratified random sampling. Strata are created within the population according to year levels (second-year, third-year, and fourth-year).

Instrumentation

The research instrument consisted of a 30-item statement (10-item for each variable) in determining the preservice teachers' math self-concept, self-efficacy, and attitude. The math self-concept, math self-efficacy, and math attitude questionnaires were modified from Alghazo (2016), Zuya et al. (2016), and Sanchal and Sharma (2017), respectively. The instrument was reviewed and revised, pilot-tested, and subjected to validity and reliability testing before administering it to the participants. Preservice teachers' degree of answer for each statement is expressed on a 4-point scale. The four options were: strongly agree (SA), agree (A), disagree (D), and strongly disagree (SD). Statement responses were coded on a scale of 4, 3, 2, and 1, correspondingly. Meanwhile, the mathematics achievement of the preservice teachers was based on their general weighted average from their math courses.

Data Collection Procedures and Analysis

First, the researchers obtained approval from school authorities. Then, the handling and retrieval of the questionnaire. Before giving out the questionnaire, the researchers sought from the participants. Lastly, the data have been gathered and tabulated. Descriptive statistics (weighted mean and standard deviation) were utilized to define the participants' math self-concept, self-efficacy, and attitude. At the same time, Spearman rank correlation, r_s (tested at .05 significance level), was used to flag relationships among the variables under study. The data collection and analysis procedures were rooted in Magulod et al. (2021) and Pentang (2021).

Ethical Consideration

The researcher ensured that all participants from various year levels participated voluntarily. Every participant is well-informed about the study's methodology. To avoid offending them, researchers assure them that the information gathered from all respondents is private and will not be shared with other students. The participant's responses to the related questions were regarded as credible and relevant data.

RESULTS AND DISCUSSION

Preservice Teachers' Math Self-Concept

Generally, the preservice teachers have a moderate math self-concept (Mean = 2.46, SD = 0.69) [Table 1]. The results indicate preservice teachers' personal views of their abilities to do, perform, and successfully overcome mathematics tasks and activities, but not to the full extent. Preservice teachers still claim that mathematics is challenging and one of the most difficult subjects. They feel upset when they cannot solve a mathematical problem

and are unsure if they are math people. These findings relate to Mutodi and Ngirande's (2014) finding that a lack of mathematical proficiency may reduce math self-concept. How the preservice teachers perceive mathematics can influence their level of math self-concept. This is alarming to note since they will be future math teachers. The preservice teachers' moderate or even low self-concept may have negative implications for their teaching practice and, eventually, their students. It is essential to understand how these preservice teachers conceptualize their mathematics skills and ability, which is a variable that can affect their preparation as role models of mathematics.

Table 1: Preservice Teachers' Math Self-Concept

Statement	Mean	SD	Description
I can understand math lessons easily.	2.80	0.56	High
I have no problem understanding math concepts.	2.52	0.64	High
Math is too challenging for me to understand well.	1.87	0.61	Moderate
I have generally done better in math than in other subjects.	2.63	0.76	High
I am a math person.	2.42	0.77	Moderate
I can get good grades in mathematics.	2.71	0.67	High
Solving mathematical problems can be pleasant and exciting.	3.03	0.65	High
I get upset when I cannot solve a mathematical problem.	2.03	0.78	Moderate
Mathematics is one of the most challenging subjects for me.	2.23	0.85	Moderate
I can solve any mathematics problem quickly.	2.40	0.62	Moderate
Grand Mean	2.46	0.69	Moderate

Legend: 3.26 - 4.00 = Very High; 2.51 - 3.25 = High; 1.76 - 2.50 = Moderate; 1.00 - 1.75 = Low

Preservice Teachers' Math Self-efficacy

The preservice teachers have a high level of math self-efficacy (Mean = 2.71, SD = 0.65) [Table 2]. This result is influenced by the preservice teachers' belief that they can understand the content taught in mathematics courses. Therefore, this belief pushes them to be active participants during mathematics class and may result in excellent grades in mathematics. As Arifin et al. (2021) and Skaalvik (2015) emphasized, high math self-efficacy increases students' interest in learning mathematics, while individuals with low math self-efficacy may avoid mathematics tasks.

Table 2: Preservice Teachers' Math Self-efficacy

Statement	Mean	SD	Description
I will expect to do well in the mathematics class	3.00	0.62	High
I can complete the tasks and problems given.	2.66	0.58	High
I feel confident when taking mathematics tasks.	2.62	0.68	High
I like asking questions during math class.	2.82	0.69	High
I am a person doing-well in mathematics.	2.51	0.66	High
I can successfully perform mathematics task	2.68	0.65	High
I can perform mathematics problems and tasks excellently.	2.58	0.66	High
I do not doubt using mathematics anywhere.	2.58	0.70	High
I believe I can get an excellent grade in a mathematics course.	2.68	0.63	High
I can understand the content taught in a mathematics course.	2.87	0.61	High
Grand Mean	2.70	0.65	High

Legend: 3.26 - 4.00 = Very High; 2.51 - 3.25 = High; 1.76 - 2.50 = Moderate; 1.00 - 1.75 = Low

Confidence in completing mathematical tasks and activities can increase math self-efficacy, which leads to an interest in learning or doing more mathematics. This is shown in Santos et al. (2022), where students' self-efficacy positively predicted their competency in mathematics. These preservice teachers can help their future students who may struggle or have low self-esteem, especially with their math courses. Self-efficacy is a more substantial variable observed in preservice teachers regarding their belief in their ability to complete mathematics tasks and problems. These preservice teachers who believe in their capability to do mathematics will do mathematics and may teach it successfully. In Giles et al. (2021) and Zuya et al. (2016), preservice teachers' math self-efficacy is significantly related to their mathematics teaching efficacy.

Preservice Teachers' Math Attitude

The preservice teachers have a high math attitude (Mean = 2.72, SD = 0.69) [Table 3], which is necessary to perform mathematical tasks and activities successfully. This result is influenced by the participants' interest, enjoyment, and confidence in mathematics, which opposes the report of Bacsal et al. (2022), Ibañez and Pentang (2021), and Pentang (2019), where preservice teachers have a negative disposition toward mathematics. While some of the participants still feel afraid of mathematics, which makes them nervous when they encounter this course. Concerning Hwang and Son (2021), preservice teachers could achieve better in mathematics if they like studying mathematics and accomplishing math-related activities, believe that learning mathematics has a positive outcome, and believe in their mathematical abilities. If a teacher has a positive attitude, the same will result in their teaching of mathematics. With this, there will be constructive achievements in teaching and learning.

Table 3: Preservice Teachers' Math Attitude

Statement	Mean	SD	Description
I am comfortable during math class.	2.93	0.65	High
Studying mathematics makes me feel nervous.	2.08	0.70	Moderate
Mathematics does not scare me at all.	2.43	0.70	Moderate
I like mathematics.	3.04	0.72	High
I have usually enjoyed studying mathematics in school.	3.00	0.66	High
I like to solve different mathematics problems.	2.81	0.66	High
I prefer to do various mathematics tasks than other subjects.	2.74	0.77	High
I like the topics in the mathematics course.	2.85	0.65	High
I am comfortable expressing my ideas during math recitation.	2.74	0.72	High
I like reciting during math class.	2.64	0.71	High
Grand Mean	2.72	0.69	High

Legend: 3.26 - 4.00 = Very High; 2.51 - 3.25 = High; 1.76 - 2.50 = Moderate; 1.00 - 1.75 = Low

Relationship among Preservice Teachers' Math Self-concept, Self-efficacy, and Attitude

The correlational analysis revealed that math self-concept has a highly significant relationship with math self-efficacy ($r_s = .697, p < .01$) and math attitude ($r_s = .750, p < .01$) [Table 4]. Math self-efficacy was also found to have a highly significant relationship with math attitude ($r_s = .819, p < .01$). This means that having a positive math self-concept implies having a positive math self-efficacy and a positive math attitude. Positive math self-efficacy directly relates to a positive math attitude. These findings corroborate previous research (Gillo, 2021; Kundu & Ghose, 2016; Parker et al., 2013), where high math self-concept is associated with high math self-efficacy and a math attitude, while lower math self-efficacy is connected with a negative attitude toward mathematics. Still, these findings

need further verification as the descriptive statistics revealed that the preservice teacher's math self-efficacy and attitude are favorable, yet their self-concept was fair.

Table 4: Relationship among Preservice Teachers' Math Self-Concept, Self-Efficacy, and Attitude

Variables	r_s	p-value	Interpretation
Math Self-Concept and Math Self-efficacy	.697	.001	The relationship is significant
Math Self-Concept and Math Attitude	.750	.001	The relationship is significant
Math Self-Efficacy and Math Attitude	.819	.001	The relationship is significant

Relationship between Preservice Teachers' Math Self-concept, Self-efficacy, and Attitude with Achievement

Mathematics achievement has a significant relationship with math self-concept ($r_s = .288$, $p < .01$), math self-efficacy ($r_s = .224$, $p < .05$), and math attitude ($r_s = .280$, $p < .01$) [Table 5]. This result suggests that high math self-concept, self-efficacy, and attitude are related to high math achievement. The preservice teachers' confidence and positive outlook toward mathematics can be reflected in their achievements. This finding is related to Capuno et al. (2019), Hannula et al. (2014), Kennedy (2019), and Timmerman et al. (2017). Preservice teachers' math self-concept, self-efficacy, and attitudes toward mathematics play a crucial role in their mathematics achievement. An optimistic view, behavior, and belief toward mathematics depend on each other.

Table 5: Relationship between Preservice Teachers' Math Self-concept, Self-efficacy, and Attitude with Achievement

Variables	r_s	p-value	Interpretation
Math Self-concept and Math Achievement	.288	.002	The relationship is significant
Math Self-efficacy and Math Achievement	.224	.015	The relationship is significant
Math Attitude and Math Achievement	.280	.002	The relationship is significant

CONCLUSION

The preservice teachers' math self-concept, self-efficacy, and attitude were explored, and their relationship was ascertained. Besides, the implications of these variables on their math achievement were examined. Preservice teachers have moderate to high innate characteristics in mathematics. They may be able to learn and teach math, yet there might be instances when they cannot accomplish mathematical tasks. The study has established that preservice teachers' innate characteristics (math self-concept, self-efficacy, and attitude) are attributed to their success in learning mathematics, which can be extended to their success in teaching mathematics. We proposed that future math teachers' added positive innate characteristics are the key to successful math achievement. In due course, this achievement will imply a stronger foundation for the preservice teachers' self-concept, self-efficacy, and attitude in teaching math (Figure 1).

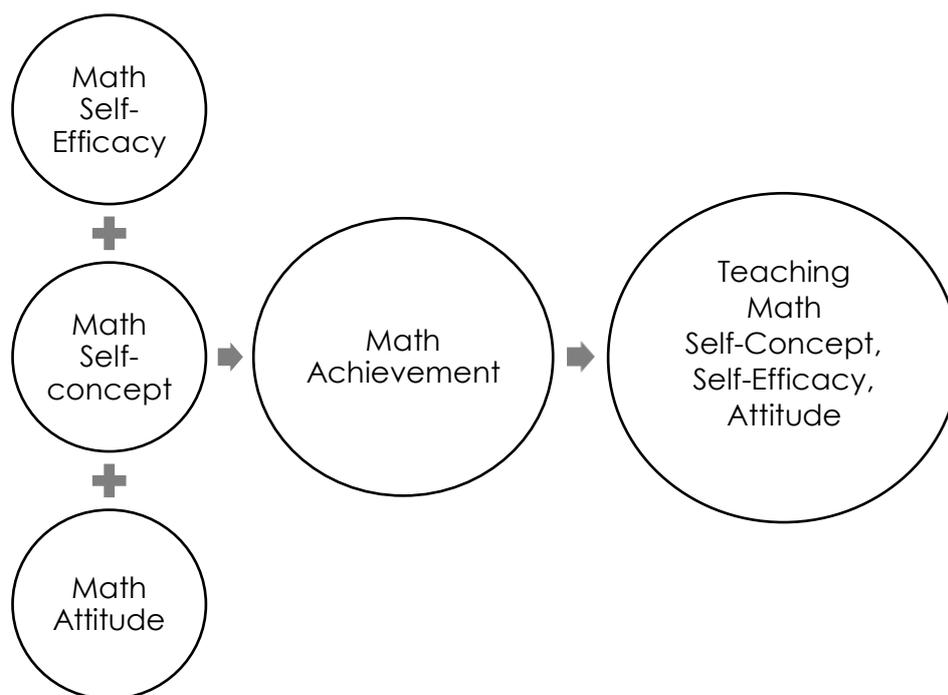


Figure 1. Innate characteristic variables attributed to preservice teachers' math achievement

Mathematics teacher educators should create math-related activities that will let preservice teachers enjoy doing mathematics, use innovative teaching strategies that will fit with their diverse backgrounds, and ensure that they will experience authentic learning in solving math-related tasks. Implementation of various training and preparation programs that focus on preservice teachers' personal development, including raising the level of math self-concept, math self-efficacy, and math attitude of the students, should be encouraged in the College of Education. Furthermore, curriculum designers should create a curriculum that focuses on the course content and how to foster preservice teachers' innate characteristics in mathematics. A similar study must be conducted to verify the findings established and the model proposed.

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