EJSIT
European Journal of Science, Innovation and Technology
ISSN: 2786-4936
www.ejsit-journal.com
Volume 5 | Number 1 | 2025

Academic Background, Engagement, and Self-Efficacy: A Correlational Analysis to Academic Achievement of Pre-service Mathematics Teachers

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ABSTRACT

Pre-service mathematics teachers' academic success is a crucial indicator of effective and competent mathematics educators. Identifying the factors influencing their academic achievement offers valuable insights for teacher preparation programs. This study investigates the interplay between academic background, academic engagement, mathematics self-efficacy, and academic achievement. The study employed a descriptive-correlational research design encompassed 71 pre-service mathematics teachers who participated voluntarily. Findings indicate pre-service teachers had diverse academic backgrounds and held moderate levels of academic achievement, academic engagement, and mathematics self-efficacy. Notably, disparities in mathematics achievement are evident, with male pre-service teachers and those aspiring to specialize in mathematics achieving higher levels. Furthermore, the study underscores a positive correlation between heightened academic engagement, self-efficacy, and enhanced mathematics achievement, underscoring the pivotal role of active engagement and confidence in fostering mathematical proficiency among pre-service teachers.

Keywords: Academic Background, Engagement, Self-Efficacy, Academic Achievement, Pre-service Mathematics Teachers

INTRODUCTION

Academic achievement is a critical metric for assessing students' progress and success. It involves gaining knowledge and skills and applying them in diverse educational and real-world contexts. The academic achievement of pre-service mathematics teachers is essential for cultivating proficient mathematics educators who can inspire and effectively teach future generations. Among the myriad factors, three constructs have garnered considerable attention: academic background, engagement, and self-efficacy. Understanding the factors contributing to their academic achievement can provide valuable insights for teacher education programs.

Academic background encompasses students' prior educational experiences and achievements in their teacher education programs. It serves as a foundation upon which further learning is built. Academic literature has emphasized the significant influence of students' characteristics and various contextual factors on their educational outcomes (Gutiérrez-de-Rozas et al., 2022). Nopiah et al. (2011) major findings highlight that pre-university qualifications and sex were associated with better academic performance. In addition, Ribeiro et al. (2019) emphasize that strong academic preparation can act as a protective factor, even when a surface approach is used. A positive correlation exists between academic preparation and adopting a deep approach, indicating that students with higher academic achievement are more likely to engage in deep learning. Thus, understanding sociodemographic characteristics and student academics can be crucial for structuring the teaching-learning process and proposing interventions in education programs (Freitas et al.,

2012). A solid academic background is advantageous for better performance in advanced mathematics courses and a greater likelihood of success in teaching mathematics.

Academic engagement refers to the extent to which students are involved in their learning processes, including participation in academic activities, investment in learning, and commitment to educational goals (Trowler, 2010). It encompasses a range of specific classroom behaviors, including writing, participating in tasks, reading aloud and silently, discussing academic topics, and asking and answering questions (Greenwood et al., 2002). According to the literature review of Alrashidi et al. (2016), there are two major approaches to engagement: Fredricks et al.'s (2004) Model of Engagement entails students' cognitive, behavioral, and emotional engagement, while Schaufeli et al.'s (2002) Model of Engagement is characterized by vigor, dedication, and absorption. Both engagement models comprehensively evaluate different dimensions of students' academic engagement, emphasizing how deeply engaging with their studies correlates with achieving successful academic outcomes. This connection underscores the critical role that active and committed participation in learning plays in students' overall educational success. Moreover, Montano (2021) underlines that engagement contributes to students' academic success and is considered a malleable variable influenced by how teachers structure instructional opportunities. It can also serve as skills that facilitate learning and achievement. Furthermore, students who are highly engaged academically and perform well are more likely to be proactive about their future careers, exercise personal control over their career choices, explore future possibilities with curiosity, and build confidence in pursuing their career goals (Datu & Buenconsejo, 2021). Engaged students tend to exhibit higher motivation, persistence, and academic achievement levels.

Self-efficacy is an individual's belief in their ability to succeed in specific tasks or situations (Bandura, 1997). In the context of pre-service mathematics teachers, self-efficacy relates to their confidence in their ability to understand and teach mathematical concepts. Pre-service teachers confident in their mathematical skills are also more likely to believe in their ability to teach mathematics effectively (Zuya et al., 2016). This correlation suggests that fostering strong mathematical self-efficacy in pre-service teachers could enhance their teaching self-efficacy, ultimately improving their instructional effectiveness and student outcomes. The study of Parker et al. (2017) found strong connections between achievement, self-efficacy, and self-concept in mathematics. Both self-efficacy and self-concept independently and equally predicted tertiary entrance ranks at the end of high school. Additionally, math self-efficacy emerged as a significant predictor of university admission. Furthermore, the study of Yurt (2014) found significant relationships between various sources of mathematics self-efficacy and achievement. Personal experiences, social persuasions, and physiological states were identified as the most significant predictors of mathematics achievement. Strong self-efficacy correlates with better academic achievement and persistence. Students who believe in their abilities are likelier to set ambitious goals, work hard, and persevere through challenges (Shengyao et al., 2014).

Despite extensive research on academic background, academic engagement, and self-efficacy individually, there is a lack of studies that simultaneously examine these factors and their combined impact on the academic achievement of pre-service mathematics teachers. Most existing studies focus on one or two of these factors in isolation or different populations, such as general teacher education or K-12 students. This gap in the literature highlights the need for a comprehensive analysis that considers the unique context of pre-service mathematics teachers.

This study addresses the identified research gap by conducting a correlational analysis of academic background, academic engagement, and self-efficacy with academic achievement, specifically among pre-service mathematics teachers. The present research aims

to provide targeted insights that can inform the development and enhancement of mathematics teacher education programs. The findings of this study will not only enhance the theoretical understanding of these constructs but also offer practical implications. Understanding the interplay between these factors can lead to more effective strategies for supporting pre-service teachers in their academic and professional growth.

Research Objectives

This research explores various aspects related to the achievement of pre-service mathematics teachers. Firstly, it describes their academic backgrounds, encompassing their profile and educational qualifications. Secondly, it aims to detail their mathematics achievements, including their performance in academic assessments and related coursework. Thirdly, the study investigates the academic engagement of these pre-service teachers, examining their participation, interaction, and commitment to educational activities. Furthermore, the research analyzes the mathematics self-efficacy of pre-service mathematics teachers, assessing their beliefs and confidence in their abilities to understand mathematics effectively. It also aims to determine if there are differences in mathematics achievement based on their academic backgrounds, examining how varying educational experiences may impact their performance in mathematics. Lastly, the study explores the relationship between academic achievement, mathematics self-concept, and academic self-regulation among pre-service mathematics teachers. The research aims to provide insights into how these variables interact and influence future mathematics educators' educational outcomes and professional development by examining these factors.

MATERIALS AND METHODS

Research Design

This research study applied descriptive – correlational research design. Correlational research is useful for determining the prevalence and relationships between variables and forecasting future events using current data and knowledge. It enables researchers to determine the direction and strength of relationships between variables, paving the way for more in-depth investigations (Cutis et al., 2016). This study explores the association of academic background, engagement, and self-efficacy with the mathematics achievement of pre-service teachers.

Respondents of the Study

The study included 71 pre-service mathematics teachers, using total population sampling to ensure precise and valid representation. These participants were second-year students at the Nueva Ecija University of Science and Technology, specializing in mathematics education, and enrolled in a mathematics class.

Research Instrument

Academic Background

The questionnaire for academic background was designed to gather data regarding the demographic and educational information of the participants. It included several categories: sex, socioeconomic status, type of school, Senior High School (SHS) strand, and academic awards received in SHS. Additionally, it inquired whether mathematics was the respondent's preferred field of specialization. This comprehensive questionnaire provided a detailed overview of the respondents' profiles and academic backgrounds.

Academic Engagement

Engagement was measured using the Utrecht Work Engagement Scale for Student Survey (UWES-9S) by Schaufeli et al. (2006). The UWES-9S measures student engagement characterized by a positive, fulfilling, work-related state of mind. It has three subdomains, namely vigor (e.g., "I feel energetic and capable when I'm studying or going to class"), dedication (e.g., "I am proud of my studies"), and absorption (e.g., "I am immersed in my studies"). Respondents were asked to rate their agreement with each item on a scale ranging from 1 (Never) to 4 (Always). In the present research, the composite score of the UWES-9S was computed to obtain an overall engagement score. The reported internal consistency of the instrument was $a = .90$ (excellent). Hence, UWES–9S produces scores that could be of value, in terms of reliability and validity, in measuring the academic engagement of undergraduate university students (Carmona-Halty et al., 2019).

Mathematics Self-Efficacy

The Mathematics Self-Efficacy Questionnaire by May (2009) measures students' confidence in their mathematical abilities. The questionnaire consists of 14 statements rated on a 4-point Likert scale, from 1 (never) to 4 (usually). The statements include: "I feel confident enough to ask questions in my mathematics class" and "I believe I can do well on a mathematics test." The reported Cronbach's alpha of this scale was $a = .93$ (excellent). Thus, the questionnaire was reliable, valid, and efficient to administer.

Mathematics Achievement

The mathematics achievement of the pre-service mathematics teachers was measured by examining their course grades in a mathematics class. Grades summarize students' progress and accurately represent the student's academic achievement (Allen, 2005).

Collection Procedure

This study implements an organized data collection procedure encompassing three phases. Initially, the study underwent an ethics review at the college to ensure safety, fairness, and impartiality. Subsequently, formal approval was secured from the Dean of the College of Education, with additional endorsement from the department's area chairman. Finally, the instruments were administered through online and face-to-face surveys. The researcher informed the respondents about the study's objectives and data handling procedures, obtained consent, and distributed the questionnaires. Then, the students were given 10-15 minutes to reflect on and respond to the questionnaire.

Data Analysis

The research study utilized both descriptive and inferential statistics. First, frequency count and percentage were used to describe the participants' academic background and mathematics achievement. Second, mean scores and standard deviation were used to describe mathematics achievement, academic engagement, and mathematics self-efficacy. Third, independent t-test and analysis of variance were used to test the difference in mathematics achievement based on academic backgrounds. Lastly, Pearson's r correlation coefficient was used to analyze the relationship between academic engagement, self-efficacy, and mathematics achievement.

Ethical Considerations

The researcher meticulously adhered to ethical guidelines during data collection. He communicated the study's objectives, obtained consent from participants, and assured them of confidentiality. Participants volunteered willingly and could withdraw from the study at any point. The researchers also complied with the provisions of the Philippines' Data Privacy Act of 2012, ensuring the protection of participants' rights and confidentiality throughout the

research process. These measures were crucial in upholding ethical standards and safeguarding the integrity of the study.

RESULTS AND DISCUSSION

Academic Background of the Pre-Service Mathematics Teachers

Table 1. Academic Background

Academic Background	f	%
Sex		
Male	13	18.31
Female	58	81.69
Socio-economic Status		
less than ₱10,957	23	32.39
between ₱10,957 to ₱21,194	33	46.48
between ₱21,194 to ₱43,828	12	16.90
between ₱43,828 to ₱76,669	3	4.23
Type of School		
Private	17	23.94
Public	54	76.06
SHS Strand		
Accountancy, Business and Management Strand (ABM)	12	16.90
Science, Technology, Engineering, and Mathematics (STEM) Strand	11	15.49
Humanities and Social Science (HUMSS) Strand	36	50.70
General Academic Strand (GAS)	10	14.08
Technical-Vocational-Livelihood (TVL) Track	2	2.82
Academic Awards in SHS		
None	22	30.99
With Honors	49	69.01
Mathematics as 1st Choice of Field of Specialization		
No	22	30.99
Yes	49	69.01
Total	**71**	**100.00**

Table 1 presents the profile and academic background of 71 pre-service mathematics teachers.

Firstly, the sex distribution shows that there was unequal representation of pre-service teachers in the field of education, with females accounting for 81.69% (58 out of 71) of the population while males represent only 18.31% (13 out of 71). The data shows that the majority of the pre-service teachers were female. It only reflects the existing trends that women dominate the teaching profession. UNESCO (2023) data reveals the global trend that women, particularly in basic education, increasingly dominate the teaching profession. They explain the differences in representation were due to cultural norms and gender biases that associate child education and caregiving with women. Increasing teacher diversity is critical for eliminating gender stereotypes and addressing labor shortages in the teaching profession. Men's aspiration to enter female-dominated occupations traditionally was influenced by several factors such as peers, parental educational attainment, and the projected growth of an occupation (Hardie, 2015).

Regarding socioeconomic status, the table above also shows the economic capability of the respondents. Socioeconomic status is essential to understand the context of the student's lives and educational experiences. The data reveals that nearly half of the respondents (46.48%) belong to households with an income between ₱10,957 and ₱21,194, placing them in a lower-income bracket. Additionally, 32.39% of students come from families earning less than ₱10,957, highlighting a substantial portion of the sample from poor backgrounds. Smaller percentages of students fall into middle-income brackets, with 16.90% earning between ₱21,194 and ₱43,828 and only 4.23% earning between ₱43,828 and ₱76,669. The results align with the 2021 Philippine Statistics Authority, which shows that 58.4% of Filipinos are low-income, while approximately 40% belong to the middle class. A small minority, only 1.4%, are considered high-income. The slight difference in the low-income and middle-class proportion is because state universities and colleges are mandated to cater to students with poor and low-income financial capabilities. Thus, the data suggests that many pre-service mathematics teachers might face economic challenges, impacting their educational opportunities and outcomes.

In addition, the type of school these students attend during their secondary education further contextualizes their academic background. A significant majority, 76.06% (54 out of 71), attended public schools, while only 23.94% (17 out of 71) were educated in private schools. The results were consistent with the Department of Education database, which shows that most SHS graduates come from public schools (57.66%), while 40.18% are from private schools, and 2.11% are from state universities and colleges. This predominance of public school attendees may reflect the accessibility and affordability of public education, which is crucial for students from lower-income families. The quality of teaching and resources available in public schools compared to private schools could also shape these future teachers' academic experiences and preparedness.

Moreover, an examination of their Senior High School (SHS) strand specialization reveals that the majority of the students, 50.70% (36 out of 71), come from the Humanities and Social Sciences (HUMSS) strand. Only 15.49% (11 out of 71) pursued a STEM specialization in high school. Even though there is a growing demand for Science and Technology (S&T) resources and employability indicators, many young Filipino students do not pursue or persist in Science, Technology, Engineering, and Mathematics (STEM) careers (Albert et al., 2020). The predominance of students from non-STEM strands, particularly HUMSS and ABM, indicates that many have strengths in areas such as communication, critical thinking, and social awareness, which are important in education. However, the lower representation of STEM strand students may point to a need for additional content-specific support and professional development to ensure that all pre-service teachers have a strong foundation in mathematics content knowledge.

Furthermore, despite the varied backgrounds and initial specializations, most students excelled academically in high school. About 69.01% (49 out of 71) graduated with honors, indicating a strong academic performance. Conversely, 30.99% (22 out of 71) received no academic awards. This achievement suggests that many pre-service teachers possess high academic aptitude and study dedication. The primary motivations for students to excel academically are their family, financial situation, and personal ambitions. Students who achieve academic excellence take pride in receiving academic recognition, as these provide a sense of self-satisfaction, make their parents proud, and occasionally come with tangible rewards (Escalera et al., 2019). Moreover, despite the controversies of having too many honor students, DepEd Assistant Secretary Francis Bringas argues that the K to 12 program awards system is inclusive and highly encourages learners to strive (ABS-CBN News, 2024).

Lastly, the data also sheds light on the motivations behind choosing mathematics as a field of specialization. A significant majority, 69.01% (49 out of 71), indicated that

mathematics was their first choice of specialization. It suggests that pre-service teachers had a strong intrinsic interest and passion for the subject. On the other hand, 30.99% (22 out of 71) did not initially choose mathematics as their preferred field, which could imply a shift in interest or a pragmatic decision based on career opportunities or academic counseling. Based on the study of Punzalan (2022), students found mathematics and science enjoyable and engaging, sparking their interest in these subjects. They believed that learning these disciplines was fun, highly relevant, and valuable for their lives as Filipinos. This perspective allowed them to appreciate the practical applications of math and science in various aspects of their daily lives, from solving everyday problems to understanding the world around them.

Mathematics Achievement of the Pre-Service Mathematics Teachers

Table 2. Mathematics Achievement

Mathematics Achievement	f	%	Verbal Description	Mean	SD
95 and above	1	1.41	Excellent	84.75	4.90
90 – 94	10	14.08	Very Good		
85 – 89	26	36.62	Good		
80 – 84	20	28.17	Fair		
75 – 79	14	19.72	Poor		
Total	**71**	**100.00**			

Table 2 provides an overview of the mathematics achievement of 71 pre-service mathematics teachers. The overall mean grade is 84.75, with a standard deviation (SD) of 4.90. The data underscore that most pre-service teachers adequately understood mathematics, with many performing above the average threshold. In the distribution, the majority of students, 36.62%, had good mathematics achievement. Additionally, 28.17% of students achieved a fair level of achievement. On the other hand, 19.72% of the students had poor academic achievement.

Most pre-service mathematics teachers had moderate mathematics achievement and possessed a satisfactory grasp of fundamental mathematical concepts but may struggle with more complex or abstract topics. Similarly, Villa & Sebastian (2021) discover that most students have average mathematics achievement and infer that achievement motivation effectively enhances their achievement. Moreover, Roman (2019) also found that mathematics major students performed satisfactorily in their fields of specialization, and it was concluded that there is a need to upgrade their foundation in basic mathematics since it significantly affects their performance in their higher mathematics subjects. It's evident that while many pre-service teachers demonstrate competence in mathematics, there is room for improvement, particularly in attaining higher mathematics achievement reflective of deeper understanding and proficiency. Also, a considerable percentage of pre-service teachers struggle to learn mathematics. The data underscores the diverse spectrum of mathematics proficiency among future mathematics educators, highlighting strengths and potential areas for targeted educational support and enhancement.

Academic Engagement of the Pre-Service Mathematics Teachers

Table 3. Academic Engagement

Academic Engagement	Mean	SD	Verbal Description
1. When I'm doing my work as a student, I feel bursting with energy	2.93	0.52	Moderate
2. I feel energetic and capable when I'm studying or going to class.	3.01	0.51	Moderate
3. When I get up in the morning, I feel like going to class.	2.79	0.67	Moderate
4. I am enthusiastic about my studies	2.92	0.49	Moderate
5. My studies inspire me	3.17	0.61	Moderate
6. I am proud of my studies	3.15	0.65	Moderate
7. I feel happy when I am studying intensely	2.97	0.66	Moderate
8. I am immersed in my studies.	2.97	0.59	Moderate
9. I get carried away when I am studying	2.92	0.58	Moderate
Overall Mean	**2.98**	**0.39**	**Moderate**

The academic engagement of pre-service mathematics teachers, as represented in Table 3, can be characterized by the overall mean score of 2.98 (SD = 0.39), which falls into the moderate category. The result implies that, on average, these pre-service teachers experience a moderate level of engagement in their academic activities. The highest mean score was observed for item 5 (M = 3.17, SD = 0.61), indicating that most pre-service teachers found their academic coursework stimulating and motivating. Conversely, the relatively lowest mean score was recorded for item 3 (M = 2.79, SD = 0.67), revealing a slightly lower level of enthusiasm towards the routine aspect of attending classes.

Pre-service mathematics teachers with moderate academic engagement show modest involvement and motivation in their academic work. It supports the previous research findings, revealing that students had a moderate level of academic engagement in learning (Zhao & Yang, 2022). Their analysis shows that teacher support and enjoyment were positively related to academic engagement, while boredom was negatively correlated. This highlights the importance of creating a supportive and enjoyable learning environment to foster higher levels of academic engagement among students. In addition, academic engagement is closely tied to affective factors like motivation and enjoyment, as well as social dynamics such as team spirit and concerns about social status (Amerstorfer & Münster-Kistner, 2021). This underscores that academic engagement is not just about cognitive efforts but also involves emotional and social dimensions, highlighting the importance of fostering individual motivation and supportive peer environments in educational settings. Moreover, pre-service teachers may demonstrate a reasonable commitment to their coursework and field experiences, attending classes regularly and completing assignments satisfactorily. While they may not consistently go above and beyond the requirements, they actively participate in discussions and show a genuine interest in the subject matter. In summary, it is imperative to cultivate academic engagement among pre-service mathematics teachers to facilitate their development and future success as educators. Educational institutions can more effectively assist these individuals in becoming skilled and motivated mathematics teachers.

Mathematics Self-Efficacy of the Pre-Service Mathematics Teachers

Table 4. Mathematics Self-Efficacy

Mathematics Self-Efficacy	Mean	SD	Verbal Description
1. I feel confident enough to ask in my mathematics class	2.75	0.62	Moderate
2. I believe I can do well on a mathematics test	2.83	0.44	Moderate
3. I believe I can complete all of the assignments in a math course	3.08	0.47	Moderate
4. I believe I am the kind of person who is good at mathematics	2.66	0.63	Moderate
5. I believe I will be able to use math in my future career when needed	3.61	0.52	High
6. I believe I can understand the content in a mathematics course	3.14	0.43	Moderate
7. I believe I can get an "A" when I am in a mathematics course	2.63	0.57	Moderate
8. I believe I can learn well in a mathematics course	3.17	0.49	Moderate
9. I feel confident when taking a mathematics test.	2.63	0.51	Moderate
10. I believe I am the type of person who can do mathematics	3.00	0.54	Moderate
11. I feel that I will be able to do well in future mathematics courses	3.03	0.60	Moderate
12. I believe I can do the mathematics in a mathematics course	3.17	0.48	Moderate
13. I believe I can think like a mathematician	2.45	0.73	Low
14. I feel confident when using mathematics outside of school	3.00	0.69	Moderate
Overall Mean	**2.94**	**0.37**	**Moderate**

The study revealed an overall mean score of 2.94 (SD = 0.37), indicating moderate self-efficacy in their mathematical abilities. This shows that these future educators generally possess modest confidence in their ability to learn mathematics. Among the items assessed, the highest mean score was observed for item 5 (M = 3.61, SD = 0.52), indicating a notably high confidence level among pre-service teachers in their ability to apply mathematical concepts and skills in practical, real-world settings relevant to their future careers. Contrarywise, the lowest mean score was found in item 13 (M = 2.45, SD = 0.73), reflecting a lower confidence level in adopting the problem-solving and analytical mindset typically associated with professional mathematicians.

Filipino university students had a moderate level of mathematics self-efficacy, which may also be a factor in academic success (Pendon, 2022; Cuevas & Berou, 2016). Effective intervention for improving mathematics self-efficacy is necessary for university students since it is crucial in predicting their success in mathematics and other cognitive and affect factors (Zakariya, 2022). Students with moderate self-efficacy in mathematics exhibit a balanced perspective on their mathematical abilities and learning potential. They possess confidence in their mathematical skills, understanding that they can tackle routine problems and grasp fundamental concepts with effort and practice. However, they also acknowledge the complexity of mathematics and recognize that they may encounter challenges that require

additional study or assistance. They are open to learning new mathematical techniques and strategies, although they may sometimes doubt their ability to handle more advanced or abstract mathematical concepts. Despite occasional uncertainties, their moderate self-efficacy allows them to persevere through difficulties, viewing mistakes as part of the learning process rather than setbacks. Improving confidence through embracing a mathematician's mindset and achieving academic excellence can significantly enhance pre-service teachers' ability to engage students effectively and cultivate a deeper understanding and appreciation of mathematics in educational settings.

Difference in Mathematics Achievement Based on the Academic Backgrounds of the Pre-Service Mathematics Teachers

Table 5. Differences in Mathematics Achievement Based on Academic Backgrounds

Academic Background	Mean	SD	*t/f*	*p*	*Cohen's d*
Sex					
Male	88.00	4.51	2.853	.010*	0.86
Female	84.02	4.72			
Socio-economic Status					
less than ₱10,957	85.48	6.27	.279	.840	
between ₱10,957 to ₱21,194	84.52	4.35			
between ₱21,194 to ₱43,828	84.00	4.09			
between ₱43,828 to ₱76,669	84.75	4.90			
Type of School					
Private	83.53	3.81	-1.378	.177	
Public	85.13	5.17			
SHS Strand					
Accountancy, Business and Management Strand (ABM)	85.33	2.74	1.839	.132	
Science, Technology, Engineering, and Mathematics (STEM) Strand	82.00	3.82			
Humanities and Social Science (HUMSS) Strand	85.05	5.37			
General Academic Strand (GAS)	86.80	5.49			
Technical-Vocational-Livelihood (TVL) Track	80.50	2.12			
Academic Awards in SHS					
None	84.83	4.95	.067	.948	
With Honors	84.73	4.94			
Mathematics as 1st Choice of Field of Specialization					
No	82.73	4.37	-2.512	.016**	0.63
Yes	85.65	4.90			

*Note: * $p < .05$, ** $p < .01$*

In examining the differences in mathematics achievement among pre-service mathematics teachers based on their academic backgrounds, several nuanced insights emerge from analyzing various profile variables.

Firstly, significant differences were observed based on sex, with male pre-service teachers achieving a significantly higher mean grade of 88.00 (*SD* = 4.51) compared to 84.02

(*SD* = 4.72) for female pre-service teachers (t = 2.853, p = .010), with large effect size (*Cohen's d* = 0.86). Thus, male pre-service teachers had better academic achievement than female pre-service teachers. It contradicts recent findings that sex is not a factor in the differences in mathematics achievement; both sexes are equally capable of learning the subject (Ajai & Imoko, 2015; Ghasemi & Burley, 2019). Some other research shows that females outperformed males in international mathematics assessment (Stoet & Geary, 2015). Collectively, gender differences in attitudes, self-efficacy, and achievement in mathematics and science are not universal; however, significant disparities persist in certain countries (Reilly et al., 2017). Understanding these factors is crucial for addressing potential biases or barriers impacting female pre-service teachers' academic performance. The results highlight a need for teacher education programs to consider how they support all students, regardless of gender, to ensure equitable learning and professional development opportunities.

Another significant finding pertained to the choice of mathematics as the first field of specialization. Pre-service teachers who indicated mathematics as their primary academic focus achieved a notably higher mean grade of 85.65 (*SD* = 4.90) than those who did not prioritize mathematics, scoring 82.73 (*SD* = 4.37), t = -2.512, p = .016, with moderate effect size (*Cohen's d* = 0.63). Hence, pre-service teachers with a primary interest in mathematics had better academic achievement than those who did not have an initial interest. It supports previous studies that show that students who exhibit greater interest, higher self-efficacy, and a stronger appreciation for mathematics tend to achieve better outcomes (Michaelides et al., 2019). Moreover, interest was a significant predictor of class grades, reflecting persistent achievement and engagement over time, such as consistent homework completion and compliant behavior (Jansen et al., 2016). This underscores the impact of personal academic interest and motivation on mathematics achievement, highlighting that individuals intrinsically motivated by and committed to mathematics tend to perform better academically.

Conversely, the statistical analysis reveals no significant differences in mathematics achievement based on socioeconomic status, type of school attended, senior high school strand, and academic awards received. The findings suggest that these factors may not directly affect the variation in mathematics achievement of pre-service mathematics teachers. It challenges previous studies, signifying socioeconomic status and academic background influence students' academic achievement (Lui et al., 2019; Adeyemi, 2014; Alipio, 2020; Adriano et al., 2023). The study emphasizes the importance of individualized support and educational interventions that foster academic success regardless of socioeconomic background or prior educational experiences. Further research can investigate why these demographic and educational variables do not affect mathematics achievement among pre-service teachers, potentially uncovering insights to inform equitable educational practices and policies across diverse student populations.

Relationship Between Mathematics Achievement, Academic Engagement, and Self-Efficacy of the Pre-Service Mathematics Teachers

Table 6. Relationship between mathematics achievement, academic engagement, and self-efficacy

Variables	1	2	3
1. Mathematics Achievement	1		
2. Academic Engagement	.275*	1	
3. Mathematics Self-Efficacy	.320*	.437**	1

*Note: * p < .05, ** p < .01*

The data in Table 6 provide insightful relationships between mathematics achievement, academic engagement, and self-efficacy among pre-service mathematics teachers.

Specifically, mathematics achievement is significantly correlated with academic engagement (r = .275, p < .05), suggesting that pre-service teachers who are more actively involved in their academic activities tend to perform slightly better in mathematics. It supports previous findings of Lei, Cui & Zhou (2018), wherein a moderately strong, positive correlation was found between overall student engagement (behavioral, emotional, and cognitive) and academic achievement. Likewise, the study of Moirera et al. (2018) found that higher-achieving students reported significantly higher scores of cognitive engagement compared to their lower-achieving peers. Hence, highly engaged students achieved better grades, excelled in managing their time and study environments, were more strategic in gathering information, and exhibited fewer maladaptive regulatory behaviors (Estévez et al., 2021). This relationship indicates that academic engagement, which includes participation in class, completion of assignments, and overall investment in learning, plays a significant role in enhancing mathematics performance. Educators and program designers should focus on creating engaging and interactive learning environments that foster active participation and sustained interest in mathematics.

Moreover, the analysis also reveals a significant positive correlation between mathematics self-efficacy and mathematics achievement (r = .320, p < .05). This suggests that pre-service teachers with higher confidence in their mathematical abilities are likelier to achieve slightly better academic results in mathematics. These results match those observed in earlier studies that show a significant relationship between mathematics self-efficacy and mathematics achievement (Schöber et al., 2018; Kalaycıoğlu, 2015). In addition, finding agrees with Özcan & Kültür's (2021) findings, which exhibited mathematic self-efficacy (mastery experience, vicarious experience, social persuasions, and physiological state) have direct associations with mathematics tests and course achievement, and mastery experience emerges as the strongest predictor of achievement. Self-efficacy influences how students approach challenges and persist in the face of difficulties, indicating that those with higher self-efficacy are more resilient and effective in overcoming obstacles in their mathematical studies. Therefore, strategies to boost self-efficacy, such as providing positive reinforcement, setting achievable goals, and offering opportunities for successful experiences in mathematics, could be crucial for improving academic performance.

Furthermore, a significant moderate correlation exists between mathematics self-efficacy and academic engagement (r = .437, p < .01), highlighting that students who believe in their mathematical capabilities are also more engaged in their academic activities. This also accords with our earlier observations, which showed that enhancing students' academic self-efficacy will increase student engagement (Chang & Chien, 2015. Learners with high self-efficacy actively improve their skills and are motivated to engage in the learning process. In contrast, those with low self-efficacy tend to have reduced engagement and motivation, as self-efficacy significantly influences their participation in learning activities (Christenson et al., 2012; Benlahcene et al., 2024). This relationship suggests a reciprocal dynamic where increased self-efficacy enhances engagement, and active engagement further reinforces self-efficacy. Educational interventions that simultaneously address both aspects could be particularly effective. For example, incorporating collaborative projects, interactive learning tools, and supportive feedback mechanisms can help build a sense of competence and encourage greater involvement in learning activities.

The implications of these findings are significant for the development of teacher education programs. Programs should emphasize the cognitive aspects of learning mathematics and the affective dimensions, such as building confidence and fostering a positive attitude towards the subject. Teacher education programs can create a more holistic

and supportive learning environment by integrating activities that promote self-efficacy and engagement, such as peer mentoring, problem-solving workshops, and reflective practices.

CONCLUSIONS

The study provides insights into pre-service mathematics teachers, predominantly female, from lower-income backgrounds, educated primarily in public schools, and often lacking a STEM background. Despite these demographics, a majority demonstrate strong academic performance, with many showing a keen interest in specializing in mathematics. While most possess an adequate understanding of mathematics, some still face challenges in learning the subject. The pre-service teachers exhibit moderate engagement and motivation in their academic pursuits, managing their time effectively, strategically seeking information, and displaying less maladaptive regulatory behavior. They maintain a modestly positive outlook on their mathematical abilities and academic performance, adopting a balanced approach to identifying strengths and improvement areas. The study highlights disparities in mathematics achievement, with male pre-service teachers and those interested in specializing in mathematics achieving notably higher levels. Moreover, it underscores the correlation between higher academic engagement, self-efficacy, and enhanced mathematics achievement, suggesting that active engagement and confidence contribute significantly to proficiency in mathematics among pre-service teachers.

RECOMMENDATIONS

Based on the study's findings, several recommendations are made to support pre-service mathematics teachers better. Institutions may prioritize targeted support programs for underrepresented groups, particularly female pre-service teachers from lower-income backgrounds lacking a STEM education, to reinforce their confidence and competence in mathematics through mentoring and specialized coursework. Enhancing the quality of mathematics instruction within teacher education programs is crucial to address the varying levels of mathematical understanding among pre-service teachers, utilizing innovative teaching strategies and collaborative learning opportunities to support those facing challenges. Promoting greater academic engagement through effective time management skills and strategic information-seeking behaviors can enhance overall academic performance. Institutions may foster self-efficacy towards mathematics, emphasizing growth and development while addressing gender disparities by offering tailored support and inclusive learning environments for female pre-service teachers. Additionally, promoting higher levels of academic engagement and self-efficacy among all pre-service teachers through intervention and teaching strategies can significantly improve their mathematics achievement and readiness for teaching.

ACKNOWLEDGMENTS

The researcher is profoundly grateful to the Nueva Ecija University of Science and Technology (NEUST) for their continuous support and encouragement throughout this research endeavor. I also extend our heartfelt thanks to the respondents for their willingness to participate, which significantly contributed to the success of this study.

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