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Pre-Service Teachers' Mathematics Teaching Efficacy Beliefs and Procedural Fluency in Rational Expressions

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ABSTRACT

Procedural fluency, a vital component of mathematical proficiency, involves the ability to apply mathematical procedures efficiently and accurately. Despite its importance, research indicates that pre-service teachers struggle with procedural fluency, particularly in topics like rational expressions. Therefore, this study examines the relationship between pre-service teachers' mathematics teaching efficacy beliefs and their procedural fluency in rational expressions. A descriptive-correlational design was employed in this study, and an adapted questionnaire was utilized to measure the MTEB of 176 pre-service teachers from private institutions in the Davao region, along with a test paper to assess their procedural fluency. Data were analysed using the mean, standard deviation, and Spearman's Rho. Results show that pre-service teachers have a high level of MTEB and a very low level of procedural fluency. Correspondingly, the findings revealed that the overall beliefs in teaching mathematics has a weak negative correlation to procedural fluency, however, specific aspects of rational expressions are connected to their confidence in teaching and their expectations. Hence, it is crucial for pre-service teachers to be provided with interventions that will improve their ability to apply mathematical procedure accurately and efficiently.

INTRODUCTION

Procedural fluency is an essential aspect of equitable teaching (National Council of Teachers of Mathematics [NCTM], 2023) and a foundation among the five strands of mathematical proficiency, such as conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Andal & Andrade, 2022). On the other hand, findings indicate that the procedural fluency of pre-service teachers (PST) is weak (Altarawneh & Marei, 2021), and they do not have a strong knowledge base or understanding of procedural fluency (Lyman, 2022). Furthermore, 70% of 280 pre-service teachers failed to obtain the correct answer in solving a task that assessed procedural fluency in multiplying and dividing natural and rational numbers, indicating that these student teachers have severe difficulty with the topic (Schulz, 2023). Also, 80 out of 95 pre-service teachers attempted to solve algebraic fractions, wherein 60 PST committed errors, causing a percentage error of 77.8% (Essuman *et al.*, 2024). Students who struggle to navigate procedural stages will find it challenging to enhance their mathematical concepts and relate them to formulate new solutions (Mohamoud, 2022).

Teachers have been preparing to help students become more proficient in mathematics, particularly in establishing procedural fluency, which includes accuracy and efficiency in basic calculations. In contrast, every student should have access to effective teaching of procedural fluency, enabling them to choose their strategies or methods rather than asking how it was done (NCTM, 2023; 2020) and effortlessly execute procedural

fluency in solving problems with various approaches (Inayah *et al.*, 2020). Regarding this, one study used daily fluency as a strategy that enhances students' procedural knowledge and improves their ability to tackle algebraic issues (Mohamoud, 2022). In addition, procedural fluency is beneficial in the ability of the students to connect algorithmic processes in a given problem situation that may be employed in a real-life situation (Ali Al-Mutawah, 2019).

Cognitive Load Theory is anchored as the leading theory of this study and is supported by Self-Efficacy Theory and Expectancy Value Theory. Cognitive Load Theory, which considers intrinsic, extraneous, and germane demands on working memory, significantly impacts the learning process (Paas *et al.*, 2003; Sweller, 1988). Learning results can be improved by efficiently regulating cognitive load, particularly when it comes to complex topics like rational expressions (Houichi & Sarnou, 2020). Similarly, self-efficacy—the conviction in one's skills—is emphasized as a critical component influencing motivation and performance in Albert Bandura's Social Cognitive Theory (Bandura, 2021; 1997).

The high self-efficacy of pre-service teachers is that they are more inclined to interact with mathematical information, which enhances their procedural fluency; they also have stronger views of their ability to teach effectively when they manage their cognitive load well (Bandura, 1997). Pre-service teachers with higher teaching efficacy beliefs tend to embark on more effective teaching practices because student teachers with strong teaching efficacy beliefs are likely to exert diverse instructional

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strategies that nurture procedural fluency, essential for learners' engagement and understanding (Twohill *et al.*, 2022). In addition, influencing the behaviour of one's person is inclined to the perceived self-efficacy and expected outcomes. In contrast, those with high self-efficacy perceive that they can do specific tasks even if it is hard (Olawale & Hendricks, 2024).

Moreover, by combining these ideas, the Expectancy Value Theory proposes that individuals' motivation and performance are influenced by their expectations of success and the value they place on the task (Wigfield & Eccles, 2000). In this theory, efficacy beliefs and competency are both essential components of the expectancy model (Wang & Xue, 2022). These concepts propose that pre-service teachers can be much better math teachers by decreasing cognitive load, enhancing task value, and developing self-efficacy. These theories explain the correlation between mathematics teaching efficacy beliefs and procedural fluency in rational expressions of pre-service teachers.

This study explores two parameters: mathematics teaching efficacy beliefs (MTEB) and procedural fluency. First, mathematics teaching efficacy beliefs are crucial as they indicate teachers' belief in their ability to teach effectively, determining their teaching practices (Hourigan & Leavy, 2022) and transferring a favorable outcome in mathematics teaching (Twohill *et al.*, 2020). It has two indicators: Personal Mathematics Teaching Efficacy (PMTE), referring to a belief in teachers' capability of teaching mathematics effectively, and Mathematics Teaching Outcome Expectancy (MTOE), which is a belief that effective math teachers in mathematics teaching will give a positive result of learning for the student (Thomson *et al.*, 2020). Pre-service teachers can do and teach mathematics successfully when they believe in their mathematical capabilities (Dua *et al.*, 2022). With that, motivated teachers tend to be more enthusiastic in terms of adapting innovative teaching methods, engaging in professional development, discovering methods that are suitable to students' needs (Hosseinzadeh & Moosavinejad, 2023), and planning to use a variety of activities (Olawale & Hendricks, 2022). Furthermore, pre-service teachers' teaching efficacy beliefs toward mathematics are a decisive factor in student achievement (Segarra & Julià, 2022), and having high self-efficacy is a good indicator that their teaching methods have a positive effect on students' perceptions of the subject, as well as on their course performance (Olawale & Hendricks, 2022).

On the other hand, procedural fluency is the ability to apply procedures efficiently, flexibly, and accurately; convey procedures to different problems and contexts; alter procedures from other procedures; and discern the appropriate strategy or procedure to use (NCTM, 2023). The indicators of procedural fluency in rational expressions are simplifying rational numbers, simplifying rational expressions, and solving rational equations. Rational numbers are crucial for teaching and learning

algebra for junior high school, senior high school, and tertiary-level courses (Salifu, 2021), and a good foundation for developing numerical, arithmetic, and algebraic skills in building proportional reasoning and supporting success in different professions (Novita *et al.*, 2022). Furthermore, some studies showed that in teaching rational algebraic expressions, procedural fluency should be emphasized first (Pelayo *et al.*, 2023) and is necessary for understanding Algebra (Powell *et al.*, 2019). According to one study, students struggle with procedural fluency in algebraic expressions due to a lack of comprehension in making symbolic manipulations (Steinhorst, 2022) and difficulties in simplifying rational algebraic expressions (Sanchez & Falle, 2022). The rational equation consists of at least one rational expression (Blitzer, 2022) with polynomials in the numerator and denominator (DepEd, 2021).

Researchers will focus on the limited exploration of the relationship between pre-service teachers' mathematics teaching efficacy beliefs and procedural fluency in rational expressions. Although previous studies have examined self-efficacy in teaching mathematics, few have specifically linked these beliefs to procedural fluency outcomes in a targeted context, particularly among pre-service teachers (Olawale & Hendricks, 2024; Bjerke & Xenofontos, 2023; Perera & John, 2020). Additionally, out of 35 related studies, only six were conducted locally. No similar study has explored the relationship between pre-service teachers' mathematical teaching efficacy beliefs and procedural fluency in rational expressions in the Davao Region. Moreover, this study is vital because it underscores the need for effective teacher preparation programs to enhance teacher efficacy and student achievement in mathematics, aligning with global educational goals (SDG 4) (Twohill *et al.*, 2022). This research will contribute to the literature by providing empirical evidence on how beliefs about teaching efficacy influence procedural fluency, informing teacher education practices and potentially leading to improved student outcomes (Kartal, 2020; Pandee *et al.*, 2020).

Moreover, this study holds significance because by exploring the relationship between pre-service teachers' teaching efficacy beliefs and their procedural fluency in rational expressions, then by understanding their relationship, the results of the study can inform teacher preparation programs, that can ultimately improve teaching practices and student outcomes (Twohill *et al.*, 2022; Segarra & Julià, 2022) which in prospect for enhancing mathematics education aligning to quality education (SDG 4). Moreover, this research will contribute to the educational discourse by addressing critical factors essential to effective mathematics instruction. Studying pre-service teachers' teaching efficacy beliefs and procedural fluency in rational expressions will highlight the need for strong development in these areas, which is essential for developing student engagement and achievement in mathematics. The research result can improve educational policies and practices, promoting equitable access to quality mathematics education. The

study aims to enhance students' mathematical proficiency by equipping future teachers with the necessary skills and confidence, fostering lifelong learning opportunities for each person corresponding to SDG 4, thereby contributing to a more informed and capable society (Ryve & Hemmi, 2019).

The primary intent of this inquiry is to uncover the relationship between mathematics teaching efficacy beliefs and procedural fluency in rational expressions of pre-service teachers. Specifically, it will ascertain the pre-service teachers' level of mathematics teaching efficacy beliefs in terms of personal mathematics teaching efficacy and mathematics teaching outcomes expectancy, and the level of procedural fluency in terms of simplifying rational numbers, simplifying rational expressions, and solving rational equations, and assess the significant relationship between the mathematics teaching efficacy beliefs and procedural fluency in rational expressions. This study will also verify the hypothesis that no significant relationship exists between mathematical teaching efficacy beliefs and procedural fluency at a .05 level of significance.

MATERIALS AND METHODS

This section introduces the research methodology for this quantitative, descriptive-correlational study designed to assess the relationship between mathematics teaching efficacy beliefs and procedural fluency of pre-service teachers. It also describes the research respondents, research instruments being utilized, and the design and procedure of the study.

This study involved the pre-service teachers in private institutions in the Davao region who were enrolled in a field study from 2024 to 2025. The respondents of this study are the pre-service teachers enrolled in the Bachelor of Elementary Education and BSEd majors in Mathematics. The population of this study consisted of 244 Bachelors in Elementary Education and 60 BSEd majors in Mathematics pre-service teachers, with a total number of 304. This study has a sample size of 176 with a confidence level of 95% and a 5% margin of error. One of the locally conducted studies confirmed that a sample size of 124 pre-service teachers is both significant and statistically measurable (Mendez *et al.*, 2023). The researchers employed a stratified random sampling technique, where the population was divided into subgroups according to the major field of the pre-service teacher (Ramirez, 2020). This sampling technique ensures that all the population's interests will be represented (Murphy, 2021).

As part of the inclusion and exclusion criteria, only education students who enrolled in the Field Study (FS) course are considered in this study, and those who are not enrolled in BEEd and BSEd majors in Mathematics were excluded. In addition, the respondents' participation depended on their signed, affixed consent forms. The participants were entitled to withdraw, decline, delete, or alter their comments throughout the data collection.

The researchers implemented an adapted survey

questionnaire by Enochs *et al.* (2000) to measure the level of mathematical teaching efficacy beliefs of pre-service teachers. Moreover, the researchers utilized a validated test questionnaire to measure the pre-service teachers' procedural fluency in rational expressions. The first part contains the adapted survey questionnaire of the Mathematics Teaching Efficacy Beliefs (MTEBI) by Enochs *et al.* (2000). This questionnaire has 21 items on a five-point Likert scale measuring one (strongly disagree) to five (strongly agree), with the following indicators of personal mathematics teaching efficacy (13 items) and mathematics teaching outcomes efficacy (8 items).

The rating scale comprises five distinct levels, each corresponding to a different level of mathematics teaching efficacy beliefs of pre-service teachers. The Likert scale interval consists of five categories: 4.20 to 5.00 illustrates very high teaching efficacy beliefs indicating that they are very confident in their teaching ability which reflects excellent student outcome; 3.40 to 4.19 rate is equivalent to high teaching efficacy beliefs describing that they are confident in their teaching ability which reflects good student outcome; 2.60 to 3.40 denoted as moderate in teaching efficacy beliefs having moderate confidence in their teaching ability shows an average performance of the student; 1.80 to 2.59 indicate low teaching efficacy beliefs reflects they are slightly confident in their teaching ability which equivalent to poor performance outcome of the student. Lastly, 1.00 to 1.79 serves as very low in teaching efficacy beliefs, indicating they are not confident in their teaching ability, which results in poor student performance outcomes. Overall, these rating levels provided significant support for interpreting and categorizing the different aspects of mathematics teaching efficacy beliefs of pre-service teachers.

The second section of the questionnaire contained items divided into three sections. The researchers adapted some rational expressions exercises specifically, regarding simplifying rational numbers (5 items), simplifying rational algebraic expressions (5 items), and solving rational equations (5 items) from the books *Today's Mathematics* by Heddens & Speer (2000), *Elementary and Intermediate Algebra* by Hitchison *et al.*, (2000), *Algebra and Trigonometry* by Blitzer, (2022), *Beginning Algebra* by Schmitz (2012), *DepEd* (2020) and from the thesis of Steinhorst, D. (2022). To measure the procedural fluency of the respondents, the researchers utilized the Scoring Guide for Mathematics Proficiency test, with a score ranging from zero to three points. The scoring was based on the procedure's accuracy and efficiency in solving rational expressions: 3 points for the accurate and efficient process, 2 points for minor mistakes in the procedure, 1 point for major mistakes in the procedure, and 0 points for inappropriate procedures or no response (Dejoras & Vistro-Yu, 2023).

The grading scale comprises five levels based on the DepEd grading scale, each corresponding to a different level of procedural fluency in rational expressions. Percentage-based raw scores should be used to ensure

a valid and equitable evaluation of pre-service teachers' procedural fluency, applying the formula (Actual Score / Total Score) × 100, by DepEd guidelines on learner assessment, which supports valid instructional decisions and remediation (DepEd Order No. 31, s. 2020). To illustrate, a 90 to 100 grade is referred to as outstanding with extreme procedural fluency, an 85 to 89 grade is comparable to strongly satisfactory (passed) with strong procedural fluency, an 80-84 grade indicates satisfactory (passed) with moderate procedural fluency, next is 75 to 79 signifies reasonably satisfactory with low procedural fluency, and lastly below 75 represent did not meet expectations (failed) with very low procedural fluency. These grading scales served as a valuable tool in interpreting and categorizing the procedural fluency of pre-service teachers in rational expressions.

Inter-rater reliability was assessed to verify the reliability and validity of the survey questionnaire and test paper, wherein two experts validated the adapted questionnaire and test paper. Subsequently, the researchers ran a pilot test on a small group of students not subject to being respondents in this study to examine whether the survey questionnaire measured what it intended to measure. After verifying that the survey questionnaire and test paper were reliable and legitimate, the researchers prepared them for data gathering. The Cronbach's Alpha for the MTEB and procedural fluency questionnaires are .916 and .775, respectively.

This quantitative study utilized the descriptive-correlation approach relevant to its primary issue. A descriptive correlational design describes a relationship among variables without inferring causation (Devi *et al.*, 2023). It relates to the present study since knowing the relationship between mathematical teaching efficacy beliefs and procedural fluency in rational expressions

The researchers followed several steps to get the essential information for the current study. Primarily, the researchers submitted a letter asking permission to conduct this study to the college dean and requested data from the enrolled students in a field study S.Y. 2024-2025. After the permission had been granted, participants were given a consent form letter to sign as approval of their participation in this study. The respondents were given approximately 45 minutes to answer the test paper and survey questionnaire during the data gathering. Once

the questionnaires had been completed, the researchers collected and organized the information. Afterward, the researchers transmitted the gathered data to the statistician to analyse and verify the results. Consequently, the researchers interpreted the data once the statistician returned it.

The researchers ensured that the ethical standards in carrying out this study were followed. The researchers emphasized that the respondents were free to withdraw their consent to participate in this study. The respondents' information was used only for academic purposes, and the researchers provided separate sealed envelopes marked "Confidential File"; only the authorized members of this research had access to it, and the information was enclosed within the researchers' scope. The data gathered was analysed using the following statistical tools. The mean and standard deviation for the respondents' levels of mathematics teaching efficacy, belief, and procedural fluency in rational expressions. Kolmogorov-Smirnov and Shapiro-Wilk test was utilized to test the normality of the data. The result shows that both mathematics teaching efficacy beliefs ($p=.000$) and procedural fluency of pre-service teachers ($p=.000$) have skewed distributions, as their significance values are below 0.05. Therefore, the Spearman-Rho test — a non-parametric test — was being utilized.

RESULTS AND DISCUSSIONS

This section discusses the findings of the study. In particular, it discusses the level of mathematics teaching efficacy beliefs of pre-service teachers, their procedural fluency level on rational expressions, and the relationship between the two variables. The results are intended to provide insights into how confident pre-service teachers are in teaching math and how this self-assurance relates to their mathematical abilities, especially in solving rational expressions.

Mathematics Teaching Efficacy Beliefs

Table 1 presents the level of mathematics teaching efficacy beliefs of pre-service teachers. Data shows that the pre-service teachers manifest high teaching efficacy beliefs ($\bar{x} = 3.53$, $SD = .412$) and their responses were pretty close to the mean.

It indicates that they are confident in their teaching

Table 1: Pre-service teachers' Levels of Mathematics Teaching Efficacy Beliefs

Indicators	Mean (M)	Standard Deviation (SD)
Personal Mathematics Teaching Efficacy (PMTE)	3.35	.444
Mathematics Teaching Outcomes Efficacy (MTOE)	3.71	.496
Overall	3.53	.412

ability, continually find better ways to teach mathematics, and often exert extra effort, reflecting good student outcomes. This result is similar to the study of Kartal (2020), which reveals that pre-service teachers have a high level of teaching efficacy beliefs, where they have a

great enthusiasm for teaching and are more likely to adapt practices as well as exert effort. Therefore, it is vital to maintain and enhance the teaching abilities of pre-service teachers, as it can positively affect their teaching approach and improve student learning outcomes in mathematics.

Moreover, among the indicators, MTOE has a higher mean of 3.71 (SD = .496), interpreted as a high level of teaching efficacy beliefs, and the responses were relatively close to the mean. The results indicate that despite pre-service teachers being confident in their ability to teach mathematics effectively, they are more confident about their beliefs that their teaching strategies and efforts will lead to positive student learning outcomes in mathematics. This finding contradicts the study of Byrd and Giles (2023), where the results revealed that pre-service teachers were inadequately confident about their teaching impact on students' learning achievements. However, they are more confident in their mathematics teaching ability.

The respondents believed that when their students' mathematics grades improve, they have found a more effective teaching approach, which signifies that pre-service teachers feel more confident about their ability to influence student outcomes. It aligns with the studies of Segarra *et al.* (2021) and Hourigan & Leavy (2022) where most pre-service teachers agreed that the grade improvement of the students in mathematics was often due to their founding of more effective teaching approaches.

Moreover, the result is congruent with the findings of Twohill *et al.* (2022) where pre-service teachers reported high levels of MTEB, as well as with the study of Hendricks *et al.* (2024) where the results revealed that pre-service teachers expressed high teaching efficacy beliefs in mathematics. These findings are positively associated with better academic achievement and positive attitudes towards mathematics. It suggests that when pre-service teachers believe they can teach mathematics, they are more likely to exert effort on providing the best approaches or strategies for a positive outcome in mathematics (Twohill, 2022).

Procedural Fluency of Pre-service Teachers

In Table 2, it is shown that the overall mean of the levels of procedural fluency is 32.03 (SD = 11.938), equivalent to a grade of 71.18%. It indicates that the respondents did not meet the expectations for procedural fluency, and the variability in their performance is relatively high, indicating that while some respondents may have performed better, the majority are significantly struggling. It reveals that the ability of pre-service teachers to apply mathematical procedures accurately and efficiently in the solving process is inferior, demonstrating a very low level

Table 2: Pre-service teachers' Levels of Procedural Fluency

Indicators	Mean	Standard Deviation (SD)
Simplifying Rational Numbers	12.9	4.096
Simplifying Rational Expressions	10.14	4.469
Solving Rational Equations	8.99	5.04
Overall	32.03	11.938

of procedural fluency.

The result aligns with the study of Schulz (2023) where most of the pre-service teacher respondents had severe difficulty in solving tasks that assess procedural fluency. It also aligns with the study of Svensson and Holmqvist (2021), highlighting the initial severe difficulty pre-service teachers had with procedural tasks, especially when efficiency and accuracy are required. It meant those prospective teachers struggled to solve tasks accurately and efficiently, which should be addressed.

Additionally, solving rational equations has the lowest mean of 8.99 (SD = 5.04), which is equivalent to a grade of 59.93%. It implies that among the indicators, pre-service teachers have the lowest performance in solving rational equations, with a high variation in their performance. It signifies that while some pre-service teachers perform adequately, others struggle to solve rational equations efficiently and accurately. Solving rational equations requires a deeper understanding of algebraic manipulation, and its complexity is one of the factors in pre-service teachers' struggles. Correspondingly, the result emphasizes that solving rational equations is a challenging area for pre-service teachers, and this lines up with the study of Essuman *et al.* (2024), where pre-service mathematics teachers have below-average performance in

the same area.

Moreover, the result is consistent with the findings of Altarawneh and Marei (2021) and Lyman (2022), which revealed that the pre-service teachers had difficulty in solving rational equations, indicating that their procedural fluency was weak. In addition, Keazer and Phaiiah's (2023) study showed that student teachers do not demonstrate strong procedural fluency. It signifies the need for further development and support to improve this domain of mathematical proficiency, ensuring the success of good quality in teaching and learning process with their students.

Correlation of Pre-service Teachers' Mathematics Teaching Efficacy Beliefs and Procedural Fluency

Table 3 shows the correlation analysis of the relationship between the mathematics teaching efficacy beliefs and procedural fluency in rational expressions of pre-service teachers. The data reveal a weak negative relationship between mathematics teaching efficacy beliefs and procedural fluency in rational expressions of pre-service teachers ($r = -.092, p = .223$). It indicates that when pre-service teachers' mathematics teaching efficacy beliefs increase, their confidence in solving rational expressions decreases. However, insufficient evidence supports

Table 3: Correlation between Mathematics Teaching Efficacy Beliefs and Procedural Fluency

Mathematics Teaching Efficacy Beliefs	Procedural Fluency			
	Solving Rational Numbers	Simplifying Rational Expressions	Solving Rational Equations	Overall
Personal Mathematics Teaching Efficacy (PMTE)	.116 (.127)	-.258* (.001)	-.089 (.242)	-.118 (.114)
Mathematics Teaching Outcome Expectancy (MTOE)	.162* (.031)	-.163* (.031)	-.029 (.706)	-.031 (.682)
Overall	.134 (.075)	-.237* (.002)	-.070 (.356)	-.092 (.223)

* $p < 0.05$

rejecting the null hypothesis between the two variables since the $p = 0.223$ ($p > .05$).

This finding aligns with the prior study of Velez and Abuzo (2024), revealing that despite having high mathematical self-efficacy, students' problem-solving skills are still very low. Moreover, the study of Chirove (2023) shows an insignificant weak positive relationship between the mathematical self-efficacy beliefs and the non-routine problem-solving achievement of the student. It indicates that mathematical self-efficacy beliefs are not clearly or reliably enough to predict better performance in solving non-routine mathematical problems (Kaskens *et al.*, 2020).

It reinforces the Cognitive Load Theory, which posits that excessive cognitive demands could interfere with the performance and learning of pre-service teachers. High teaching efficiency beliefs among pre-service teachers may cause them to commit more cognitive resources to conceptual expertise and instructional strategies, which could overload their working memory and reduce their ability to perform procedural tasks efficiently. Therefore, their procedural fluency in rational expressions may decrease when their cognitive load grows.

Specific indicators imply notable relationships, even though there is no significant correlation between pre-service teachers' procedural fluency and their beliefs concerning the importance of teaching mathematics. The data demonstrate a weak linear relationship between mathematics teaching efficacy beliefs and simplifying rational expressions ($r = -.237$, $p .002$). As teachers' confidence in their ability to teach mathematics increases, their proficiency in performing procedural tasks, such as simplifying rational expressions, slightly decreases. This finding aligns with Altarawneh & Marei's (2021) study, indicating that the classroom student teachers show a weak performance in terms of procedural fluency in their mathematical proficiency.

It resonates with the Self-efficacy Theory, as they believe they can teach a specific topic no matter how hard it is, if they are confident. It suggests that pre-service teachers believed they could teach effectively despite low procedural fluency performance. However, this idea was opposed by the study of Aytekin and Sahiner (2020) and Hasanah and Yulianti (2020), finding that a lack of familiarity with the content knowledge or fundamental

concept can hinder them from teaching the concept effectively and lead to procedural fluency reduction (Lyman, 2022). Another study highlights that pre-service teachers faced average difficulty in solving mathematical problems. It is because they performed comprehension errors, most likely misrepresentation, misinterpretation, and miscalculation of the problems (Pentang *et al.*, 2024). Additionally, there is a weak positive correlation between the indicators of mathematics teaching outcomes expectancy and solving rational numbers of pre-service teachers ($r = .162$, $p = .031$). It demonstrates that they perform slightly better in solving rational numbers if they have high confidence in their teaching skills, which can positively impact their learners. Since they are efficient at solving rational numbers, they can educate their students in that concept. Moreover, factors such as empowerment, readiness, commitment, and perceived usefulness further enhance their problem-solving abilities in mathematics, contributing to overall teaching effectiveness (Mohammed, 2024). It aligns with the study of Akendita *et al.* (2025), which found that when teachers are confident and capable in teaching, students are more apt to do mathematical problems.

This finding aligns with Expectancy Theory, which states that individuals are motivated to perform well when they believe their efforts will yield beneficial outcomes. In this context, pre-service teachers possessing high teaching outcome expectancy may exercise greater effort in mastering mathematical procedures because they foresee that their skills will manifest as effective teaching. It is consistent with the study of Twohill *et al.* (2022), which reveals that good teaching strategies are more likely to be adopted by pre-service teachers who hold significant beliefs about their own teaching outcomes expectancy. In alignment with this, the use of various teaching techniques promotes procedural fluency, thereby improving student engagement and comprehension (Kaitera & Harmoinen, 2022).

Overall, the data show no significant relationship between pre-service teachers' mathematical teaching efficacy beliefs and procedural fluency. However, solving rational expressions holds significance to mathematics teaching efficacy beliefs, along with its indicators, PMTE and MTOE. Also, indicators of mathematics teaching outcome expectancy and solving rational problems hold a weak correlation.

CONCLUSIONS

The results of this study revealed that the pre-service teachers' level of mathematics teaching efficacy beliefs is high, which means that they expressed confidence in their ability to teach mathematics effectively. However, even though their mathematics teaching efficacy beliefs are high, their procedural fluency is low, particularly in solving rational equations. Moreover, Cognitive Load Theory can account for this finding by stating that pre-service teachers believe they can teach and concentrate on instructional strategies and conceptual knowledge that can interfere with their procedural skills. Furthermore, their difficulties with rational expressions illustrate that their confidence does not always align with their procedural fluency. It might affect their teaching quality. Thus, it is recommended that the procedural fluency of pre-service teachers, especially those programs with the potential to be math teachers, be enhanced.

To achieve this, Mathematics organizations in the college of teacher education should initiate weekly tutorial classes, conducting student development activities like problem-solving workshops, peer coaching sessions, and friendly competitions to enhance active learning and collaboration. Lastly, tracking the students' learning progress and identifying their strengths and weaknesses is also necessary. By constantly improving the teacher education programs, educational institutions can prepare better future teachers who deliver high-quality mathematics teaching.

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