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Preservice Teacher's Attitude Toward Problem-Solving in Mathematics Education

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Abstract

This study delved into the attitudes of 90 level 300 preservice teachers towards problem-solving in mathematics education, recognising its significance in enhancing students' mathematical proficiency. Conducted through a cross-sectional survey design, the research encompassed preservice teachers from various specialities, including Junior High School, Upper Primary, and Early Grades in a college of education in the Upper West Region of Ghana. Utilising a structured questionnaire, rate their agreement or disagreement with the 27-item attitudinal scale on a four-point scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The scores were interpreted as follows: a score of one represents the lowest possible level, indicating a negative attitude, while a score of five represents the highest possible level, indicating an assertive positive attitude. The attitude scores had a standard deviation of 5.19085, suggesting moderate variability from the mean. The attitude ratings displayed a negative skewness of -0.967, indicating that most preservice teachers had predominantly favourable attitudes towards problem-solving as a teaching method. Notably, the research found no significant differences in attitudes between male and female preservice teachers, nor across different programs of study, indicating the need to consider additional factors influencing attitudes towards problem-solving in mathematics education. The lack of significant differences in attitudes based on gender or program of study suggests that factors beyond these demographic variables may influence preservice teachers' perceptions of problem-solving.

INTRODUCTION

Mathematics education is the fibre-optic nerve of school curricula worldwide. Due to the importance of mathematics education, several scholars have proposed numerous strategies for teaching and learning the discipline. Among the proposed strategies for teaching mathematics is the problem-solving approach. The problem-solving approach is proven to be an effective means of improving students' achievement in mathematics (Ali, Hukamdad, Akhter, & Khan, 2010). It is equally asserted to be a potent means for inculcating in learners the required skills for solving novel problems (Guzman, 2018). Cognisance of these, the current curricula for Ghanaian Basic Mathematics Education emphasise the problem-solving approach to teaching and learning mathematics (Ministry of Education, 2019).

Ghanaian teachers are encouraged to use problem-solving strategies in their mathematics classrooms to motivate and instil in learners problem-solving skills. This is evident in almost all curricula for teaching and learning mathematics in Ghanaian pre-tertiary and tertiary institutions (Ministry of Education, 2019). The concept of problem-solving is asserted to be fundamental and practical in bringing to light the practicality of mathematics and its application in our daily lives (Schoenfeld, 2016).

Students' conceptual comprehension of mathematical concepts is enhanced by problem-solving, which also develops their reasoning abilities, allows them to communicate numerically, and cultivates their interests and curiosities (Cai & Lester, 2010). According to Faulkner et.al. (2020), problem-solving is prevalent in all mathematical tasks. Moreover, it promotes independent thinking and situational analysis; both are essential for lifelong learning. It is, therefore, imperative for Ghanaian mathematics teachers to develop mathematical problem-solving skills and convey them to learners at the primary school level to promote lifelong learning and to prepare them for the world of work.

Despite the high value placed on mathematics education in Ghana, several challenges persist in its teaching and learning. This aligns with Li and Schoenfeld (2019), who opined that mathematics has always been challenging for students since its inception in the school curriculum and that many students leave disciplines in science, technology and engineering for its sake. If mathematics is conceived as problematic, then teaching through problem-solving doubles as collateral damage for students with a phobia of mathematics (Mahapatra, 2020). Among the challenges and concerns surrounding mathematics teaching and learning, the most prominent are students' problem-solving abilities and their level of mathematics anxiety (Santos, Belecina, & Diaz, 2015). The most fundamental reason students perform poorly in mathematics is that they still do not see how mathematics applies to their lives. Students understand how to use elementary mathematical principles daily but tend to dispute the significance of more complicated mathematics problems (Mabena, Mokgosi, & Ramapela, 2021).

Great civilisations are alleged to be a product of the ingenuity employed by men in solving the problems that confront them in their respective societies (Posamentier, Kose, Virgadamo, & Keefe-Cooperman, 2019). The concept of problem-solving is alleged to be rooted in the thoughts expressed by John Dewey that experimentation and practice are more long-lasting methods of learning (Ali, Hukamdad, Akhter, & Khan, 2010). Several studies on student performance in mathematics education reported students to have performed poorly due to their inability to appreciate the application of mathematics in their lives (Santos et al., 2015). In light of these, problem-solving can be explained as a teaching method in which learners are given maximum opportunity to make decisions and to appreciate various dimensions of the learning process and the applicability of the knowledge gained.

Problem-solving is opined to be a sine qua non of school mathematics (Donaldson, 2011). The National Council of Teachers of Mathematics (2000) conceived problem-solving as mathematics tasks or assignments presenting intellectual difficulties

in improving pupils' mathematical learning and growth. The utility and potency of mathematical ideas, knowledge, and skills are negatively impacted by the lack of capacity to solve problems (Donaldson, 2011). Similarly, Olivares, Lupiáñez and Segovia (2021) perceived the development of learners' problem-solving abilities as the primary aim of the school mathematics curriculum. A mathematical problem is an activity or task that learners do not have a definite or prescribed procedure to solve (Lithner, 2017). Learning to solve mathematical problems helps to develop learners' understanding of mathematical concepts and infuse them with the skills of solving real-life problems.

The most common justification for problem-solving in mathematics education is that it increases the mathematics comprehension of learners. According to Santos-Trigo, Barrera-Mora and Camacho-Machin (2021), students are reported to develop, extend, and enrich their understandings by solving problems. Similarly, scholars in the mathematics community acknowledged that the study of mathematics places much emphasis on posing and solving mathematical problems. Problems and problem-solving are crucial in students' acquisition of mathematical information and making connections between different areas of mathematics. As a result, most of the mathematics children encounter can be introduced by engaging them in tasks to make meaningful progress (National Council of Teachers of Mathematics, 2000).

Given the benefits of problem-solving for mathematics learners and teachers, the National Teacher Education Curriculum Framework emphasises problem-solving as a core competency that should be prioritised by both pre-service and in-service mathematics teachers (Ministry of Education, 2018). Similarly, problem-solving is emphasised as one of the core and transferable skills professionally trained mathematics teachers should inculcate in learners under their care. Teaching through problem-solving is a method of instruction in which teachers utilise problem-solving to teach mathematical ideas and assist students in synthesising their knowledge (Donaldson, 2011). The National Council of Teachers of Mathematics also considers problem-solving to be one of the five foremost process standards mathematics teachers should acclimatise with (Martinie & Thiele, 2020). Teachers' pedagogical choice in using the problem-solving approach in mathematics classrooms is reported to impact students' mathematical achievements positively (Samuelsson, 2010).

Particular emphasis should be placed on problem-solving when studying mathematics. The ability to solve a wide range of challenging mathematical problems is one of the main objectives of mathematics education (Schoenfeld, 2016). However, it is worth noting that the conception of problem-solving also poses a significant challenge to mathematicians and scholars in other fields. Thus, what an individual may consider a problem may not be a problem for another. As a result, the concept of problem-solving has different connotations (Schoenfeld, 2016).

A study focusing on primary school mathematics instructors' viewpoints towards problem-solving (Altintas et al., 2022). The study emphasises the importance of developing problem-solving abilities in mathematics education. It highlights how teachers rely on regular problems in lessons and do not fully use problem-solving tactics.

Although regular challenges are common, most teachers create their own sets of problems. Teachers acknowledge the benefit of non-routine problems for developing students' metacognitive skills but believe that students' challenges in problem-solving stem from comprehension issues. The study utilises a qualitative research approach, namely the case study model, to collect data from 15 primary school mathematics instructors in Turkey. A semi-structured opinion form with seven open-ended questions is used for data collection. The study is hampered by its convenience sample approach, reliance on self-reported data, and absence of explicit recommendations for further research, although providing valuable insights.

Research on elementary school teachers' views on mathematical problem-solving shows various educational opinions and approaches. The researchers found that teachers acknowledge the importance of non-routine problems in enhancing students' metacognitive skills but mostly use routine problems in their instruction. This preference for routine issues, even while the advantages of non-routine ones are recognised, highlights a common tendency to prioritise familiarity and ease of implementation in educational environments.

Research emphasises teachers' sophisticated awareness of problem-solving approaches (Siswono et al., 2017). Teachers are skilled at incorporating problem-solving into their teaching but struggle with learning problem-solving approaches. This gap between theoretical comprehension and real-world implementation indicates a need for specific assistance and professional growth programmes to improve instructors' problem-solving teaching abilities. High school instructors and secondary school teachers, respectively, hold a favourable outlook on mathematics problem-solving (Dorimana et al., 2021). They acknowledge its significance in fostering critical thinking and reasoning abilities in students. On the other hand, most Australian primary pupils hold a positive perspective toward learning mathematics through problem-solving exercises, indicating their optimistic views (Russo & Minas, 2020). Nevertheless, the necessity of promoting critical thinking dispositions, specifically among future mathematics instructors (Kloppers, 2014). This indicates a possible area for enhancement within the education system.

These studies highlight a changing paradigm that emphasises the significance of problem-solving in mathematics education. Although some primary school instructors may have concerns or face difficulties when using problem-solving procedures, there is increasing recognition of its importance in developing pupils' critical thinking, metacognitive skills, and overall mathematics ability. This changing viewpoint indicates a growing tendency to incorporate problem-solving techniques into mathematics instruction to improve student learning results.

This study aims to explore potential differences in preservice teachers' attitudes toward problem-solving in mathematics education based on their gender and program of study, which includes Early Childhood Education, Primary Education, and Junior High School Education. Through this exploration, the study intends to provide insights that could inform teacher preparation programs and instructional strategies in mathematics

education. The study seeks to find answers to the following:
Research question: "What is the attitude of preservice teachers toward problem-solving as a method of teaching mathematics?". The *Hypotheses are:*

- $H_{0:}$ There is no difference in the perceived attitude toward problem-solving in mathematics education between male and female preservice teachers.
- H_0: There is no difference in the perceived attitude toward problem-solving in mathematics education among preservice teachers across different programs of study (Early Childhood Education, Primary Education, and J.H.S. Education)

METHOD

Research Approach and Design

A cross-sectional survey design was adopted for the study. This design was selected to capture a snapshot of preservice teachers' attitudes toward problem-solving in mathematics education at a specific time. By administering a survey to a sample of preservice teachers, the study aims to gather quantitative data on their perceived attitudes, providing valuable insights into this crucial aspect of teacher preparation.

Participants

The study encompassed 90 level 300 preservice teachers categorised into three groups: Junior High School specialists, Upper Primary Specialists, and Early Grade Specialists, with 30 participants in each category. These preservice teachers had all completed coursework in mathematics problem-solving and related subjects. Participants were selected using a stratified random sampling method, with 30 individuals randomly chosen from each stratum. The average age of the preservice teachers was around 24 years, ranging from 20 to 32 years, and the gender distribution was evenly split between males (45) and females (45), totalling 90. All participants were enrolled in a college of education affiliated with the University of Winneba.

Research Instruments

The data collection instrument utilised in this study was a structured questionnaire designed to assess attitudes toward scientific research among the participants. The questionnaire consisted of statements about preservice teachers' attitudes toward problem-solving in mathematics teaching; participants were asked to rate on a four-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." The development of the questionnaire followed established guidelines to ensure content validity and reliability. The questionnaire comprised 27 statements to gauge participants' attitudes toward problem-solving in teaching mathematics. Each statement was accompanied by response options ranging from 'Strongly Disagree' (coded as 1) to 'Strongly Agree' (coded as 4).

The reliability of the questionnaire was assessed using Cronbach's alpha coefficient, which yielded a high value of 0.967, indicating strong internal consistency among the items. This suggests the questionnaire reliably measures attitudes toward scientific research among the target population. Before data collection, the questionnaire was pilot-tested with a small sample to ensure clarity and comprehension of the items.

Ethical considerations were also considered, and informed consent was obtained from all participants before they participated in the study. Overall, the questionnaire was a robust and valid instrument for capturing participants' attitudes toward scientific research, contributing valuable data to the study's objectives.

Data Collection and Analysis

Quantitative data played a pivotal role in providing structured insights to ensure a comprehensive exploration of the research questions and to attain a deep understanding of the phenomenon under investigation. A survey instrument was meticulously crafted to gather quantitative data, facilitating the systematic collection of numerical responses from participants. This quantitative approach enabled the analysis of large datasets using statistical methods, yielding precise numerical measurements and patterns. The collected quantitative data were meticulously processed and analysed using the statistical software SPSS version 29. Through descriptive statistics, such as means, standard deviations, and frequencies, key trends and distributions within the dataset were elucidated, shedding light on various facets of the phenomenon.

Furthermore, inferential statistical techniques were employed to uncover relationships, associations, and differences among variables of interest. Utilising descriptive and inferential tools in SPSS, such as the Mann-Whitney U test, Kruskal Wallis test and regression analysis, allows for rigorous examination of hypotheses and identifying significant findings. The emphasis on quantitative data analysis provided empirical support for the research questions, offering precise numerical evidence to validate hypotheses and draw robust conclusions. By leveraging the power of quantitative analysis in SPSS, this study uncovered quantitative insights, discerned trends, and made evidence-based assertions about the phenomenon under scrutiny.

RESULTS

To ensure the reliability of the findings and facilitate accurate interpretation of the results, individual items on the attitudinal scale were aggregated into single variables using SPSS version 29. This approach is supported by research indicating that item aggregation can reduce measurement error and enhance the stability of the resulting data (DeVellis, 2017). Additionally, a four-point scale was employed instead of a five-point (odd-numbered) scale to minimise central tendency bias. Studies have shown that even-numbered scales reduce the likelihood of respondents selecting a neutral midpoint, thereby providing more distinct and interpretable data (Chyung, Roberts, Swanson, & Hankinson, 2017).

The study focused on preservice teachers' attitudes toward problem-solving as a teaching methodology. Participants were asked to indicate their agreement or disagreement with a 27-item attitudinal scale using a four-point scale ranging from 1 (strongly disagree) to 4 (strongly agree). A score of one represented the lowest level of agreement, indicating a negative attitude. In contrast, a score of four represented the highest level of agreement, indicating an assertive positive attitude. Descriptive statistics

revealed that the average attitude score was 25.90, with a median score of 27. The standard deviation of 5.19 suggested moderate variability around the mean.

The skewness and kurtosis of the attitude scores were also examined to assess the distribution's normality. The skewness value of -0.967 indicated a negative skew, suggesting that most preservice teachers had favourable attitudes toward problem-solving as a teaching method, with a smaller subset expressing less positive attitudes. The kurtosis value of 1.075 indicated that the distribution was slightly leptokurtic, meaning it had somewhat heavier tails and peaked more than a normal distribution. Despite these deviations, the skewness and kurtosis values were relatively close to zero, indicating that the departure from normality was not substantial.

While the data exhibited minor skewness and kurtosis, they remained within acceptable limits for parametric analysis. This finding aligns with existing literature, which suggests that slight deviations from normality do not significantly affect the validity of parametric tests (Pallant, 2020). Therefore, the results can be interpreted confidently, considering the slight deviations observed in the data distribution.

Table 1. Attitude of preservice teachers toward problem-solving as a method of teaching mathematics

			Statistic	Std. Error
PATPStotal	Mean		25.9000	.54716
	95% Confidence Interval for Mean	Lower Bound	24.8128	
		Upper Bound	26.9872	
	5% Trimmed Mean		26.3148	
	Median		27.0000	
	Variance		26.945	
	Std. Deviation		5.19085	
	Minimum		8.00	
	Maximum		32.00	
	Range		24.00	
	Interquartile Range		7.00	
	Skewness		-.967	.254
	Kurtosis		1.075	.503

Normality of data distribution

Notwithstanding the normality alluded to in the data analysis for research question one and the proposition that a parametric test could be run with this data. A follow-up Levene's test indicated otherwise.

Table 2. Assessing the normality of Preservice Teacher's Attitude Toward Problem-solving via Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
PATPS total	Based on Mean	5.181	5	84	.000
	Based on Median	3.459	5	84	.007
	Based on the Median and with adjusted df	3.459	5	50.941	.009
	Based on trimmed mean	4.750	5	84	.001

Table 2 shows that there are significant differences in variances among groups. The test revealed a statistically significant result, indicating that the assumption of homogeneity of variances was violated (Levene's test statistic = 4.750, df = 5, $p < 0.05$). Furthermore, a trimmed mean of 4.750 was used in the analysis, which suggests that extreme values were excluded from the computation. This could have been done to mitigate the influence of outliers on the test results.

The significant p-value ($p = 0.001$) indicates significant differences in variances among groups, which may affect the validity of the statistical analyses. Therefore, caution is warranted when interpreting the results, and alternative methods that do not assume equal variances may be considered. Hence, the researcher used the Mann-Whitney-U test and the Kruskal Wallis test, respectively, to ascertain the relationship between sex and programme of study compared to preservice teachers' attitudes toward problem-solving. The results of this analysis are presented below and are in line with the research hypotheses.

Comparison of views based on sex

$H_{0:}$ Male and female preservice teachers have no difference in the perceived attitude toward problem-solving in mathematics education.

The study investigates whether a discrepancy exists in the perceived attitude toward problem-solving in mathematics education among male and female preservice teachers. The Mann-Whitney U test was employed to assess this. The variable 'sex' was categorised as 'Male' (coded as 0) and 'Female' (coded as 1), while the responses to the Likert scale questions, ranging from 1 to 4, were used to gauge attitudes, with higher values indicating more favourable responses. The Mann-Whitney-U test is justified due to the nominal nature of the 'sex' variable and the dichotomous responses it comprises (Male or Female).

Table 3. Comparison of teachers' views concerning sex via Independent-Samples Mann-Whitney U Test

	Preservice Teachers' Attitude Toward Problem-Solving
Mann-Whitney U	903.000
Wilcoxon W	1938.000
Z	-.889
Asymp. Sig. (2-tailed)	.374

Calculation of effect size (r)

$r = \frac{z}{\sqrt{n}}$

z = -.889

n = 90

This implies $r = \frac{-.889}{\sqrt{90}}$

Therefore r = -.094

The effect size of -0.094 with a sample size of 90 (Males = 45 and Females = 45) indicates a slight difference between males and females in their attitude toward problem-solving in mathematics education. The negative sign suggests that, on average, females tend to have slightly lower values on the variable than males. However, the small magnitude of the effect size suggests that this difference may not be practically significant. While statistically significant differences may exist between the groups, the effect size suggests these differences are relatively minor.

The Mann-Whitney U test was employed to assess whether a disparity exists between male and female preservice teachers' perceived attitude toward problem-solving in mathematics education. The test showed no statistically significant difference in attitudes between male and female preservice teachers, as the p-value of 0.374 exceeds the 0.05 significance level. Consequently, the null hypothesis, which posited no difference in attitudes based on gender, was not rejected. The findings corroborated with studies that argued that gender differences in cognitive and educational outcomes, including attitudes and abilities in subjects like mathematics, are often small or negligible (Hyde, 2005; Opara, 2018). These findings imply that factors other than gender may play a more significant role in shaping preservice teachers' attitudes toward problem-solving in mathematics education.

While the test's outcome suggests no significant gender-based differences in attitudes toward problem-solving in mathematics education among preservice teachers, it is essential to acknowledge potential limitations. Further research could explore additional variables or employ alternative methodologies to deepen understanding. Nonetheless, this study contributes valuable insights into the factors influencing attitudes toward problem-solving in mathematics education, underscoring the need for nuanced approaches to teacher training and curriculum development that consider diverse perspectives and experiences beyond gender distinctions.

Comparison of view based on programme of study

H_0: There is no difference in the perceived attitude toward problem-solving in mathematics education among preservice teachers across different programs of study (Early Childhood Education, Primary Education, and J.H.S. Education).

Table 3 presents the results of a Kruskal-Wallis analysis examining attitudes towards mathematics education across various programmes of study. The variable under investigation, 'programme of study,' was coded as follows: 'Early Childhood Education' coded as 1, 'Primary Education' coded as 2, and 'Junior High School Education' coded as 3. This coding scheme reflects the distinct subgroups within the variable, each representing a different educational focus within the broader teaching field. Given the nominal nature of these subgroups and their threefold categorisation, the Kruskal-Wallis test was selected as the appropriate statistical method for this analysis.

The Kruskal-Wallis test is a non-parametric alternative to the one-way analysis of variance (ANOVA). It is well-suited for comparing three or more independent groups when the dependent variable is ordinal or continuous. However, the assumptions of normality and homogeneity of variance are not met. In this context, the Kruskal-Wallis test allows for examining whether there are statistically significant differences in attitudes towards mathematics education among preservice teachers across the distinct programmes of study. The findings presented in the forthcoming table will elucidate any potential variations in attitudes towards mathematics education based on the programme of study, providing valuable insights for educational policy and practice.

Table 4. Comparison of teachers' views concerning their programme of study via Independent-Samples Kruskal-Wallis Test

	Preservice Teachers' Attitude Toward Problem-Solving
Test Statistic	1.389
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	.499

The Independent-Samples Kruskal-Wallis Test was employed to investigate whether there were significant differences in the perceived attitudes toward problem-solving in mathematics education among preservice teachers enrolled in different academic programs, specifically Early Childhood Education, Primary Education, and Junior High School (J.H.S.) Education. This non-parametric test is particularly suitable for comparing groups when the assumption of normality is not met, as it does not require the data to follow a normal distribution (Pallant, 2020).

The analysis, which included a sample of N = 90 participants, produced a test statistic of 1.389 with 2 degrees of freedom and an asymptotic significance value of .499. These results indicate no statistically significant difference in the perceived attitudes toward problem-solving in mathematics education among preservice teachers across the different programs of study (Test statistic (F) = 1.389, p = .499). This finding is consistent

with literature suggesting that when the p-value exceeds the significance level (commonly set at $\alpha = 0.05$), the null hypothesis cannot be rejected (Pallant, 2020). In this case, the null hypothesis posits no significant differences in perceived attitudes among the various educational programs.

The lack of statistically significant results implies that any observed attitude variations may be attributed to random variability rather than genuine differences between preservice teachers in different programs. These findings suggest that preservice teachers across Early Childhood Education, Primary Education, and J.H.S. Education programs share similar attitudes toward problem-solving in mathematics education. However, the absence of significant differences also highlights the potential limitations of the current study, such as the sample size and the sensitivity of the Kruskal-Wallis Test in detecting subtle differences. As a result, further research is recommended, potentially with larger sample sizes or alternative methodologies, to exhaustively explore the factors that may influence attitudes toward problem-solving in mathematics education across different academic programs (Cohen, Manion, & Morrison, 2007). This could provide a deeper understanding of how program-specific training and experiences might shape preservice teachers' attitudes toward teaching methodologies.

CONCLUSION

This study investigated preservice teachers' attitudes towards problem-solving in mathematics education, acknowledging its potency in enhancing students' mathematical proficiency and competency. The results revealed a positive attitude of preservice teachers toward problem-solving as a method of teaching mathematics, with no significant differences observed across gender or programme of study. These findings suggest a wide-ranging consensus among preservice teachers concerning the significance of problem-solving in the mathematics curriculum, affirming their readiness to integrate the approach into their future teaching practices.

Conversely, the insignificant variability in attitudes and a section of respondents with a negative disposition toward problem-solving underscored the need for targeted interventions in teacher education programmes. These interventions could focus on enhancing the competency and experience of preservice teachers regarding the potency of problem-solving in teaching mathematics for its effective integration.

Considering the potent role of problem-solving in mathematics education, teacher training institutions need to emphasise this pedagogical strategy in their curricula. With this in place, they can equip prospective mathematics teachers with the competency and proficiency necessary to foster a problem-solving culture in their practice, which serves as a precursor to effective mathematics education. Further research could explore the latent factors that inform preservice teachers' attitudes towards problem-solving.

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