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Exploring The Relationship Between Algebra Content Knowledge And Mathematical Ability Among Pre-Service Elementary School Teachers

Blandina Seko Bani
STKIP Modern Ngawi
Email: blandinabani64@gmail.com

Mikhael Klemens Kedang
Universitas PGRI Delta Sidoarjo
Email: pausmichael00@gmail.com

Siddik Romadhan
Universitas Wiraraja
Email: siddikromadhan@wiraraja.ac.id

Corresponding Author: Blandina Seko Bani

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ABSTRACT

This study investigates the relationship between algebra content knowledge and mathematical ability among pre-service elementary school teachers (PSETs). The study was motivated by the importance of strengthening prospective teachers' algebra knowledge as a foundation for developing effective mathematics teaching. A quantitative correlational design was employed with 46 first-semester PSETs in an Elementary Education program at a university in Ngawi, Indonesia. Data were collected using a mathematical ability diagnostic test and an algebra content knowledge test. Both instruments were validated by three mathematics education experts and demonstrated high empirical validity and reliability. Data were analyzed using normality, heteroscedasticity, and linearity tests, followed by simple linear regression. The results showed that the data met the required assumptions for regression analysis. A significant relationship was found between algebra content knowledge and mathematical ability ($p = 0.001 < 0.05$), with the regression equation $Y = 38.158 + 0.044\ X$. The findings indicate that higher algebra content knowledge was associated with higher mathematical ability among PSETs. These results highlight the importance of strengthening algebra content knowledge in elementary teacher education and provide practical implications for designing learning experiences that develop prospective teachers' conceptual understanding and mathematical competence in algebra

Keywords: Algebra; Mathematical Ability; Pre-Service Elementary Teachers; Teacher Knowledge

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INTRODUCTION

A recent UNESCO study, *Mathematics for Action*, highlights that mathematics can contribute to addressing various global challenges, including poverty alleviation, provided that qualified mathematicians and teachers are available (Ferri, 2026). The quality of mathematics education is closely related to the knowledge possessed by teachers and pre-service teachers. For more than three decades, scholars have developed various conceptual frameworks to describe the knowledge required for teaching mathematics (Charalambous et al., 2019). One of these frameworks defines content knowledge as an understanding of the subject matter and structure of a discipline (Shulman, 1986). Such knowledge encompasses not only an understanding of mathematical concepts but also why mathematical statements are true, the basis for providing justification, and the conditions under which such justification may be questioned or rejected. In line with this perspective, the concept of *profound understanding of fundamental mathematics* has been proposed to describe the deep mathematical knowledge required by teachers (Ma, 2020). This is important because the mathematical knowledge required for teaching is extensive (Ball et al., 2008). Teachers need to understand mathematics meaningfully and functionally, including being able to interpret students' mathematical work, understand mathematical meanings, and select appropriate representations and explanations so that mathematical ideas can be understood by students (Ball et al., 2008). Thus, advanced mathematical knowledge alone does not necessarily fulfill all the demands of teaching mathematical content.

Teachers need not only to understand that something is true but also to understand why it is true (Shulman, 1986). Content knowledge is important because it supports teachers in interpreting and responding productively to students' mathematical thinking (Ball et al., 2008). Therefore, content knowledge constitutes one of the important foundations of *pedagogical content knowledge* (Johnson & Larsen, 2012). Mathematics teaching requires not only knowledge of concepts and facts but also an understanding of the principles, relationships, strategies, and procedures involved in solving mathematical problems (Ball et al., 2008). Therefore, the development of mathematical content knowledge needs to begin during pre-service teacher education, particularly at the undergraduate level for students preparing to become teachers (An et al., 2004). Pre-service teachers need opportunities to develop adequate and in-depth knowledge of the mathematical content they will teach, rather than merely memorizing procedures or obtaining correct answers.

However, previous studies have shown that pre-service teachers still experience difficulties with mathematical content knowledge. For example, a study involving 1,367 pre-service teachers in Turkey found that algebra was one of the areas in which content knowledge was relatively low (Çelik & Güler, 2018). Similarly, a study of 328 pre-service teachers in the United States showed that some pre-service teachers did not yet have an adequate understanding of the prerequisite knowledge required for learning algebra (Tatto et al., 2013). The *Teacher Education and Development Study in Mathematics* (TEDS-M) also revealed challenges in pre-service teachers' mathematical and pedagogical knowledge (Ellerton & Clements, 2011). These findings are consistent with research indicating that the mathematical knowledge of teachers and pre-service teachers may be relatively limited and insufficient to provide the learning opportunities necessary for students to develop mathematical understanding (Ball & Bass, 2000). Other studies have also emphasized that teachers and pre-service teachers need to possess adequate knowledge of mathematical content, which constitutes an important component of effective teaching (Ball & Bass, 2003; Black, 2009; Sam et al., 2023). Pre-service teachers may experience difficulties in supporting students' understanding of a particular mathematical topic if they themselves do not have sufficient knowledge of that content.

The issue becomes increasingly important in the context of pre-service elementary school teachers (PSETs). Unlike pre-service secondary mathematics teachers, who are specifically prepared to teach mathematics, PSETs are prepared to teach mathematics as one of several subjects in elementary school. Nevertheless, PSETs still need adequate and meaningful mathematical content knowledge because elementary education provides the foundation for the development of students' mathematical abilities at subsequent educational levels. One area of content that deserves attention is algebra. Although algebra is often associated with formal symbolic manipulation at the secondary education level, its foundations are developed through elementary mathematics learning, including patterns, relationships, equality, generalization, and representation. Therefore, PSETs need to possess adequate knowledge of algebraic ideas to establish the foundation for students' algebraic thinking from the elementary education level.

Several recent studies have begun to investigate this issue. One study examined the subject matter knowledge and pedagogical content knowledge of PSETs in teaching early algebra (Öztürk et al., 2025). The findings showed that PSETs experienced difficulties in understanding several aspects of early algebra, including the relational meaning of the equal sign, generalization, representation, justification, and reasoning about arithmetic and functional relationships (Öztürk et al., 2025). In addition, another study investigated PSETs' readiness to teach early algebra and found that several algebraic concepts, particularly variables and functions, posed conceptual challenges for PSETs (Hohensee, 2015). These findings indicate that algebra knowledge among PSETs remains an important issue in teacher education.

Evidence from Indonesia also indicates similar issues. One study examined the basic mathematical abilities and misconceptions of PSETs and reported that algebra was one of the domains with the lowest achievement levels (Ekasari et al., 2025). The study also identified an association between mathematical ability and misconceptions among PSETs. This finding is important because it suggests that mathematical ability may be related to the quality of PSETs' mathematical knowledge (Ekasari et al., 2025). Recent research on the mathematical content knowledge of PSETs has also emphasized the need to strengthen their mathematical knowledge across various domains of mathematics (Mhuirí & Twohill, 2025).

Mathematical ability provides an important perspective for examining PSETs' algebra content knowledge. Mathematical ability is associated with various aspects of mathematical performance and learning (Turan & De Smedt, 2002). It encompasses more than the ability to obtain correct answers and may involve understanding mathematical concepts, connecting representations, applying procedures, reasoning about mathematical relationships, and providing appropriate justifications. These aspects are also relevant to the development of algebra content knowledge. Therefore, examining the relationship between mathematical ability and algebra content knowledge may provide a more comprehensive understanding of PSETs' mathematical knowledge and their preparedness to teach algebraic ideas at the elementary level.

Based on the review of previous studies, two research gaps can be identified. First, although previous studies have examined PSETs' mathematical knowledge and early algebra knowledge, research specifically focusing on algebra content knowledge among PSETs remains limited. Second, and more importantly, limited attention has been given to the relationship between algebra content knowledge and mathematical ability among PSETs. Previous studies have tended to examine mathematical ability, mathematical knowledge, or early algebra knowledge separately, focus on particular algebraic concepts, or investigate the development of PSETs' knowledge through instructional interventions. Consequently,

there remains insufficient empirical evidence regarding whether and how PSETs' algebra content knowledge is associated with their mathematical ability.

Based on these gaps, this study aims to explore the relationship between algebra content knowledge and mathematical ability among PSETs. Specifically, the study examines whether mathematical ability is significantly associated with PSETs' algebra content knowledge and investigates the extent to which algebra content knowledge is related to mathematical ability. By examining these two aspects simultaneously, the study provides empirical evidence concerning the relationship between PSETs' algebra knowledge and their broader mathematical ability.

The novelty of this study lies in examining the relationship between algebra content knowledge and mathematical ability specifically among pre-service elementary school teachers, a population that has received comparatively less attention than pre-service secondary mathematics teachers. By focusing on algebra content knowledge within the context of elementary teacher education, this study contributes to a better understanding of the mathematical knowledge of future elementary teachers. The findings are expected to contribute to PSET education by providing evidence that can inform the design of learning experiences aimed at strengthening algebra content knowledge and mathematical competence as foundations for effective mathematics teaching in elementary schools.

METHOD

The instruments used in this study consisted of: (1) a diagnostic test (DT) comprising five essay questions covering basic mathematics topics, namely numbers, sets, algebra, and linear equations; and (2) an algebra content knowledge test (ACKT) comprising six essay questions designed to measure students' knowledge of algebraic content.

Using a 1–5 Likert scale, the diagnostic test and algebra content knowledge test were validated by three associate professors in Mathematics Education (Creswell, 2009). The validation results indicated that both instruments were valid. The mean validation score for the diagnostic test was 4.67, while the mean validation score for the algebra content knowledge test was 4.20, with a maximum score of 5.00.

The 46 PSETs who participated as research participants were asked to complete the DT and ACKT, with 100 minutes allocated for each test. Subsequently, the diagnostic test scores and algebra content knowledge scores of the PSETs were obtained.

The hypothesis of this study was that students' algebra content knowledge influences their mathematical ability. Therefore, regression analysis was employed to test the research hypothesis. Before conducting the regression analysis, the data were first required to meet the prerequisite assumptions, including the normality test (Purwanto, 2010), heteroscedasticity test (Arikunto, 2018), and linearity test (Darma, 2021). Subsequently, a focus group discussion (FGD) was conducted to explore students' algebra content knowledge based on their levels of mathematical ability, namely the high, moderate, and low ability groups.

RESULTS AND DISCUSSION

RESULTS

The research results were obtained from the scores of the diagnostic test and the algebra content knowledge test. The results obtained were noteworthy and are presented in detail in the following table.

Table 1.

Score Recapitulation DT and ACKT

Participants	DT	ACKT
1	68	80
2	76	87
3	74	83
4	90	78
5	84	78
6	86	90
7	70	77
8	76	87
9	84	73
10	76	67
11	86	90
12	70	75
13	86	68
14	84	67
15	80	78
16	86	75
17	74	70
18	88	67
19	46	53
20	44	50
21	50	45
22	46	48
23	68	52
24	76	65
25	66	70
26	82	72
27	76	72
28	94	87
29	74	68
30	68	78
31	48	72
32	62	55
33	76	60
34	76	65
35	76	82
36	94	57
37	92	52
38	70	82
39	78	63
40	92	83
41	50	67
42	72	67
43	64	58
44	100	92
45	80	88
46	66	90

Based on Table 1, the scores from the diagnostic test and the algebra content knowledge test were classified into three categories: high ($score \geq 85$), medium ($70 \leq score < 85$), and low ($score < 70$), as presented in Table 2.

Table 2. Classified DT and ACKT

Descriptive	DT	ACKT
High ($\boldsymbol{score \geq 85}$)	11	8
Medium ($\boldsymbol{70 \leq score \leq 85}$)	22	18
Low ($\boldsymbol{score \leq 70}$)	13	20
Total	46	

Based on Table 2, DT scores and ACKT scores showed that 8 research participants consistently demonstrated high ability, 18 consistently demonstrated medium ability, and 13 consistently demonstrated low ability. A total of 7 research participants did not consistently demonstrate ability within the high, medium, or low categories. Furthermore, based on Table 1, the empirical test results (Sugiono, 2010) were obtained as follows.

Table 3
Empirical Results of DT and ACKT

Validation Aspects	DT	ACKT
Difficulty Level	0.69	0.69
Differentiate	0.58	0.6
Empirical Validity	0.484	0.474
Reliability	0.983	0.873

Table 3 presents the validity and reliability of the two tests, both of which met the high criteria. Based on the data presented in Table 1, a prerequisite test was conducted, namely the normality test using the Kolmogorov–Smirnov test (Purwanto, 2010). A significance level of 5% was used. The normality test was conducted using SPSS 26.0, and the results are presented in Table 4.

Table 4 One-sample Kolmogorov-Smirnov test

N		46
Normal Parameters	*Mean*	0.000
	Std. Deviation	10.998
Most Extreme Differences	*Absolute*	0.082
	Positive	0.066
	Negative	-0.082
Test Statistic		0.082
Asymp. Sig. (2-tailed)		0.200

Table 4 shows that the significance values for algebra content knowledge and mathematical ability were both $0.200 > 0.05$. Thus, algebra content knowledge and mathematical ability were normally distributed, allowing the analysis to proceed with testing for homogeneity of the residuals of algebra content knowledge and mathematical ability using the heteroscedasticity test. The heteroscedasticity test was conducted at a 5% significance level (Sugiono, 2010). The heteroscedasticity test was performed using SPSS 26.0, as presented in the table below.

Table 5. Heteroscedasticity Test

Group	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	9.404	4.991		1.884	0.066
X	-0.004	0.066	-0.009	-0.058	0.954

Table 5 shows a significance value of $0.954 > 0.05$, indicating that there is no equality of variance or residuals between algebra content knowledge and mathematical ability. Therefore, the analysis can proceed by examining the linear relationship between algebra content knowledge and mathematical ability using the linearity test. The linearity test was conducted at a 5% significance level (Arikunto, 2018). The linearity test was calculated using SPSS 26.0, as presented in the table below.

Table 6 Linearity Test

Grup			Sum of Squares	f	Mean Square	F	Sig.
1	Between Groups	(Combined)	3810.759	21	181.465	1.313	0.258
		Linearity	1683.272	1	1683.272	12.183	0.002
		Deviation from Linearity	2127.487	20	106.374	0.770	0.722
	Within Groups		3315.958	24	138.165		
	Total		7126.717	45			

Based on Table 6, the linearity test results show a significance value of $0.722 > 0.05$. Thus, there is a linear relationship between algebra content knowledge and mathematical ability. Based on Tables 4, 5, and 6, it can be concluded that the data on algebra content knowledge and mathematical ability met the prerequisite assumptions for analysis, namely the normality, heteroscedasticity, and linearity tests. Subsequently, hypothesis testing was conducted, including the coefficient of determination and the t-test.

The coefficient of determination was used to measure the extent of the relationship between algebra content knowledge and mathematical ability based on the data presented in Table 1. The coefficient of determination was calculated using SPSS version 26.0. The results of the calculation are presented in the following table.

Table 7
Determination Coefficient Test

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.486	0.236	0.219	11.123

Based on Table 7, the coefficient of determination test results in the R-square column show a value of 0.236, or 23.6%. This indicates that algebra content knowledge accounts for 23.6% of the variation in mathematical ability. The remaining 76.4% may be attributable to other factors that were not examined in this study.

After obtaining the coefficient of determination, which indicates the contribution of algebra content knowledge to mathematical ability, the analysis continued with a t-test to examine the effect of algebra content knowledge on mathematical ability (Darma, 2021). The t-test was used to determine whether there was a significant effect of algebra content knowledge on mathematical ability at a 5% significance level (Arikunto, 2018). The t-test was conducted using SPSS version 26.0, and the results are presented in Table 8.

Table 8 t –Test

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	38.158	9.152		4.169	0.000
	X	0.446	0.121	0.486	3.689	0.001

Table 8 shows a significance value of $0.001 < 0.05$. Therefore, H_0 is rejected and H_1 is accepted, indicating that there is a significant effect of algebra content knowledge on mathematical ability. Based on Table 8, the regression equation is obtained as follows:

Based on Table 8, the following regression equation was obtained: Mathematical ability = $38.158 + 0.446$ (algebra content knowledge). The equation has a constant of 38.158 and a regression coefficient of 0.446. It can be used to predict mathematical ability based on the algebra content knowledge score. For example, if a student's algebra content knowledge score increases from 60 to 75, the predicted mathematical ability score is: $Y = 38.158 + (0.446)(75) = 71.608$.

Thus, the predicted mathematical ability score is 71.608. This indicates that each one-point increase in the algebra content knowledge score is associated with an increase of 0.446 points in the predicted mathematical ability score. Therefore, a 15 point increase in the algebra content knowledge score corresponds to a 6.69 point increase in the predicted mathematical ability score.

The participants' responses during the Focus Group Discussion (FGD) were categorized according to their levels of mathematical ability: high, medium, and low in relation to their algebra content knowledge. The findings are presented as follows.

a. Participants with High Mathematical Ability

The FGD findings indicate that, in general, participants were able to apply their knowledge of distance, substitution, and numerical operations. They used this knowledge to relate the information provided in the problems to the questions being asked. They were also able to connect mathematical content, particularly algebra, with appropriate rules and problem-solving strategies. Furthermore, the participants provided correct answers and

applied their content knowledge to formulate final conclusions. Thus, participants with high mathematical ability demonstrated a strong understanding of mathematical content, particularly algebra

b. Participants with Medium Mathematical Ability

The FGD findings indicate that, in general, participants were unable to optimally utilize their knowledge to connect the information provided in the problems with the questions being asked. This was evident when participants identified two different rockets to determine the distance. They also lacked sufficient understanding to explain the rockets' arrival times. Although they possessed mathematical content knowledge, their explanations were not always logically sound. They also experienced difficulties in connecting mathematical content, the information provided in the problems, and appropriate problem-solving strategies. Furthermore, participants were inconsistent in applying their mathematical content knowledge, particularly algebra, to draw conclusions.

c. Participants with Low Mathematical Ability

The FGD findings indicate that, in general, participants were unable to answer the questions correctly. This was evident in their inability to apply the concept of distance and their errors in using the concept of linear equations. In solving the given test problems, participants also experienced difficulties in connecting the information provided, the questions asked, and the relevant mathematical concepts. They were unable to logically explain the knowledge used to develop problem-solving strategies. These difficulties affected both the problem-solving process and the formulation of final conclusions. Thus, participants with low mathematical ability demonstrated limitations in their mastery of mathematical content knowledge, particularly algebra.

d. Educational Background of PSETs

The educational backgrounds of undergraduate students preparing to become teachers are quite diverse. Not all students have a background in science-related disciplines during their secondary education. This condition highlights the need for continuous training programs to strengthen their mastery of mathematical content knowledge, particularly algebra, so that they are adequately equipped to understand and apply mathematical concepts.

DISCUSSION

Teacher knowledge is difficult to measure (Beswick & Goos, 2012) highlighting the importance of identifying alternative approaches to examining the knowledge and practices possessed by teachers (Gess-Newsome, 2013). In line with this perspective, previous research has developed various alternative methods for investigating pre-service teachers' knowledge through their engagement in mathematical tasks (Chapman et al., 2015). Building on these perspectives, this study employs a case study approach to explore PSETs' algebra content knowledge in relation to their mathematical ability. The findings provide empirical evidence through statistical analysis and focus group discussions, allowing the quantitative findings to be examined more deeply through the responses and problem-solving processes demonstrated by PSETs.

The statistical analysis revealed differences in PSETs' abilities. The DT showed a validity coefficient of 0.484 and a reliability coefficient of 0.983, whereas the ACKT showed a validity coefficient of 0.474 and a reliability coefficient of 0.873. These results indicate that the instruments provided adequate information for identifying PSETs' abilities. The differences in PSETs' scores were subsequently used to classify algebra content knowledge into three categories: high ($score \geq 85$), medium ($70 \leq score < 85$), and

low ($score < 70$). These differences indicate variations in PSETs' ability to utilize algebraic knowledge when solving algebra problems in different contexts. This finding is consistent with previous research showing that individuals may possess different levels of knowledge of mathematical content (An et al., 2004). In this study, only 8 out of 46 PSETs consistently demonstrated high levels of both algebra content knowledge and mathematical ability. This finding indicates that a high level of algebra content knowledge has not yet been attained uniformly among all PSETs.

The FGD findings provide further insight into these differences. PSETs with high mathematical ability were generally able to identify relevant information, establish connections among mathematical concepts, and apply appropriate procedures and strategies. They were also able to utilize algebra content knowledge to obtain correct answers and formulate appropriate conclusions. In contrast, PSETs with moderate mathematical ability possessed relevant mathematical knowledge but were not yet consistent in using it to connect information, concepts, and problem-solving procedures. Meanwhile, PSETs with low mathematical ability experienced greater difficulties in identifying relevant concepts, applying the concept of linear equations, connecting information with mathematical procedures, and explaining the reasoning underlying their problem-solving strategies. These findings indicate that possessing mathematical content knowledge does not automatically ensure PSETs' ability to utilize such knowledge effectively when solving mathematical problems.

These findings are consistent with previous research indicating that pre-service teachers still have limitations in their mathematical content knowledge (Norton, 2019). Other studies have also shown that the mathematical content knowledge possessed by teachers and pre-service teachers, particularly in algebra, remains at a medium level (Guler & Celik, 2021). The present study extends these findings by demonstrating how limitations in algebra content knowledge manifest during the problem solving process. PSETs in the medium and low ability groups tended to experience difficulties in connecting mathematical concepts, information provided in the problems, and appropriate solution procedures. This finding is consistent with previous research showing that pre-service teachers continue to experience difficulties in connecting different mathematical concepts and have not yet developed sufficiently strong content knowledge (Turnuklu & Yesildere, 2007). Therefore, pre-service teachers need opportunities for independent and structured learning to strengthen their mathematical content knowledge (Hanifah et al., 2024).

The quantitative analysis further supports these qualitative findings. The linearity test yielded a significance value of $0.723 > 0.05$, indicating that the relationship between algebra content knowledge and mathematical ability met the assumption of linearity. Furthermore, the regression analysis revealed a significant relationship between algebra content knowledge and mathematical ability, with a coefficient of determination (R^2) of 0.236. This indicates that algebra content knowledge explained 23.6% of the variance in mathematical ability, while the remaining 76.4% was associated with other factors not examined in this study.

The regression equation obtained was: Mathematical ability = $38.158 + 0.446$ (algebra content knowledge). The equation indicates that each one-point increase in algebra content knowledge was associated with a 0.446 point increase in the predicted mathematical ability score. For illustration, a 15 point increase in algebra content knowledge was associated with a 6.69 point increase in the predicted mathematical ability score.

These findings support the view that mathematical content knowledge and mathematical ability are interconnected in the development of PSETs' competencies. PSETs

require not only pedagogical knowledge but also adequate content knowledge and mathematical ability (Akbar & Misri, 2026; Sarabia & Belecina, 2026; Wicaksono et al., 2026). In the context of PSETs, algebra content knowledge can serve as an important foundation for developing pedagogical content knowledge (Appova, 2019). However, the findings of this study also indicate that mastery of algebraic knowledge needs to be accompanied by the ability to apply, connect, and explain such knowledge in problem-solving situations. Therefore, the development of PSETs' mathematical competencies should not focus solely on improving content mastery but should also provide opportunities for PSETs to use their knowledge flexibly across various mathematical contexts.

The findings also have implications for instruction in PSETs' teacher education programs. PSETs need learning experiences that encourage them to identify relevant information, connect concepts and procedures, explain the reasoning underlying the strategies they use, and reflect on the appropriateness of the solutions obtained. Lecturers can facilitate this process by providing mathematical tasks that enable PSETs to compare different problem-solving strategies, explain relationships among concepts, and reflect on errors and alternative solutions (Turnuklu & Yesildere, 2007). Such learning experiences can help PSETs develop not only procedural knowledge but also a more connected and meaningful understanding of algebra. Therefore, PSETs' teacher education programs should provide systematic learning experiences to strengthen algebra content knowledge while simultaneously developing PSETs' ability to apply such knowledge to solve mathematical problems.

CONCLUSION

These findings provide empirical evidence of the relationship between algebra content knowledge and PSETs' mathematical ability. The t-test results showed a t-value of $3.689 > 1.683$, with a significance value of $0.001 < 0.05$. Thus, there was a statistically significant effect of algebra content knowledge on mathematical ability. The regression analysis yielded the following equation: Mathematical ability $= 38.158 + 0.446$ (algebra content knowledge)

The equation indicates that each one-point increase in algebra content knowledge was associated with a 0.446 point increase in the predicted mathematical ability score. The coefficient of determination (R^2) of 0.236 indicates that algebra content knowledge accounted for 23.6% of the variance in mathematical ability, while the remaining 76.4% was associated with other factors not examined in this study.

The quantitative findings were further supported by the results of the FGD. PSETs with high mathematical ability were generally able to identify relevant information, connect algebraic concepts with appropriate procedures, apply problem solving strategies, and formulate conclusions. PSETs with medium mathematical ability possessed relevant mathematical knowledge but were not yet consistent in connecting concepts, information, and problem-solving procedures. Meanwhile, PSETs with low mathematical ability experienced difficulties in applying algebraic concepts, connecting information with mathematical procedures, explaining the reasoning underlying the strategies used, and drawing conclusions. These findings indicate that mastery of algebra content knowledge needs to be accompanied by the ability to use and apply such knowledge in mathematical problem solving situations.

The findings of this study have implications for PSET education. PSETs need learning experiences that strengthen both their algebra content knowledge and mathematical problem-solving abilities. Lecturers should not focus solely on students' mastery of

mathematical concepts but should also provide opportunities for PSETs to apply, connect, explain, and reflect on their mathematical knowledge across various problem-solving contexts. Particular attention should also be given to PSETs' mastery of school-level algebra content and to how such content can be communicated and represented in ways that are accessible and understandable to school students.

Based on these findings, PSET teacher education programs should provide learning activities and training that integrate algebra content knowledge with mathematical problem-solving abilities and their application in teaching practice. Such activities may include contextual mathematical problems, analysis of students' strategies and errors, comparison of different solution methods, and reflection on the use of algebraic concepts. Further research is needed to identify other factors that contribute to PSETs' mathematical ability and to develop and examine instructional interventions that can strengthen algebra content knowledge and PSETs' ability to apply such knowledge in teaching practice.

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