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'Assessing Students' Problem-Solving Skills and Self-Efficacy Belief through Posing-Exploring-Doing-Evaluating (PEDE) Model

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Abstract: The study examined how the Posing-Exploring-Doing-Evaluating (PEDE) model affects students' problem-solving skills and self-confidence in math at Catumbalon National High School, Valencia City, Bukidnon, during the third quarter of the 2024-2025 school year. It used a quasi-experimental design with 31 students in the experimental group and 34 in the control group to address challenges in math proficiency identified by local and international assessments. Results showed that students who learned with the PEDE model scored higher on posttests and retention tests in problem-solving than those in the control group, with a significant difference in retention scores. However, self-efficacy (students' belief in their abilities) reached only a moderate level for the PEDE group, though there was a significant difference between groups before and after the study. The PEDE model effectively improves students' problem-solving skills and moderately boosts their self-confidence in math compared to traditional methods.

Keywords: Problem-Solving, PEDE, problem-solving skills and self-confidence .

INTRODUCTION

Mathematics is an essential tool used in many fields, and it is important for students to learn and understand it because of its wide use in everyday life. However, many students today face difficulties in learning mathematics, which leads to poor understanding and low performance. This study aims to address these challenges by assessing students' problem-solving skills and self-efficacy beliefs through the Posing-Exploring-Doing-Evaluating (PEDE) model.

Low problem-solving skills among students have become a serious concern because they affect academic performance and students' readiness to solve real-world problems. For example, the 2012 Programme for International Student Assessment (PISA) results in Ireland showed that students scored below the OECD average in problem-solving proficiency. Only 12% of Irish students achieved level 3 or higher, compared to the 18% average across OECD countries. This highlights the need to improve problem-solving skills among students in Ireland.

In Indonesia, although mathematics is an important subject, many students are not interested in it, and their problem-solving abilities remain low. Studies by Nidya, *et al*., (2015) and Yerizon, *et al*., (2018) reported this issue. Additionally, Laurens, *et al*., (2018) found that many students feel afraid and face challenges when learning mathematics. Surya, *et al*., (2017) also noted that mathematics is not a popular subject among most learners. These findings show that low mathematical problem-solving ability is a serious problem that needs to be addressed.

In the Philippine context, the 2019 Trends in International Mathematics and Science Study (TIMSS) revealed that Filipino students ranked behind other countries in mathematics and science assessments for grade four. The Philippines scored 297 in mathematics and 249 in science, which is significantly lower than other participating countries. Only 19% of Filipino students reached the low benchmark in mathematics, indicating basic knowledge, while 81% did not meet this level.

This low achievement often leads to students feeling disappointed, which negatively affects their self-efficacy-the belief in their own abilities (Sahara, *et al*., 2017). When students face academic challenges or failures, their confidence decreases, making them less motivated to improve their problem-solving skills. This cycle contributes to poor learning outcomes in mathematics.

Despite the importance of problem-solving skills, many students still need help in solving mathematical problems (Granberg, 2016). In the Philippines, only 19% of eighth-grade students demonstrated proficiency in mathematics according to TIMSS 2019, showing a strong need for improvement. Furthermore, a study by Ambasa and Tan (2022) in Valencia City, Bukidnon, revealed that all 46 students in their sample had very low problem-solving skills, with a mean score of 14.20, indicating poor performance.

This study aims to assess the students Problem-solving skills and self-efficacy belief using PEDE model among grade 9 students at Catumbalon

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National High School. Specifically, this research will address four questions:

1. What is the level of students problem-solving skills when exposed to Posing-Exploring-Doing-Evaluating (PEDE) model and non-Posing-Exploring-Doing-Evaluating (non-PEDE) model?
2. What is the level of student's self-efficacy belief when exposed to Posing- Exploring-Doing-Evaluating (PEDE) model and non-Posing-Exploring-Doing-Evaluating (non-PEDE) model?
3. Is there a significant difference on level of students problem-solving skills when exposed to Posing- Exploring-Doing-Evaluating (PEDE) model and non- Posing-Exploring-Doing-Evaluating (non-PEDE) model?
4. Is there a significant difference on level of student's self-efficacy when exposed to Posing- Exploring -Doing-Evaluating (PEDE) model and non- Posing-Exploring-Doing-Evaluating (non-PEDE) model?

METHODS

This study utilized a quasi-experimental research design to assess the effects of the PEDE model compared to the 5E's lesson plan on students' problem-solving skills and self-efficacy beliefs in mathematics. Two intact groups were utilized: one experimental group exposed to the PEDE model and one control group exposed to the 5E's lesson plan. Both groups were administered a pretest, posttest, and a retention test two weeks after the intervention using a teacher-made open-ended problem-solving skills test that was validated by three experts. Also, both groups administered a self-efficacy belief questionnaire before and after the intervention.

DISCUSSION

In this section, it represents the analysis and interpretation of the data collected from the respondents, which are essential for testing the study's hypothesis. Relevant tables and figures are included to provide a convenient and comprehensive view of the result.

Table 1: Level of students Problem-Solving Skills

	PEDE n=31						Non-PEDE n=34						
	Pretest		Posttest		Retention test		Pretest		Posttest		Retention test		
Range	f	%	f	%	f	%	f	%	f	%	f	%	QI
90-100	0	0	1	3.23	1	3.23	0	0	4	11.76	0	0	VHPSS
86-89	0	0	1	3.23	0	0	0	0	1	2.94	0	0	HPSS
80-85	0	0	3	9.68	2	6.45	0	0	4	11.76	0	0	MPSS
75-79	0	0	3	9.68	2	6.45	0	0	3	8.82	1	2.94	LPSS
0-74	31	100	23	74.19	26	83.87	34	100	19	64.71	33	97.06	VLPSS
Mean	3.29		30.61		28.96		8.29		30.44		22.08		
MPS	6.58		61.22		57.92		16.58		60.88		44.16		
	VL		VL		VL		VL		VL		VL		

Percentage Score	Qualitative interpretation
90-100	Very high Problem-Solving Skill
86-89	High Problem-Solving Skill
80-85	Moderate Problem-Solving Skill
75-79	Low Problem-Solving Skill
74 -0	Very low Problem-Solving Skill

Level of students Problem-Solving Skills in Pretest

The students in the PEDE group had a mean score of 3.29, which is equal to an MPS (Mean Percentage Score) of 6.58. This means that they had very low problem-solving skills. Meanwhile, the non-PEDE group had a higher mean score of 8.29, equal to an MPS of 16.58, but it still falls under the very low category. These results show that both the PEDE and non-PEDE groups had very low problem-solving skills at the start.

This tells us a few important things. First, it shows that we need better ways to teach problem-solving in math. Second, it suggests that students may be missing some basic math skills. Because of this, teachers might need to go back and review earlier lessons. Finally, using real-life examples and group activities could help students understand and

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remember basic math skills, which are important for learning new topics.

These findings are supported by the study of Ermac and Tan (2023). They found that students in both the joint productive activity method and the non-joint productive activity method had very low problem-solving skills in the pretest. This is expected, as students had not yet learned the lessons and were only depending on what they already knew.

A similar result was found in the study of Day-ongao and Tan (2022). In their study, students also had a hard time solving problems because the problems were new or unfamiliar. So, it was expected that the students would get low scores in the pretest due to their limited prior knowledge.

This research is also supported by Valdez and Bungihan (2019). They found that students in both the problem-based learning (PBL) group and the non-PBL group also showed very low problem-solving skills in the beginning. This happened because both groups had not yet been taught structured ways to solve problems before the pretest.

Level of Students Problem-Solving Skills in Posttest

As shown in the table, both the PEDE and non-PEDE groups had higher scores in the posttest compared to the pretest. In the PEDE group, 23 students or 74.19% still had very low problem-solving skills. Three students (9.68%) had low skills, another three (9.68%) had moderate skills, one (3.23%) had high skills, and one (3.23%) had a very high level of problem-solving skills.

For the non-PEDE group, 19 students or 64.71% still had very low skills, 3 students (8.82%) had low skills, 4 students (11.76%) had moderate skills, 1 student (2.94%) had high skills, and 4 students (11.76%) reached very high problem-solving skill.

The average score for the PEDE group was 30.61, with a Mean Percentage Score (MPS) of 61.22. This is still classified as very low problem-solving skill. The non-PEDE group had a mean score of 30.44 and an MPS of 60.88, which also falls under the very low category.

Before the intervention, both groups had similar scores showing very low skills in the pretest. After the intervention, students showed better scores in the posttest because they had already learned the topic. However, the scores still stayed in the very low category.

This tells us several things. First, even though the posttest scores improved, the problem-solving skills of most students are still very low. This means that the intervention used may not have been strong enough. Teachers might need to use better and more focused strategies to really help students understand problem-solving. Second, the rise in scores shows that the intervention had some positive effect, but it was not enough to move most students out of the "very low" level. More support and better teaching methods are needed. Lastly, the range of skill levels within each group shows that some students need extra help or more personal attention to succeed.

This result agrees with the study of Ermac and Tan (2023), where both the joint productive activity group and the non-joint productive activity group also increased their scores. However, their problem-solving skills were still at a moderate level. In this study, both PEDE and non-PEDE groups also had better posttest scores, but they still remained in the very low level.

Likewise, Ambasa and Tan (2022) found that most students in both the ELE and non-ELE groups were at a very low level of performance. Still, both groups had better scores in the posttest compared to the pretest. Also, the ELE group had a higher mean score than the non-ELE group—just like the PEDE group in this study, which had a slightly higher mean than the non-PEDE group.

Finally, Osman, *et al*., (2018) also found similar results. Although students had better posttest scores compared to the pretest, most students still performed at a low to medium level. Only 10 students reached a high level using the Bar Model Technique. Still, this method was helpful in improving students' problem-solving skills, suggesting that new strategies can make a difference over time.

Level of Students Problem-Solving Skills in Retention test

The table shows that in the PEDE group, 26 students or 83.87% had very low problem-solving skills, 2 students (6.45%) had low problem-solving skills, another 2 (6.45%) had moderate problem-solving skills, and only 1 student (3.23%) reached very high problem-solving skill.

In the non-PEDE group, 33 students or 97.06% had very low problem-solving skills, and only 1

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student (2.94%) had low problem-solving skills. This means that in the retention test, most students in both groups still had very low problem-solving abilities.

The PEDE group had an average (mean) score of 28.96, which is equal to a 57.92% mean percentage score. This falls under the very low category. The non-PEDE group had a lower mean of 22.08, or 44.16%, which is also considered very low.

The table shows that both groups had a drop in scores compared to their posttest results. Still, the PEDE group had a higher mean score than the non-PEDE group. This means that students who were taught using the PEDE model were better at remembering math lessons than those in the non-PEDE group.

Based on the results, this suggests that students need constant practice and review to keep their problem-solving skills strong. Even though both groups had lower scores in the retention test, the PEDE group still did better. This tells us that the PEDE model may help students remember math lessons more effectively. However, since both groups still had very low problem-solving skills, the intervention should still be improved to make it more effective.

These findings agree with the study by Ambasa and Tan (2022). In their research, even though both groups showed very low skills, the experimental group had a higher mean score than the control group—just like in this study, where the PEDE group scored higher than the non-PEDE group.

A similar result was seen in the study of Tan and Asparin (2018), where students who were taught using EGGRIM had better scores in the retention test compared to those who were not. The authors explained that the dyad learning part of EGGRIM helped students improve their problem-solving ability.

Also, Ermac and Tan (2023) found the same in their study using the Joint Productive Activity Method. While both groups had lower scores in the retention test than in the posttest, they still showed moderate problem-solving skills. This shows that when students are taught using exciting and interactive strategies, they tend to do better in problem-solving.

Table 2: Comparison of Student’s problem-solving skills on Posttest Scores

GROUP	N	MEAN	SD
PEDE	31	30.61	8.991
Non-PEDE	34	30.44	12.521
Total	65		

Source	SS	df	MS	F-value	Sig	eta-square
Group	66.285	1	66.29	0.553	0.460	0.009
Pretest	165.077	1	165.07	1.377	0.245	0.022
Error	7434.66	62	119.91			
Total	68158	65				
Note:	R Squared = .022 (Adjusted R Squared = -.010)					

The table shows that students in the PEDE group had an average score (mean) of 30.61 with a standard deviation of 8.99. On the other hand, students in the non-PEDE group had a mean of 30.44 with a standard deviation of 12.52. The F-value is 0.553 and the significance value is 0.460. Since the significance value is greater than 0.05, this means there is no significant difference between the problem-solving skills of the two groups. So, the null hypothesis is accepted.

This means that students in the PEDE and non-PEDE groups performed almost the same in the posttest. It suggests that both teaching methods led to similar results in problem-solving skills. The PEDE model did not show a clear advantage over the usual or traditional method.

Because of this, it may be helpful to try other teaching strategies to improve students' problem-solving skills. The results show that while the PEDE model has potential, it may need to be improved or combined with other methods to be more effective.

This finding agrees with the study of Jimenez (2020), which showed that students' problem-solving skills were not significantly affected by the teaching strategies used by the teacher.

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However, this is different from the study of Linaza, *et al*., (2025). In their study, the use of manipulatives (hands-on materials) in teaching helped students get better scores in the posttest, placing them in the very satisfactory category. The control group, which did not use manipulatives, did not meet expectations. This shows that the experimental group did significantly better than the control group.

Likewise, the study by Dinglasan, *et al*., (2024) found that using the Realistic Mathematics Education (RME) approach helped students learn better. It helped them develop different skills and understand the topic more clearly. This improvement helped increase their problem-solving abilities through all four phases of the lesson. The RME approach was effective in improving students' problem-solving skills.

Table 3: Comparison of Student's problem-solving skills on Retention test Scores

GROUP	N	MEAN	SD
PEDE	31	28.96	9.166
Non-PEDE	34	22.09	7.798
Total	65		

Source	SS	df	MS	F-value	Sig	eta-square
Group	917.839	1	917.84	13.091	0.001	0.174
Pretest	180.661	1	180.66	2.577	0.114	0.04
Error	4347.042	62	70.11			
Total	47129	65				
Note:	R Squared = .179 (Adjusted R Squared = .153)					

As shown in the table, the F-value for the PEDE and non-PEDE groups is 13.09, with a significance value of 0.001. This means that there is a significant difference between the two groups. Because the significance value is less than 0.05, the null hypothesis is rejected. This tells us that the students in the PEDE group (with a mean score of 28.96) performed better than those in the non-PEDE group (with a mean score of 22.09) in the retention test.

This result means that the PEDE model helped students remember their problem-solving skills better than the regular or traditional method. Since there is a clear difference in scores, it shows that PEDE is more effective in helping students retain what they learned in math. Because of this, teachers may consider using the PEDE model in teaching to help improve students' long-term learning.

This finding is supported by the study of Bayarcal and Tan (2023), which showed that there was a significant difference in students' problem-solving skills when using an open-ended approach compared to a non-open-ended one. Students using the open-ended approach had better problem-solving skills.

The same result was seen in the study of Cambaya and Tan (2022). Their research showed that students who were taught using contextualized instruction (CI) were better at solving problems and remembering what they learned. The CI helped students understand and keep math concepts in mind, which led to positive results.

Another study by Handa and Talisayon (2023) also supports this. They found that using practical problem-solving tasks (PPST) helped students understand math better and remember it longer. Their research shows that PPST supports long-term learning and improves students' problem-solving skills.

Table 4: Level of Students Self-efficacy Belief before and after intervention.

Self-Efficacy Belief Towards Mathematics	Group							
	PEDE				Non-PEDE			
	Pretest		Post-test		Pretest		test	
	Mean	QD	Mean	QD	Mean	QD	Mean	QD
I feel proud when I solve a harder mathematical problem.	3.81	A	3.74	A	3.88	A	4.21	A
Without a good knowledge of Mathematics, I will find it hard to enroll in the college I wish.	3.32	U	3.61	A	3.53	A	3.76	A

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Success in Mathematics can only be achieved by regular study and practice.	3.58	A	3.61	A	3.56	A	3.44	U
I admire people who knows Mathematics well.	3.68	U	3.58	A	3.06	U	3.91	A
A solid mathematical knowledge opens more possibilities when selecting a future profession.	3.45	U	3.58	A	3.47	U	3.62	A
Solving mathematical problems can be pleasant and interesting.	3.77	A	3.45	U	3.18	U	3.29	U
For success in daily today, it is sufficient to know four basic arithmetic operation.	3.61	A	3.42	U	3.38	U	3.35	U
I do not usually give up solving mathematical problem until I have found its solution.	3.55	A	3.35	U	3.50	U	3.47	U
I enjoy solving mathematical problems.	3.61	A	3.29	U	3.18	U	3.15	U
I am always ready to solve mathematical problems.	3.48	U	3.26	U	3.03	U	3.32	U
When I meet an interesting mathematical problem, I cannot come down until I solve it.	3.51	A	3.23	U	3.29	U	3.21	U
I am more successful than most students of my age at solving mathematical problems.	2.84	U	3.23	U	2.91	U	2.88	U
Good mathematicians are highly esteemed in society.	3.58	A	3.22	U	3.50	U	3.47	U
A knowledge of Mathematics gives a base of sound thinking in everyday life.	3.32	U	3.22	U	3.26	U	3.53	A
I get upset when I cannot solve mathematical problem.	3.32	U	3.06	U	3.09	U	3.32	U
You cannot deal anything seriously today without good mathematical knowledge.	2.97	U	3.06	U	3.24	U	3.18	U
When I begin to solve a mathematical problem, I suspect in advance that I will not finish it successfully.	3.29	U	3.00	U	3.24	U	3.09	U
Success in Mathematics depends on good or bad luck to a great extent.	3.29	U	3.00	U	3.29	U	3.00	U
No matter how much I try, I cannot essentially influence my success in Mathematics.	3.13	U	2.97	U	3.32	U	3.09	U
Sometimes, it seems I can spend all my life solving mathematical problems	3.03	U	2.93	U	3.18	U	3.35	U
Sometimes, even after class, I think about mathematical problem that I could not solve in it.	3.06	U	2.87	U	3.32	U	3.41	U
The mark in Mathematics mostly depends on the teacher's good or bad mood.	2.87	U	2.77	U	3.21	U	2.88	U
If I cannot solve a problem in 10-15 minutes, I cannot solve it all.	2.68	U	2.77	U	3.06	U	3.24	U
I do not try to solve a task if it appears too difficult.	2.65	U	2.55	U	3.09	U	2.97	U
I am made for Mathematics.	2.65	U	2.52	U	2.47	D	3.71	A
A mathematical way of thinking degrades human life.	2.97	U	2.52	U	3.00	U	3.09	U
I simply cannot do mathematics.	2.61	U	2.29	D	2.82	U	3.03	U
I am not all interested in mathematics.	2.19	D	2.29	D	2.76	U	2.91	D
These days, learning Mathematics is a complete waste of time.	2.61	U	2.13	D	2.38	D	2.26	D
Overall Mean Interpretation	3.19	M	3.06	M	3.2	M	3.25	M

Students Self-Efficacy Beliefs towards Mathematics Before Intervention

Based on the result, the overall mean score of students' self-efficacy beliefs before the intervention was 3.19 for the PEDE group and 3.20 for the non-PEDE group. This shows that both groups had a moderate level of self-efficacy, which means that students were not very confident yet in their ability to succeed in learning mathematics. They still need support to believe more in themselves when doing math tasks.

This result means that, because both groups had only a moderate level of self-efficacy, it is important to use teaching methods that improve students' confidence in math. Although the scores

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are close, students in the PEDE group seem to have slightly more positive feelings about solving math problems. This suggests that using problem-solving strategies, like in the PEDE model, may help increase students' motivation and enjoyment in learning math. When students enjoy solving problems, they may develop a better attitude toward math.

Also, teachers and researchers should try to understand and address any negative thoughts students may have about their ability in math. These negative beliefs can stop students from learning well. One way to help is to create a supportive classroom where students feel safe to try hard problems without being afraid to fail.

The results of this study are supported by Saligumba and Tan (2018), who found that students in both GRIMM and non-GRIMM groups also had moderate levels of self-efficacy before any intervention. This is the same as the results found for both the PEDE and non-PEDE groups.

However, the study by Pagtulun-an and Tan (2018) showed different results. In their study, students in both the RATE and non-RATE groups had high self-efficacy beliefs in math before the intervention. This means that those students already believed strongly in their math ability, unlike the students in this current study.

A similar finding to this study comes from Pendon (2022). In that study, students also had a moderate level of self-efficacy before going through math engagement training. This was used as a starting point to measure how much the intervention would help. It also showed that there is a need to improve students' confidence in math through effective teaching approaches.

Students Self-Efficacy Beliefs towards Mathematics after Intervention

The overall mean score of students' self-efficacy after the intervention was 3.06 for the PEDE group and 3.25 for the non-PEDE group. This shows that both groups still had a moderate level of self-efficacy in mathematics after the intervention.

This means that even though students received different teaching methods, their confidence in solving math problems stayed in the "moderate" level. Because of this, teachers still need to find better ways or stronger interventions to boost students' confidence and performance in math. The result also shows that the PEDE group had positive feelings towards solving math problems, suggesting that using problem-solving strategies can help students feel more motivated and enjoy learning math. This can lead to a more positive attitude toward the subject.

Teachers and researchers should also help students deal with negative beliefs about their math abilities. These beliefs can stop students from doing their best. To help, classrooms should be supportive spaces where students are not afraid to make mistakes, especially when solving hard problems.

The result of this study supports the findings of Saligumba and Tan (2018), who found that both GRIMM and non-GRIMM groups still had moderately low levels of self-efficacy even after an intervention.

However, the result contradicts the study of Pagtulun-an and Tan (2018). Their study showed that after the intervention, students in both RATE and non-RATE groups had higher self-efficacy in math, meaning they became more confident.

On the other hand, Zakariya (2022) also showed that different interventions can improve students' belief in their math abilities. For example, the intervention by Huang, *et al*., (2020) using a computerized example-based learning environment helped students gain more confidence in math, showing a higher level of self-efficacy.

Table 5: Comparison of Student's Self-Efficacy Belief on Posttest Scores

Source	SS	df	MS	F-value	Sig	Partial Eta Squared
Group	0.519	1	0.519	4.698	0.034	0.7
Pretest	1.127	1	1.127	10.200	0.002	0.141
Error	6.848	62	0.11			
Total	656.599	65				
Note:	a. R Squared = .198 (Adjusted R Squared = .172)					

As shown in the results, students who were taught using the PEDE model had a mean self-efficacy score of 3.06 with a standard deviation of 0.43, while those in the non-PEDE group had a mean of 3.25 with a standard deviation of 0.26. The table also shows an F-value of 4.698 and a significance value of 0.034, which means there is a significant difference between the two groups.

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This tells us that students in the non-PEDE group had higher self-efficacy beliefs than those in the PEDE group. In other words, they felt more confident in their ability to do math after the intervention. This result may suggest that the non-PEDE approach helped students feel more confident, or that the PEDE model may still need improvement when it comes to building students' belief in themselves.

This result is different from the findings of Saligumba and Tan (2018), who found no significant difference in self-efficacy beliefs between students exposed to GRIMM and those who were not.

On the other hand, the study of Shone, *et al*., (2023) showed a significant improvement in math self-efficacy after students were given an intervention. It means the training helped students in the treatment group feel more confident in their math skills than those in the comparison group.

Similarly, the study by Jose (2015) also found a significant difference in self-efficacy beliefs between two groups—students exposed to ICT-GDLE and those who were not. This shows that certain types of teaching approaches, especially those involving technology or interactive strategies, can greatly improve students' belief in themselves when it comes to learning math.

CONCLUSION

Based on the findings of this study, the following conclusions are made based on each research question:

The level of students' problem-solving skills in both the PEDE and non-PEDE groups during the pretest was rated as "very low". Even though the scores increased a little in the posttest, both groups still had "very low" problem-solving skills. In the retention test, the scores went down slightly, but the level of problem-solving skills remained "very low" for both groups.

For students' self-efficacy beliefs, both the PEDE and non-PEDE groups had a "moderate" level during the pretest. Even after the intervention and during the posttest, both groups still had the same moderate level of self-confidence in doing math.

The analysis of covariance showed that there was no significant difference between the two groups in terms of their problem-solving skills in the posttest. However, in the retention test, there was a significant difference, which means one group did better in remembering how to solve problems.

Lastly, the analysis of covariance for self-efficacy beliefs showed a significant difference between the two groups. This means that one group felt more confident in math than the other after the intervention.

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