Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika
Volume 7, Issue 1, 190-214, June 2025
e-ISSN: 2715-6109 | p-ISSN: 2715-6095
https://journal.ibrahimy.ac.id/index.php/Alifmatika

Unlocking mathematical potential: The impact of PAKEM learning and local wisdom on high school students' problem-solving abilities

Supratman Supratman[1*], Fitriyani Hali[2], Ebenezer Bonyah[3]

[1*,2]Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Sembilanbelas November Kolaka, Sulawesi Tenggara 93561, Indonesia
[3]Department of Mathematics Education, Akenten Appiah Menka University of Skill Training and Entrepreneurial Development, Kumasi 2286, Ghana

[1*]supratmanmathusnkolaka@gmail.com, [2]fitriyanihali@gmail.com, [3]ebonyah@aamusted.edu.gh

Received: April 17, 2025 | Revised: June 27, 2025 | Accepted: July 5, 2025 | Published: July 10, 2025
*Corresponding author

Abstract:
Mathematical problem-solving ability refers to the capacity to solve problems through sound decision-making, which is essential for effective learning. Students must be able to think positively, logically, and methodically to address mathematical problems. Based on local cultural knowledge, this study aims to examine how high school students taught using the PAKEM model (Active, Creative, Effective, and Fun Learning) differ in their mathematical problem-solving abilities compared to those taught through direct instruction. The population of this study comprised all Grade *X* students at SMA Negeri 1 Tanggetada, Tanggetada District, Kolaka Regency. The sample was selected using purposive sampling, consisting of 30 students each from classes X_1 (experimental group) and X_3 (control group) of the same school. This quasi-experimental study employed quantitative research methods. Data were collected using test instruments, and the analysis techniques applied included N_{gain} analysis, independent t-test, homogeneity test, and normality test. The research results show that the H_0 was rejected and H_1 was accepted, with a t_{count} of 5.239 and a significance value (2-tailed) of 0.000, which is less than the alpha level of 0.05. It indicates that the experimental class taught with the PAKEM model performed better in mathematical problem-solving than the control class taught through direct instruction. Qualitative analysis showed that three students' strong potential in solving mathematical problems through the application of the PAKEM learning model. The pretest and posttest scores show significant improvement: the experimental group increased from 57.90 to 85.13, while the control group improved from 56.57 to 78.13. These results indicate that the PAKEM model, grounded in regional local wisdom, has greater instructional effectiveness than direct instruction in improving students' mathematical problem-solving abilities.

Keywords: Local Wisdom; Mathematical Potential; Mathematical Problem; PAKEM Learning; Problem-Solving Abilities.

How to Cite: Supratman, S., Hali, F., & Bonyah, E. (2025). Unlocking mathematical potential: The impact of PAKEM learning and local wisdom on high school students' problem-solving abilities. *Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika*, 7(1), 190-214. https://doi.org/10.35316/alifmatika.2025.v7i1.190-214

Introduction

Learning Active Creative Effective and Fun, or PAKEM for short, is a type of learning that has been created by the Indonesian government in partnership with UNICEF and UNESCO for several decades. PAKEM (active, creative, effective, and enjoyable) was made one of the three pillars of school quality improvement through a program called MBS (School-Based Management) (Unicef, 2013). PAKEM received a resounding reception along the road. PAKEM's qualities were reinforced by Government Regulation No. 19 and codified in Article 40 of the National Education System Law No. 20 of 2003. PAKEM is used by nearly all foreign aid education quality improvement projects from NZAID, AusAID, and USAID, in addition to UNICEF and UNESCO. Related to aspect M in PAKEM, namely the fun aspect, Mazid et al. (2023) suggested several characteristics of learning in a fun situation.

The PAKEM learning paradigm can boost student engagement and innovative learning (Supriyanto Manurung & Halim, 2021). Dynamic, Imaginative, Productive, and Entertaining Learning, represented by the PAKEM learning model, emphasizes engaging students in the learning process. This approach encourages participation, fosters creativity, promotes effective learning strategies, and makes education enjoyable, leading to a more enriching experience for students. Hidayati et al. (2023) claim that the instructor can establish a learning environment where students actively ask questions, voice their thoughts, and participate in the learning process. There are close relationships between the PAKEM learning model and other educational models (Samura & Juandi, 2022). These connections highlight the shared principles of engagement and creativity, demonstrating that integrating various approaches can enhance student learning outcomes and foster a more dynamic educational environment. Using other models of learning. The Active, Creative, Effective, and Fun learning approach can produce meaningful learning and is very beneficial. Beneficial and capable of fostering meaningful learning.

According to As’ari et al. (2019), there are four abilities that students must master so that they can survive or even color life. The four abilities are (1) critical thinking, (2) creative thinking, (3) cooperation, and (4) communication. So, the personalities expected from school graduates in the 21st century are not focused on being a person with a lot of knowledge or a person with a deep understanding of science. The expected person is a person who has the 4Cs above (the ability to think critically, think creatively, work with others, and communicate). The five dimensions of learning proposed by Masaki (2023) are as follows: (1) mindset and viewpoint; (2) obtain and assimilate information; (3) expand and enhance understanding; (4) utilize knowledge in a meaningful way; and (5) thinking habits (including critical thinking, creative thinking, and self-directed learning skills). Habits of mind appear to be at the top of the learning dimension. They said that a pleasant learning atmosphere is: (1) calm, (2) unburdened, (3) secure and cozy, (4) captivating, (5) stimulate curiosity in learning, (6) complete participation, (7) student focus, (8) a visually appealing learning environment, and (9) a burning spirit in students, (10) there is a feeling of joy, and (11) high concentration. In principle, enjoyable learning is characterized by a learning experience that makes students feel pleasure in the learning process (Godino et al., 2023). However, in the author's observation, this enjoyable learning is widely implied to be learning that contains only singing and clapping activities, and is carried out monotonously, so that it no longer seems fun. In connection with that, the author intends to introduce several forms of mathematics learning experiences that are fun in forming individuals who have

4Cs or habits of mind, including Game Potency, Outdoor Activities Potency, Guessing Potency, Cooperative Learning Potency, Differentiated Instruction Potency (Chen & Fan, 2025).

Problems can be defined in a variety of ways. According to the literature, when we encounter an issue, we are unable to solve it by applying a previously established approach, experience, or strategy. According to this consensus, the perception of an issue is contingent upon the individual who encounters it (Gravett & Carless, 2024). A similar dilemma occurs when we attempt to define problem-solving. Examining this query by Ayllon et al (2016) cites three definitions: (a) A reasoning process that a problem solver undertakes when a concern appears, believes it to be a problem, desires to fix it, and then evaluates the task completed. (b) A task that a participant can comprehend because of prior knowledge but lacks a strategy to do, leading to uncertainty. The method through which the subject resolves this misunderstanding is called problem-solving. (c) The procedure by which a solver uses past information to novel and unfamiliar circumstances. The adoption of instruction and assessment that is more focused on HOTS is what defines the reform. Students' academic success can be greatly aided by HOTS since it allows them to solve problems and think back on their experience doing so (Djong et al., 2024). To put it another way, problem-solving is an activity that involves cognitive processes and calls for mature, creative, and solution-focused thinking in order to identify a solution to a problem and overcome hurdles (Eviota & Liangco, 2020).

The definition of problem-solving affects how it is used in math instruction. Mahanal et al. (2022) identified three key functions of problem-solving: (1) teaching about problem-solving (utilizing heuristics and strategies to address challenges), (2) teaching for problem-solving (employing problems as practical exercises), and (3) teaching through problem-solving (using it as a pedagogical approach). The authors argue that no single role should take precedence. However, the third role deserves more emphasis in the curriculum, as it helps students develop higher-level skills and mathematical concepts through inquiry-based experiences. Research on problem-solving has been a significant area of interest for a long time. Many facets of the topic have piqued the interest of researchers since the release of Polya's seminal work. Castro highlighted the main issues addressed, including identifying the key factors that influence problem difficulty, recognizing the characteristics of effective problem solvers, providing training in heuristics and metacognition, considering affective factors and beliefs, and examining social interactions, problem formulation, assessment methods, representations, and computer-assisted problem-solving (Olivares et al., 2021). Wakhata et al. (2023) claimed that when solving problems, one may decide to take the route that appears to lead to some advancement toward the objective. Solving that places more emphasis on the desired outcomes than the method of problem-solving (Rahmadani et al., 2024). Al Kayyis (2024) said that by realizing how effective the Polya model is and how simple it is to apply, students will be more likely to employ it in the future to solve any mathematical difficulty they encounter.

Traditional knowledge and practices that have been present in communities for centuries have demonstrated their effectiveness in promoting maintainability (Prasetyawan, 2023). Integrating local wisdom fosters the creation of more comprehensive and responsible solutions that facilitate economic development while maintaining a balance with environmental conservation and cultural sustainability (Susanto et al., 2022). Therefore, the relationship between indigenous insights and sustainability is crucial for maintaining the balance of Earth's functions while ensuring the fair realization of well-being for local communities (Arifiani et al., 2019; Made et al., 2020). Education grounded in local wisdom promotes community engagement and the preservation of local traditions, all while fostering active, student-oriented learning (Andrijati, 2024). Foster environmental stewardship and strengthen their cultural identities (Lestari et al., 2024).

The community itself is the source of local wisdom, which is informal, owned collectively by local members, developed, modified, and ingrained in the community's way of life as a means of survival for many generations. It is also readily adapted and ingrained in the community's way of life as a means of survival (Parwati et al., 2018). The admirable principles found in local knowledge have the power to fortify national identity and foster patriotism. It is since local wisdom is derived from the admirable ideals present in the society. In addition to being well-known for the Bajo community's traditional knowledge in Anaiwoi Village, Tanggetada is one of the subdistricts under the Kolaka Regency government. Tanggetada is also well-known for its intangible forms of local wisdom, such as culture and customs, which are meant to keep the younger generation in the area from doing things that could hurt themselves, the community, and the surrounding nature that is their home and source of livelihood, However, this is not reflected in the context of education which to this day has not explored the potency of students more creatively so that math looks unpleasant, besides that the context of local cultural wisdom in tanggetada sub-district, kolaka district, Southeast Sulawesi province especially in learning mathematics has not been applied way that, at the high school level, it affects poor learning results in mathematics in particular.

One alternative solution that can be offered is education that shapes the kids' character in line with the character that the current local culture has inherited. As a result, Indonesian educational institutions are able to use local knowledge to inform their instruction. Education that is more grounded in cultural values is known as "local wisdom-based education." Students who receive this instruction learn to stay connected to real-world scenarios in their daily lives. A cultural holdover from the past, local wisdom ought to be consistently applied as a life guide. Suastra (2017) states that local wisdom is characterized as the truth that has become a cultural heritage. In addition to introducing local culture to students, PAKEM learning based on local cultural wisdom also has the goal that teachers need to encourage students to use their authority or rights in developing ideas. The responsibility for learning, indeed, lies with the students. Still, the teacher is responsible for providing situations that encourage initiative, motivation, attention, perception, retention, and transfer in learning, as a form of student responsibility for lifelong learning, togetherness, being Being receptive to one another, cultivating a sense of family, improving communication, and being aware of how the outside world is changing makes it intriguing and warrants further study. The PAKEM learning model's potential to improve high school students' mathematical problem-solving abilities more effectively than the direct learning model is the study's uniqueness, and this is supported by research from Yulia and Suhendra (2017) that the PAKEM model is better than the conventional learning model in terms of mathematical Problem-Solving skills of junior high school students.

Research results by Jala (2024) indicate that the initial results indicate that the prototype of the learning model and its materials meet the criteria of "validity" based on expert evaluations. The model effectively integrates local wisdom into problem-solving activities, making mathematics learning more relevant and meaningful for students. The results of research by Arion (2024) showed that the ethnomathematics approach can increase learning motivation, student engagement, understanding of mathematical concepts, and creative problem-solving skills. In addition, ethnomathematics can also be used as a means to preserve the local wisdom and cultural values of Indonesian society. Therefore, the integration of ethnomathematics into mathematics instruction emerges as a promising strategy to enhance students' creative thinking skills while simultaneously deepening their appreciation of cultural heritage. Building on this perspective, the present study introduces a distinctive instructional model that combines PAKEM learning with local wisdom as a contextual foundation. This approach aims to strengthen students' mathematical problem-solving abilities by embedding learning within their lived cultural experiences, making abstract mathematical concepts more tangible and relatable.

The local wisdom incorporated in this study draws specifically from the values and practices of the Bajo community in Tanggetada, Southeast Sulawesi, a region known for its rich cultural traditions, environmental awareness, and communal way of life. These cultural traits emphasize harmony, mutual support, and practical reasoning, all of which align naturally with the cognitive and affective components of mathematical problem-solving. Such culturally rooted perspectives foster persistence, logical structuring, contextual sensitivity, and reflection skills that are often underdeveloped when mathematics is taught in a purely abstract or decontextualized manner. This research is critically important in addressing persistent challenges in mathematics education, particularly the low engagement and underperformance of students in solving non-routine or real-world problems. Conventional instruction often emphasizes rote procedures and algorithmic memorization, leaving students unprepared for tasks requiring higher-order thinking, flexibility, and real-life application. In contrast, the culturally responsive pedagogy proposed in this study not only fosters cognitive growth but also affirms students' identities and socio-cultural backgrounds, leading to more inclusive and equitable learning outcomes.

By utilizing local wisdom as a meaningful learning context, the approach showcased in this study demonstrates that students can develop more robust problem-solving capabilities that are relevant to their daily lives and community realities. Mathematics becomes less of an abstract challenge and more of a tool for understanding, navigating, and improving their world. This alignment between mathematical learning and students' cultural environment enhances both motivation and depth of understanding.

Research Methods

According to Flannelly et al. (2018), experimental designs can be categorized based on the quality and rigor of their implementation, distinguishing between successful or unsuccessful, and flawless or flawed designs. Generally, these are grouped into (1) True Experimental Designs, and (2) Pre-Experimental Designs, with quasi-experimental designs often viewed as a bridge between the two. Although labeled differently across literature, true experimental designs typically involve random assignment, while quasi-experimental designs maintain experimental structure without randomization, often due to practical or ethical constraints in educational and social science contexts (Akbar et al., 2022). The present study employs a quasi-experimental design that includes both an experimental group and a control group, aiming to identify causal effects of the intervention by observing measurable differences in outcomes. The quasi-experimental approach was selected due to the natural setting of the school, where random assignment was not feasible.

Purposive sampling was used to select class X1 as the experimental group and class X3 as the control group at SMA Negeri 1 Tanggetada. This decision was based on several criteria: both classes had similar academic profiles based on previous semester mathematics scores, the same teacher handled both classes to minimize instructional variability, and their schedules allowed for equal allocation of instructional time. Furthermore, to ensure baseline equivalence, a pre-test on mathematical problem-solving ability was administered before the intervention. The results of the pre-test were analyzed to confirm that there were no significant differences in mathematical proficiency between the two groups before the PAKEM-based treatment was applied.

The independent variable in this study is PAKEM learning integrated with local wisdom, while the dependent variable is students' mathematical problem-solving ability. To ensure construct clarity, the operationalization of PAKEM based on local wisdom was explicitly designed to incorporate the principles of Active, Creative, Effective, and Joyful learning, contextualized through the cultural values of the Bajo community in Tanggetada. Local wisdom elements integrated into the learning included traditional problem-solving approaches used in navigation, spatial awareness, communal cooperation, and sustainability practices, which were embedded into real-life mathematical tasks. These values were introduced in learning activities through collaborative group discussions, outdoor mathematical explorations, games that reflected traditional logic and reasoning, and culturally relevant story problems. Each PAKEM component was aligned with these cultural elements to foster both engagement and contextual understanding. The control group, on the other hand, received instruction through direct learning (also known as conventional or teacher-centered instruction), which involved explanation of formulas and procedures followed by example problems and practice exercises, without integration of local cultural elements or exploratory activities. This experimental research was designed with a Nonequivalent Control Group Design. Table 1 below shows the whole.

Table 1. Nonequivalent Control Group Design

0_1	X	0_2
0_3	-	0_4

Description:
0_1 : Experimental group pretest
0_2 : Posttest of the experimental group
X : Treatment
0_3 : Control group pretest
0_4 : Control group posttest

Students in the first grade from SMA Negeri 1 Tanggetada's five classrooms during the 2023–2024 academic year made up the study's population. Students from SMA Negeri 1 Tanggetada's X_1 and X_3 classes were chosen as samples using the purposive sampling technique, provided that all five classes were homogeneous. The rationale for taking these two classes is that, in this study, using experimental research, specifically research that necessitates the existence of an experimental class and a control class.

Class X_1 became the experimental class, consisting of 12 male students and 18 female students, while class X_3 became the control class, consisting of 17 females and 13 males. Comprising thirteen male and seventeen female pupils. Validity and reliability tests are used in the instrument test, but the experimental and control classes' pre-test and posttest results represent the study's data. The effectiveness of PAKEM learning based on local knowledge in the region on students' problem-solving skills was then determined by analyzing the data from the pre-test and posttest. The independent sample t_{test} and the N_{gain} test are the data analysis methods employed in this study.

However, the assumption tests, the normality, and homogeneity tests are conducted first to determine whether the data is normal and whether each class is homogeneous before the inferential test is conducted. Initial data analysis includes a normality test and a homogeneity test. This study employed the Kolmogorov-Smirnov test for normalcy at a significance level of 0.05 and Levene's homogeneity test for homogeneity. Done by Levene's homogeneity test at the 0.05 significance level. The N_{gain} test and the Independent Sample t-test were employed to evaluate the final data. The N_{gain} test measured the improvement in student performance. To determine if students' cognitive learning outcomes had improved following treatment, the normalized gain test (N_{gain})was used. This increment is deducted from the students' posttest results for both the experimental and control groups to isolate the actual improvement attributable to the learning intervention. This adjustment allows for a clearer comparison of the effectiveness of the teaching methods used in each group. Students were given a control class. A comparison of the actual gain score and the maximum gain score is known as normalized gain (Andrijati, 2024). The following are the N_{gain} Interpretation criteria score (Hake, 1999).

Table 2. Interpretation of Effectiveness Categories N_{gain}

Average Percentage (%)	Interpretation
< 40	Ineffective
40 - 55	Less effective
56 - 75	Effective enough
> 75	Effective

Results and Discussions

Quantitative results

This research was conducted in two classes, namely class X_1 SMA Negeri 1 Tanggetada served as the intervention class, while class X_3 was selected as the control class. The experimental class experienced instruction implementing the PAKEM learning model, which incorporated local cultural wisdom, whereas the control class was taught using a direct learning model. This design aimed to compare the effectiveness of the two teaching approaches. Students' division problem-solving ability was measured by giving a pretest and a posttest. The results of the pre-test and posttest of problem-solving ability of students in class X_1 SMA Negeri 1 Tanggetada, as the experimental class, and class X_3 SMA Negeri 1 Tanggetada served as the control class in this study. This class followed a traditional direct learning model, allowing researchers to assess the differences in student engagement and performance when compared to the experimental class, which utilized the PAKEM learning approach, and is presented in Table 3.

Table 3. Results of Descriptive Analysis of Pretest and Posttest

Statistics		Pretest Experiment	Pretest Control	Postest Experiment	Posttest Control
N	Valid	30	30	30	30
	Missing	30	30	30	30
Mean		57.9000	56.5667	85.1333	78.1333
Std. Deviation		10.40673	9.22023	5.14435	5.20433
Variance		108.300	85.013	26.464	27.085
Minimum		40.00	40.00	70.00	70.00
Maximum		82.00	72.00	90.00	86.00

Based on Table 2, the results of descriptive analysis, it can be seen that the average pre-test of the experimental class is 57.90, and the average pre-test of the control class is 56.56. After being given treatment, the posttest results show that both the experimental class and the control class have a higher average increase compared to the pretest results, which are 85, 13, and 78.13. After being administered therapy, the minimum and maximum values of the experimental class increased by 70.00 and 90.00, while the control class grew by 70.00 and 86.00. After calculating the average gain in the experimental class.

Table 4. Normality Test Results

One-Sample Kolmogorov-Smirnov Test		Problem-solving mathematics			
Mathematics problem-solving test results		Pretest Experiment	Pretest Control	Posttest Experiment	Posttest Control
N		30	30	30	30
Normal Parameters[a,b]	Mean	57.90	56.56	85.133	78.133
	Std. Deviation	10.406	9.220	5.144	5.204
Most Extreme Differences	Absolute	0.120	0.120	0.223	0.141
	Positive	0.120	0.095	0.172	0.141
	Negative	-0.091	-0.120	-0.223	-0.140
Kolmogorov-Smirnov Z		0.657	0.656	1.221	0.772
Asymp. Sig. (2-tailed)		0.780	0.782	0.101	0.590

The normality test in this study employed the Kolmogorov-Smirnov test. The outcomes of the pretest and posttest data of the experimental class and the control class are distributed, according to the results of the normality test of the pretest and posttest data calculated using the Kolmogorov-Smirnov test in Table 4 above. The significance value on the pre-test and posttest data of both classes is ≥ 0.05. The experimental class and the control class are normally distributed. After the normality test is carried out, researchers also ran a homogeneity test on the pre-test and posttest data of the experimental class and control class to see if the samples had the same variance. If the variance of the two samples is the same, then If the samples have the same variance, then the data is termed homogenous. To ensure the comparability of the experimental and control groups before the intervention, a homogeneity test was conducted on the pre-test scores. The results are presented in Table 5.

Table 5. Pre-Test Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Mathematics problem-solving test results	Based on the Mean	0.107	1	58	0.744
	Based on the Median	0.103	1	58	0.749
	Based on Median and with adjusted df	0.103	1	53.969	0.749
	Based on the trimmed mean	0.107	1	58	0.744

To ensure the validity of comparisons between the experimental and control groups, a homogeneity test was conducted on the posttest scores. The results are presented in Table 6.

Table 6. Posttest Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Mathematics problem-solving test results	Based on the Mean	0.923	1	58	0.341
	Based on the Median	0.658	1	58	0.421
	Based on Median and with adjusted df	0.658	1	56.390	0.421
	Based on the trimmed mean	0.972	1	58	0.328

A homogeneity test was conducted using Levene's test. Based on the homogeneity test, the significance value based on the average pre-test and posttest is 0.05, revealing that the pre-test and posttest findings for both the experimental and control classes have the same variance. This homogeneity of variance suggests that the data from the control class is consistent, reinforcing the validity of the comparison between the groups. Initial data shows that the pre-test data and posttest data, as well as students' mathematical problem-solving in the experimental and control courses, are normal and homogeneous. Both the control and experimental classes are uniform and typical. Next, test the hypothesis using parametric data analysis methods, such as the N_{gain} test and the independent sample t_{test}. N_{gain} test and independent sample t_{test}. The test is displayed in Table 7 below, the results of the independent sample t-test.

Table 7. Independent Samples Test of Posttest of Experimental and Control Class

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	**Sig.**	**t**	**df**	**Sig.**	**Mean Difference**
Problem-solving mathematics	Equal variances assumed	0.923	0.341	5.239	58	0.000	7.00000
	Equal variances not assumed			5.239	57.992	0.000	7.00000

H_0 is rejected and H_1 is approved based on the data analysis results in the Equal variances assumed row in Table 6 (t_{count} = 5,239 with Sig. (2-tailed) = 0.000 < α = 0.05). Accepting H1 leads to the conclusion that the experimental class, which used PAKEM learning, differed from the control class, which merely used the direct learning model. Therefore, based on the Region Local Wisdom Approach, it can be said that PAKEM learning has a greater learning potency than direct learning in terms of enhancing students' arithmetic problem-solving abilities. The application of learning PAKEM learning based on the area's cultural wisdom is highly essential and advantageous to the advancement of students. It is in accord with the results of the research from Supriyanto Manurung and Halim (2021), who claimed that one strategy to raise math learning achievement is the active creative learning model approach, which is both effective and entertaining (PAKEM). Al-Fananie et al. (2020) said that the spatial capacity of pupils taught with the PAKEM model with tangram media is higher than that of those taught with the expository model.

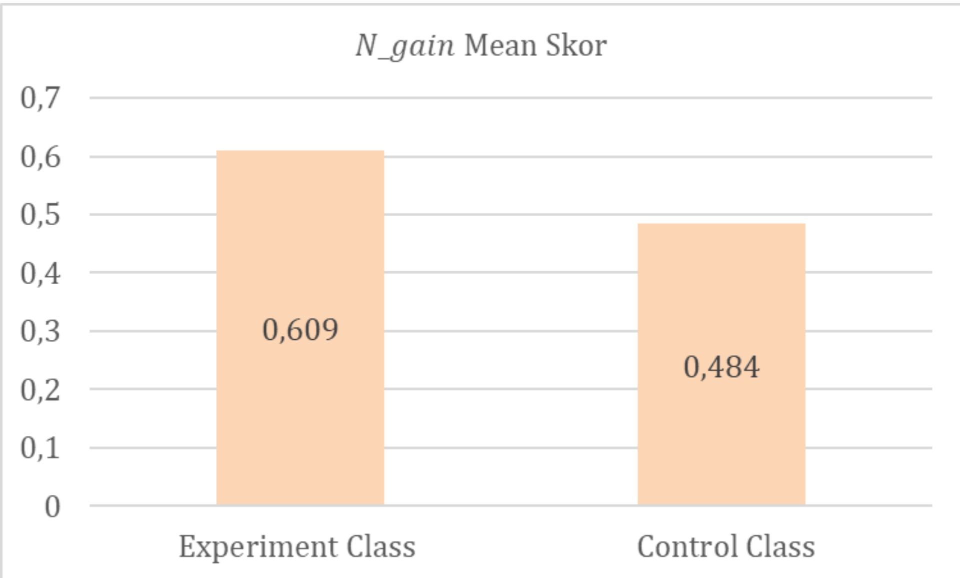
The N_{gain} test was conducted to determine the average increase between pre-test and posttest scores in experimental classes that applied PAKEM learning based on regional cultural wisdom and control classes that applied conventional learning models. N_{gain} test results for pre-test and posttest scores are shown in Table 8.

Table 8. Descriptives of the N_{gain} Score

			Statistic	**Std. Error**
N_{gain} Experiment percent	**Mean**		0.6093	0.03957
	95% Confidence Interval for Mean	Lower Bound	0.5284	
		Upper Bound	0.6902	
	5% Trimmed Mean		0.6276	
	Median		0.7000	
	Variance		0.047	
	Std. Deviation		0.21675	
	Minimum		0.06	
	Maximum		0.80	
	Range		0.74	
	Interquartile Range		0.12	
	Skewness		-1.528	0.427
	Kurtosis		0.915	0.833

			Statistic	Std. Error
N_{gain} Control percent	Mean		0.4844	0.02308
	95% Confidence Interval for Mean	Lower Bound	0.4371	
		Upper Bound	0.5316	
	5% Trimmed Mean		0.4889	
	Median		0.4848	
	Variance		0.016	
	Std. Deviation		0.12643	
	Minimum		0.14	
	Maximum		0.72	
	Range		0.58	
	Interquartile Range		0.09	
	Skewness		-0.642	0.427
	Kurtosis		1.193	0.833

Table 9 shows that the N_{gain} value of students' division problem-solving skill per indicator in the experimental class is higher than that of the control class. Based on the test findings, it can be inferred that there isaverage growth in students' problem-solving ability is higher in the experimental class compared to the control class compared to the control class. The biggest gain in both courses was in the indicator of developing problem-solving techniques. The study's findings show that the experimental class, which used PAKEM learning based on local cultural wisdom, had better problem-solving abilities than the control group, which used the direct learning approach. The increase in the average pre-test to posttest score in the experimental class was 0,609, and the control class was 0.484. The growth in the average pretest and posttest of pupils in class X SMA Negeri 1 Tanggetada is depicted in the following diagram.

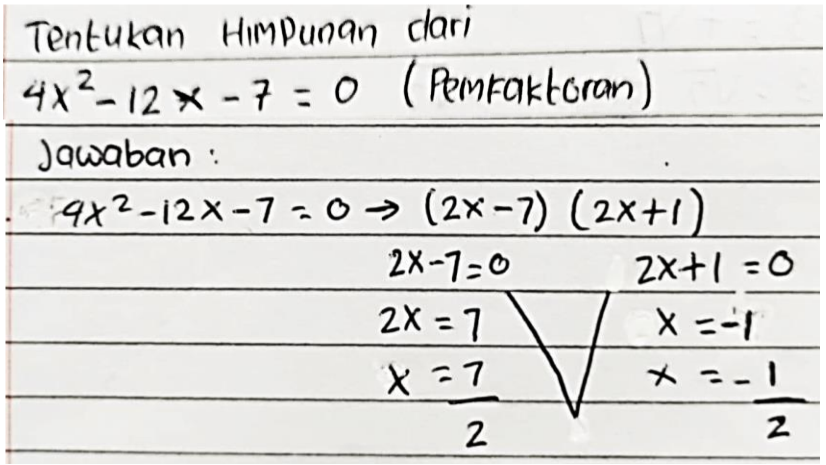


Picture 1. Average N_{gain} Test Results

There is a difference in improvement between the experimental and control classes. Based on Picture 1, it can be shown that the mathematical problem-solving ability of high school students in the experimental class is higher than that of the control class. The average N_{gain} value in the experimental class was 0.609, with a fairly effective category, while the average N_{gain} value in the control class was 0.484, with a less effective category.

Qualitative results

Analysis of pretest results of high school mathematics Problem-Solving ability based on student answer sheets as follows.



Picture 2. Student Answer Sheet Pretest Stage

The results of the interview with student 1, based on the answer sheet, are as follows. The following is a transcription of the interview results of student one on mathematical problem-solving skills at the pretest stage.

Researcher	:	You worked on the pretest question about factoring. Can you explain how you solved the equation $4x^2 - 12x - 7 = 0$?
Alicia	:	Yes, I started by identifying the coefficients in the general quadratic equation: $ax^2+bx+c=0$. For the equation $4x2-12x-7=0$ we have: a=4; b=-12; c= -7. Then I found two numbers that multiply to give: a × c = (4 × -7) = -28, and add up to -12. The two numbers are -14 and 2.
Researcher	:	Which numbers did you find?
Alicia	:	I used -14 and 2, because -14 + 2 = -12 and -14 × 2 = -28.
Researcher	:	Good. What did you do next?
Alicia	:	I split the middle term -12x into -14x and +2x, so the equation became $4x^2 - 14x + 2x - 7 = 0$. Then I factored by grouping.
Researcher	:	What was the result?
Alicia	:	From the grouping, I got (2x + 1) (2x - 7) = 0, then I solved for x from each factor.
Researcher	:	What values of x did you get?

Alicia : From 2x + 1 = 0, I got x = $-\frac{1}{2}$, and from 2x - 7 = 0, I got x = $\frac{7}{2}$.

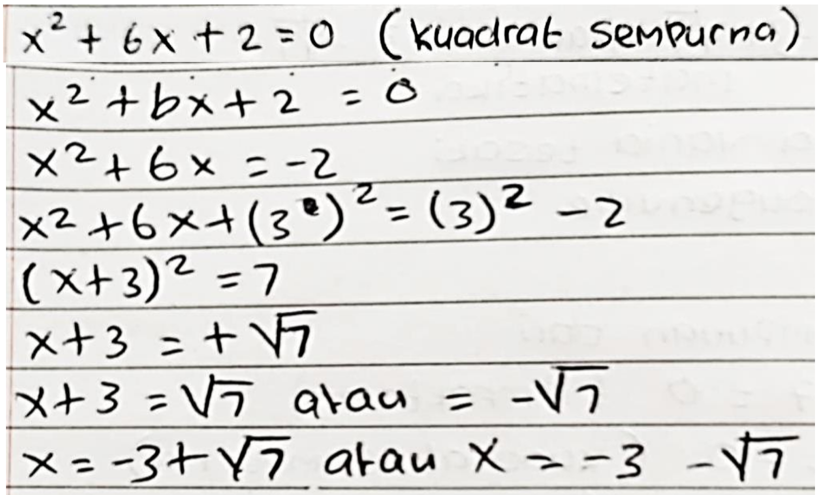
Researcher : But earlier, you wrote x = -1 and x = 7. How did that happen?

Alicia : Oh, yes... I was supposed to divide by 2, but I forgot. I made a mistake. The correct answers are x = $-\frac{1}{2}$ and x = $\frac{7}{2}$, not -1 and 7.

Researcher : That's okay, what matters is that you understand your mistake. Do you get it now?

Alicia : Yes, Sir. I now realize how important it is to divide correctly after moving terms.

Analysis of posttest results of high school mathematics problem-solving ability based on student answer sheets is as follows.



Picture 3. Student Answer Sheet Postest Stage

The results of the interview with student 1, based on the answer sheet, are as follows. The following is a transcription of the interview Results of Student 1 on Mathematical Problem-Solving Skills at the Posttest Stage.

Researcher : Hi! Can you tell me what you're working on here?

Alicia : I'm solving a problem about finding the extreme point or the vertex of a quadratic function. The question is f(x) = $3x^2 + 6x - 2 = 0$.

Researcher : Great. Can you explain the steps you took?

Alicia : At first, I tried to simplify the equation, but I think I made a mistake. I ended up writing $x^2 + 6x + 2 = 0$, which isn't the original equation. I think I was trying to factor or complete the square, but I got a bit confused.

Researcher : I see that you attempted to complete the square. Can you explain how you did it?

Alicia : Yes, I took $x^2 + 6x$ and added $(3)^2$ to complete the square, so it became $(x + 3)^2 = 7$, because 9 - 2 = 7. Then I solved it by taking the square root of both sides.

Researcher : Good effort. But the question asks for the extreme point or vertex of the function. Do you know how to find that directly?

Alicia : Oh, right! To find the vertex of a quadratic function in the form $f(x) = ax^2 + bx + c$, we use $x = -\frac{b}{2a}$. Thus, for this function, $x = -\frac{6}{(2 \times 3)} = -1$.

Then we substitute it back into the function to find the y-coordinate.

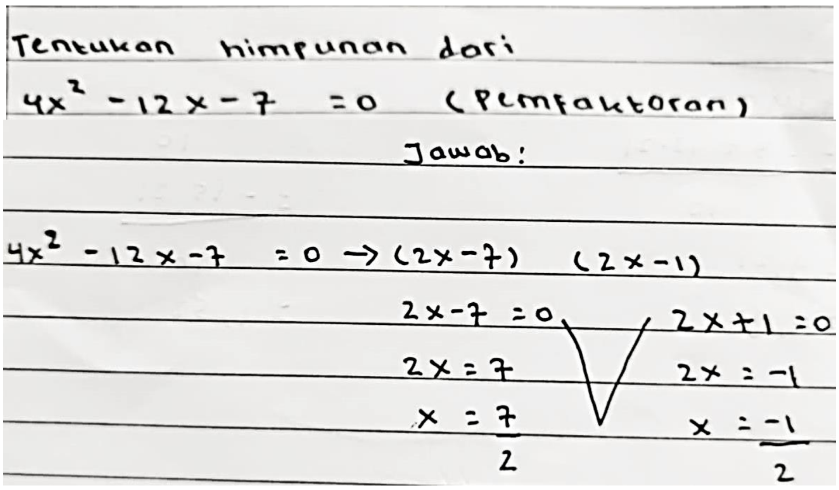
Researcher : Exactly! So you were solving for the roots instead of the vertex. But that's okay, you're learning.

Alicia : Yes, I see my mistake now. I'll try the vertex method next time.

Researcher : That's the spirit! Keep practicing, you're doing well.

The findings of the study demonstrate a clear improvement in students' performance, as evidenced by the comparison between pretest and posttest scores. A considerable portion of the students who initially exhibited a limited grasp of the material during the pretest were able to achieve substantial progress after undergoing the learning intervention. This notable enhancement in posttest outcomes suggests that the instructional strategies and activities implemented during the learning sessions were effective in facilitating student understanding. The ability of the students to perform better in the posttest reflects the success of the pedagogical approach in addressing their initial learning gaps and supporting conceptual development. As such, it can be concluded that the teaching methods employed not only increased students' engagement but also had a significant positive impact on their academic achievement. The observable progress from pre-instruction to post-instruction performance serves as strong evidence of the efficacy of the chosen teaching strategy in promoting deeper comprehension and retention of the subject matter.

Analysis of pretest results of high school mathematics Problem-Solving ability based on student answer sheets as follows.

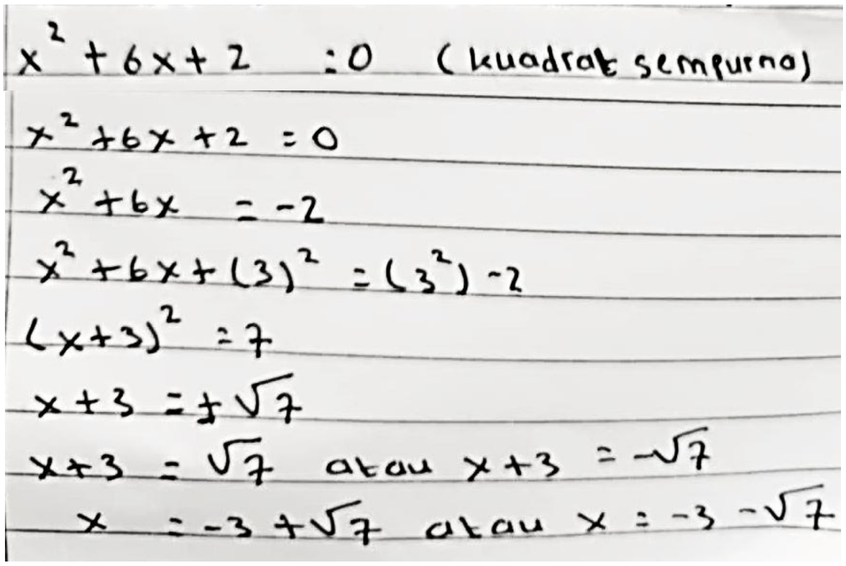


Picture 4. Student Answer Sheet Pretest Stage

The results of the interview with student 2, based on the answer sheet, are as follows. The following is a transcription of the interview results of student 2 on Mathematical Problem-Solving Skills at the Pretest Stage.

Researcher	:	You worked on the pretest question about factoring. Can you explain how you solved the equation $4x^2 - 12x - 7 = 0$?
Hasri	:	Sure, first I looked for two numbers that multiply to -28 and add up to -12.
Researcher	:	Which numbers did you find?
Hasri	:	I chose -14 and 2, because when multiplied, they give -28, and when added, they give -12.
Researcher	:	Good. What did you do next?
Hasri	:	I rewrote $-12x$ as $-14x + 2x$, then grouped the terms: $4x^2 - 14x + 2x - 7 = 0$.
Researcher	:	What was the result?
Hasri	:	I factored each group, which gave me 12x as $-14x + 2x$. That became $(2x + 1)(2x - 7) = 0$, then I solved for x from each factor.
Researcher	:	What values of x did you get?
Hasri	:	I set each factor equal to zero: $2x + 1=0$ and $2x - 7=0$. Solving these, I got $x = -\frac{1}{2}$, and got $x = \frac{7}{2}$.
Researcher	:	Earlier, your answer was $x = -1$ and $x = 7$. Why?
Hasri	:	I forgot to divide by 2 at the end. I realize now that it was a mistake.
Researcher	:	That's okay. Did you understand the process better now?
Hasri	:	Yes, I understand it better now. I'll be more careful with the last steps next time.

Analysis of posttest results of high school mathematics Problem-Solving ability based on student answer sheets as follows.



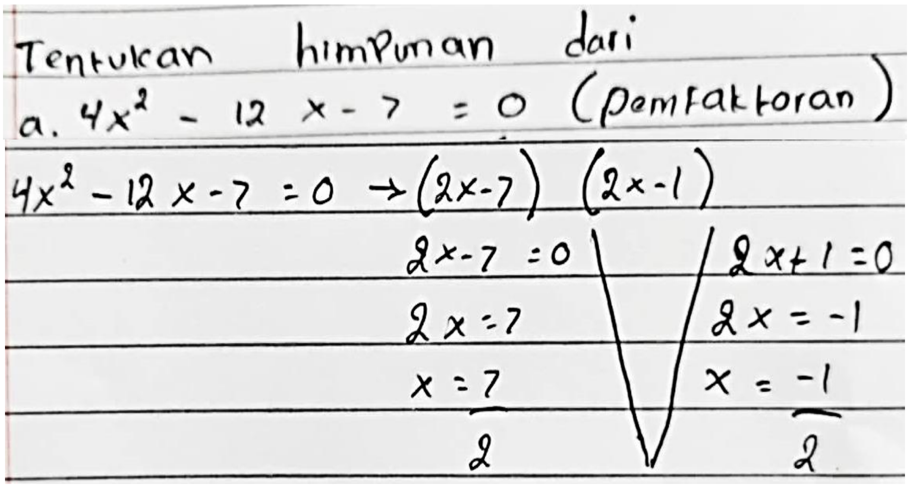
Picture 5. Student Answer Sheet Postest Stage

The results of the interview with student 2, based on the answer sheet, are as follows. The following is a transcription of the interview results of Student 2 on mathematical problem-solving skills at the posttest stage.

Researcher	:	Hi! Can you tell me what you're working on here?
Hasri	:	I'm working on finding the vertex of the quadratic function given by f(x) = 3x^2 + 6x - 2. I want to find its extreme point.
Researcher	:	Great. Can you explain the steps you took?
Hasri	:	Sure. At first, I thought about using the method of completing the square, but I got stuck trying to rewrite the equation properly. I realized I was changing the coefficients incorrectly, which gave me the wrong expression.
Researcher	:	I see that you attempted to complete the square. Can you explain how you did it?
Hasri	:	Then I remembered the vertex formula. Since the general form of a quadratic is f(x) = ax^2 + bx + c, we can find the x-coordinate of the vertex using x = -b / 2a. So in my case, a = 3 and b = 6, which gives x = -6 / (2 × 3) = -1.
Researcher	:	Good effort. But the question asks for the extreme point or vertex of the function. Do you know how to find that directly?
Hasri	:	Oh, right! To find the vertex of a quadratic function in the form f(x) = ax^2 + bx + c, we use x = -b / 2a. So for this function, x = -6 / (2 × 3) = -1. Then we substitute it back into the function to find the y-coordinate.
Researcher	:	Exactly! So you were solving for the roots instead of the vertex. But that's okay, you're learning.
Hasri	:	I learned that completing the square is useful, but if I get confused, I can always fall back on the vertex formula to find the extreme point quickly and accurately.
Researcher	:	That's a great reflection. Keep up the good work!

The analysis of the results reveals a significant enhancement in students' performance from the pretest to the posttest. Initially, many students showed limited understanding of the topics during the pretest assessment. However, after participating in the instructional activities, they exhibited notable progress as reflected in their posttest scores. This improvement suggests that the teaching strategies and learning processes implemented were effective in promoting a deeper understanding of the material. It can be concluded that the instructional approach positively influenced student learning outcomes by addressing their initial difficulties and reinforcing key concepts. The transition from lower pretest scores to higher posttest scores highlights the success of the educational intervention in facilitating better knowledge retention and concept mastery. Thus, the findings support the notion that well-designed teaching methods can substantially improve students' comprehension and academic achievement.

Analysis of pretest results of high school mathematics Problem-Solving ability based on student answer sheets as follows.

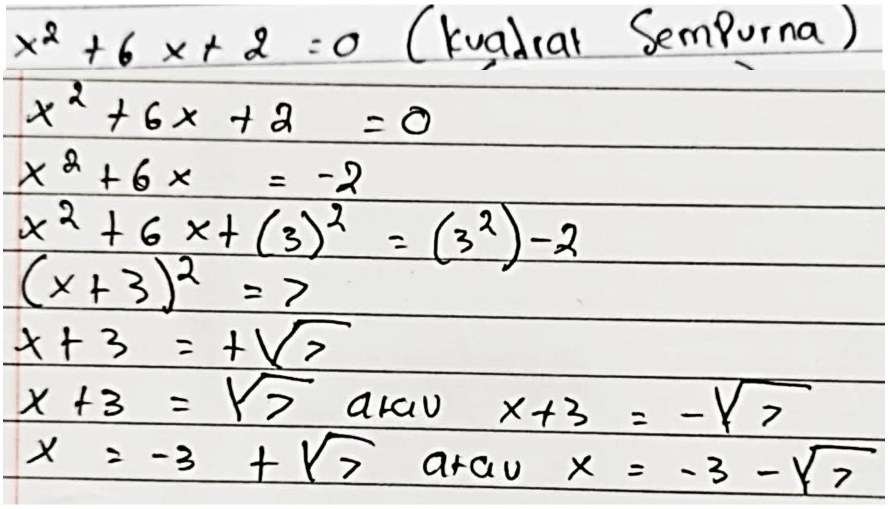


Picture 6. Student Answer Sheet Pretest Stage

The results of the interview with student 3, based on the answer sheet, are as follows. The following is a transcription of the interview results of student 3 on mathematical problem-solving skills at the pretest stage.

Researcher	:	You worked on the pretest question about factoring. Can you explain how you solved the equation $4x^2 - 12x - 7 = 0$?
Aqilah	:	Yes, I started by looking for two numbers that multiply to -28 and add up to -12.
Researcher	:	Which numbers did you find?
Aqilah	:	I found -14 and 2 because -14 × 2 = -28 and -14 + 2 = -12.
Researcher	:	Good. What did you do next?
Aqilah	:	I rewrote the middle term $-12x$ as $-14x + 2x$ and then grouped the terms into two pairs.
Researcher	:	What was the result?
Aqilah	:	I factored out 2x from the first group and 1 from the second group, which gave me 2x(2x−7)+ 1(2x - 7)
Researcher	:	What values of x did you get?
Aqilah	:	I got x = (2x+1) + 1(2x - 7)
Researcher	:	But earlier, you wrote x = -1 and x = 7. How did that happen?
Aqilah	:	I made a mistake by not dividing both sides by 2 when solving the equations. I understand now that I need to do that.
Researcher	:	That’s okay, what matters is that you understand your mistake. Do you get it now?
Aqilah	:	Yes, I do. I’ll be more careful next time.

Analysis of posttest results of high school mathematics Problem-Solving ability based on student answer sheets as follows.



Picture 7. Student Answer Sheet Postest Stage

The results of the interview with student 3, based on the answer sheet, are as follows. The following is a transcription of the interview results of student 3 on mathematical problem-solving skills at the posttest stage.

Researcher : Hi! Can you tell me what you're working on here?

Aqilah : I'm working on finding the vertex of a quadratic function. The equation I'm given is f(x) = $3x^2 + 6x - 2$.

Researcher : Great. Can you explain the steps you took?

Aqilah : At first, I thought I had to solve the equation, so I tried to factor it. But then I realized it's not easy to factor, so I switched to another method.

Researcher : I see that you attempted to complete the square. Can you explain how you did it?

Aqilah : I remembered that completing the square is one way to rewrite the function into vertex form. I started with the expression $3x^2 + 6x - 2$. First, I factored out the 3 from the first two terms: $3(x^2 + 2x) - 2$. Then I added and subtracted 1 inside the parentheses to complete the square: $3[(x + 1)^2 - 1] - 2$.

Researcher : Good effort. But the question asks for the extreme point or vertex of the function. Do you know how to find that directly?

Aqilah : I distributed the 3: $3(x + 1)^2 - 3 - 2 = 3(x + 1)^2 - 5$. So now it's in vertex form, and I can see the vertex is at (-1, -5).

Researcher : Exactly! So you were actually solving for the roots instead of the vertex. But that's okay you're learning.

Aqilah : Yes! I used x = $-\frac{b}{2a}$. With a = 3 and b = 6, it becomes x = $-\frac{6}{(2 \times 3)}$ = -1.

Then I plugged it back into the original function to find f(-1) = $3(-1)^2$ +

6(-1) - 2 = 3 - 6 - 2 = -5. So the vertex is (-1, -5).

Researcher : Very thorough. You clearly understand both methods. Great job!

The results indicate that students' posttest scores generally improved compared to their pretest scores. Many students who initially demonstrated limited understanding of the material during the pretest were able to show significant improvement after the learning process, as reflected in their posttest performance. It suggests that the teaching and learning activities implemented were effective in enhancing students' comprehension of the topic. Therefore, it can be concluded that the instructional approach used during the lesson had a positive impact on student learning outcomes. The improvement from pretest to posttest highlights the success of the strategy in helping students grasp the concepts more thoroughly.

The results of statistical analysis, student answer sheets, and interviews it was found that students demonstrated varying levels of understanding regarding the concept of quadratic functions. The quantitative data revealed that only a portion of the students were able to accurately determine the vertex using the formula; $x = -\frac{b}{2a}$, and even fewer could correctly substitute the x-value back into the function to find the corresponding y-coordinate. Analysis of student answer sheets showed frequent errors in completing the square, including mistakes in factoring and sign confusion. Furthermore, many students attempted to solve the quadratic equation rather than identify the vertex, indicating a conceptual misunderstanding between finding the roots and locating the extreme point. Interviews supported these findings by uncovering students' thought processes and strategies. Some students expressed uncertainty about which method to use and when, while others incorrectly modified the original equation during their calculations. However, the interviews also highlighted positive indicators, such as students' willingness to reflect on their errors and a basic understanding of the structure of quadratic functions. These results suggest that while foundational knowledge is present, there is a need for more explicit instruction, guided practice, and formative feedback focused on distinguishing between different forms of quadratic problem-solving. Strengthening these areas could lead to improved conceptual clarity and better overall performance.

Discussion

The results showed that PAKEM learning based on local cultural wisdom positively contributed to students' mathematical problem-solving skills at SMA Negeri 1 Tanggetada. Compared to the direct learning model, PAKEM was more effective in enhancing students' abilities. Students in class X_1, who were taught using the PAKEM model, showed greater enthusiasm, creativity, and engagement. The integration of local cultural elements helped make the learning process more meaningful and enjoyable. Moreover, PAKEM encourages collaboration, appreciation of peers' potential, and supports the development of life skills. In contrast, students in class x_3, who experienced direct and monotonous instruction, were less motivated and showed lower problem-solving performance. It is in line with research from Zulkarnain et al. (2022) that the implementation of the Pakem (Participatory, Active, Creative, Effective and Fun) learning model dramatically enhances pupils' mathematics learning outcomes. Other than that, PAKEM learning is based on the area of cultural wisdom, based on the relevance of high school students' higher-order thinking skills that students must have in the learning process. This development can build quantitative problem-solving skills, the ability to think rationally, and methodically based on local cultural knowledge. It is in accordance with the conclusions of studies by Parwati et al. (2018) claimed that students are motivated to study by the challenges that are provided at the start of the class, and that they should be selected from situations that they are accustomed to in their everyday lives.

The problems offered to pupils are not only routine problems or closed problems, but also non-routine difficulties with open problems. Open math problems are recommended to be employed to train pupils to answer problems creatively. Besides that, according to Al-Fananie et al. (2020), students' ability to solve math story problems using local wisdom has increased. In addition to helping students become better mathematicians. There is therefore a need for continuous studies as a way to show love for the nation and to constantly preserve their cultural heritage, in addition to the significance of strengthening the ability of SMA Negeri 1 Tanggetada students to solve mathematical problems based on the local cultural wisdom in each region. Education that is more grounded in national values and consistently upholds one another's cultural heritage is known as local wisdom-based education. This education helps learners always be close to concrete problems in real life. It is consistent with the findings of studies conducted By Ota and Wali (2019) stated that mathematics learning is based on the culture of the Ngada region through introducing students to traditional objects, connecting traditional objects with mathematical material, creating other props that are similar to traditional objects This is to train their memory and understanding to become more meaningful. Supiyati et al. (2023) said that metacognitive abilities in the experimental class are rated as effective, indicating that a Collaborative-Based Inquiry approach, rooted in local wisdom, significantly enhances students' metacognitive skills in mathematics.

Nursakiah et al. (2022) said that in order to improve pupils' mathematical comprehension when tackling mathematical issues, it is crucial to construct questions incorporating local wisdom with other mathematical skills. Agustina et al. (2021) stated that Questions rooted in local wisdom, particularly from Sidoarjo, help students become more familiar with their cultural context. Consequently, integrating local wisdom into mathematics problems enhances students' comprehension of mathematical concepts. In addition to introducing local culture to pupils, character education grounded in local cultural knowledge also aims to alter the mindsets and actions of current human resources to boost productivity and prepare them for future problems. The advantages of establishing a positive culture can also improve communication, be more adaptable to future difficulties, and strengthen the attitude of kinship, cooperation, togetherness, and openness.

This study offers several important implications for mathematics education, particularly in multicultural or rural contexts like Tanggetada. First, the success of PAKEM learning based on local wisdom suggests that contextualized and culturally responsive pedagogy can significantly improve student outcomes. Educators are encouraged to design learning experiences that draw on students' cultural backgrounds to make learning more relevant and meaningful. Second, school policymakers should support the integration of local cultural knowledge into curricula and teacher training programs to ensure broader and more sustainable implementation. Third, the results highlight the potential of local wisdom as a vehicle for developing not only cognitive competencies but also character education and social awareness.

While this study provides strong evidence supporting the effectiveness of PAKEM learning based on local wisdom, it also has several limitations. First, the research was conducted in a specific regional context (Tanggetada, Kolaka District), which may limit the generalizability of the findings to other regions with different cultural characteristics. Second, the sample size was relatively small and limited to two classes, which may affect the statistical power of the analysis. Third, the study relied on quantitative measures with some qualitative insights; a more comprehensive understanding could be achieved through longitudinal or mixed-method studies that include classroom observations and in-depth interviews. Future research is recommended to explore the long-term effects of this learning model, its scalability in diverse educational contexts, and its adaptability to other disciplines beyond mathematics. Moreover, studies should examine how teacher readiness and institutional support influence the successful implementation of culturally grounded learning strategies.

Conclusions and Suggestions

Based on the results of the study, it can be concluded that PAKEM learning integrated with local cultural wisdom has a significant effect on improving students' mathematical problem-solving abilities. It is evidenced by the results of the independent sample t-test, which showed a significance value of less than 0.05, and the N-gain analysis, which indicated a higher increase in the experimental group compared to the control group. The integration of local wisdom, particularly from the cultural values of the Bajo community in Tanggetada, into an active, creative, effective, and fun learning approach has created a more contextual, relevant, and meaningful learning environment. This approach not only enhanced student engagement but also strengthened their understanding of mathematical concepts through experiences closely related to their everyday lives. Therefore, PAKEM learning based on local cultural wisdom has proven effective in enhancing the quality of mathematics learning, especially in terms of students' problem-solving abilities. It is recommended that this instructional model be more widely implemented in secondary schools, particularly in the Tanggetada Sub-district, Kolaka District, Southeast Sulawesi Province, as a strategic effort to promote more contextual and meaningful mathematics education.

Acknowledgements

The researcher would like to thank the beloved campus of Universitas Sembilanbelas November Kolaka, the LPMP Universitas Sembilanbelas November Kolaka, the Universitas Sembilanbelas November Kolaka research center, DIPA Universitas Sembilanbelas November Kolaka, and those involved in the process until the completion of this research.

References

Akbar, S., Imamuddin, M., Rahmi, F., & Isnaniah, I. (2022). The effectiveness of innovative learning on mathematical problem-solving ability: Quasi-experimental.

International Journal of Learning and Instruction (IJLI), *4*(2), 111. https://doi.org/10.26418/ijli.v4i2.59784

Al-Fananie, A. Z., Syahputra, E., & Eviyanti, E. (2020). The influence of PAKEM model using tangram media on learning motivation and spatial mathematical ability of grade II students of SD IT Khalisaturrahmi Binjai. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *3*(4), 2244–2258. https://doi.org/10.33258/birle.v3i4.1508

Al, R. et al. (2024). The analysis of senior high school students' mathematical literacy viewed from PISA problems. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, *13*(2), 586–599. http://doi.org/10.24127/ajpm.v13i2.8624

Al Kayyis, A., Tohir, M., & Muhasshanah, M. (2024). The urgency of Polya model problem-solving on students mathematical ability in facing the Industrial Revolution 5.0. *Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika, 6*(2), 218-231. https://doi.org/10.35316/alifmatika.2024.v6i2.218-231

Andrijati, S. R. E. P. & N. (2024). Discovery learning model assisted by geogebra-based napier bones on students' division problem-solving ability. *Jurnal Pendidikan MIPA*, *25*(August), 223–235. http://doi.org/10.23960/jpmipa/v25i1.pp223-235

Arifiani, K. N., Wijaya, C. K. W., Irfan, A., Septiasari, A., Iskandar, J., Iskandar, B. S., Partasasmita, R., & Setyawan, A. D. (2019). Review: Local wisdom of Baduy people (south Banten, Indonesia) in environmental conservation. *Asian Journal of Ethnobiology*, *2*(2), 92–107. https://doi.org/10.13057/asianjethnobiol/y020204

Arion, K. (2024). Exploring local wisdom: Utilizing ethnomathematics to improve mathematical creative thinking skills. *Jurnal Theorems (The Original Research of Mathematics)*, *9*(1), 100–113. https://doi.org/10.31949/th.v9i1.9538

As'ari, A. R., Kurniati, D., & Subanji. (2019). Teachers' expectation of students' thinking processes in written works: A survey of teachers' readiness in making thinking visible. *Journal on Mathematics Education*, *10*(3), 409–424. https://doi.org/10.22342/jme.10.3.7978.409-424

Ayllon, M. E., Gomez, I. A., & Claver, J. B. (2016). Mathematical thinking and creativity through mathematical problem posing and solving. *Propósitos y Representaciones*, *4*(1), 169–218. https://eric.ed.gov/?id=EJ1126306

Chen, G., & Fan, Y. (2025). The effectiveness of digital game-based pedagogy in language abilities among children with delay. *International Journal of Distance Education Technologies*, *23*(1), 1–19. https://doi.org/10.4018/IJDET.369824

Dimitriadis, C. (2012). How are schools in England addressing the needs of mathematically gifted children in primary classrooms? A review of practice. *Gifted Child Quarterly*, *56*(2), 59–76. https://doi.org/10.1177/0016986211433200

Djong, K. D., Lusi, Y. K., Lakapu, M., & Guterres, I. (2024). Students' thinking process in solving mathematics problems oriented to higher order thinking skills. *Jurnal Pendidikan MIPA*, *25*(1), 155–165. https://doi.org/10.23960/jpmipa/v25i1.pp155-165

Eviota, J. S., & Liangco, M. M. (2020). Students' performance on inquiry-based physics instruction through virtual simulation. *Jurnal Pendidikan MIPA, 21*(1), 22-34. http://doi.org/10.23960/jpmipa/v21i1.pp22-34

Flannelly, K. J., Flannelly, L. T., & Jankowski, K. R. B. (2018). Threats to the internal validity of experimental and quasi-experimental research in healthcare. *Journal of Health Care Chaplaincy*, *24*(3), 107–130. https://doi.org/10.1080/08854726.2017.1421019

Godino, J. D., Batanero, C., & Burgos, M. (2023). Theory of didactical suitability: An enlarged view of the quality of mathematics instruction. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(6). https://doi.org/10.29333/ejmste/13187

Gravett, K., & Carless, D. (2024). Feedback literacy-as-event: relationality, space and temporality in feedback encounters. *Assessment and Evaluation in Higher Education*, *49*(2), 142–153. https://doi.org/10.1080/02602938.2023.2189162

Hidayati, A., & Dharin, A. (2023). The Importance of active, innovative, creative, effective, and fun learning applications on natural science subject at islamic elementary school. *International Journal of Multidisciplinary Research and Analysis*, *6*(9), 4425–4435. https://doi.org/10.47191/ijmra/v6-i9-61

Irwan, Taufiq, M. A., & Fernando, R. (2019). A review of the integration of local wisdom in english language teaching in 5.0 Society Era. *Proceeding of 4th International Conference on Education*, *1990*, 143–148. https://ojs.iainbatusangkar.ac.id/ojs/index.php/proceedings/article/viewFile/2171/1607

Jala, J. (2024). Development of a problem-solving learning model based on local wisdom for junior high school students in Sidrap. *Lotus: Education Journal, 1*(1), 17-25. https://jurnal.umsrappang.ac.id/LOTUS/article/view/1790

Kuhnlein, H. V., & Chotiboriboon, S. (2022). Why and how to strengthen indigenous peoples' food systems with examples from two unique indigenous communities. *Frontiers in Sustainable Food Systems*, *6*(5), 1–20. https://doi.org/10.3389/fsufs.2022.808670

Lestari, N., P., & Suyanto, S. (2024). A systematic literature review about local wisdom and sustainability: Contribution and recommendation to science education. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(2), 1–19. https://doi.org/10.29333/ejmste/14152

Made, I., Acwin, N. K., & Wisdom, L. (2020). Local wisdom in reducing greenhouse effect on balinese traditional settlement patterns in Bongli village, Bali, Indonesia. *Engineering and Technology Quarterly Reviews, 3*(1), 23-33. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3581784

Mahanal, S., Zubaidah, S., Setiawan, D., Maghfiroh, H., & Muhaimin, F. G. (2022). Empowering college students' problem-solving skills through RICOSRE. *Education Sciences*, *12*(3), 1-17. https://doi.org/10.3390/educsci12030196

Masaki, F. (2023). Self-regulation from the sociocultural perspective—A literature review. *Cogent Education*, *10*(2), 1-15. https://doi.org/10.1080/2331186X.2023.2243763

Mazid, H., Rachmalia, L., Suyanta, S., & Widjajanti, E. (2023). Teacher strategies in managing chemistry learning time to improve student learning achievement. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 1129–1136. https://doi.org/10.29303/jppipa.v9i11.5192

Nurmala Sari Agustina, E., Widadah, S., & Afinanun Nisa, P. (2021). Developing realistic mathematics problems based on sidoarjo local wisdom. *Mathematics Teaching Research Journal*, *13*(4), 181–201. https://eric.ed.gov/?id=EJ1332336

Nursakiah, N., Arriah, F., & Dharma, S. (2022). Developing mathematical literacy test with context of Bugis-Makassar local wisdom for junior high school students. *Jurnal Elemen*, *8*(1), 16–28. https://doi.org/10.29408/jel.v8i1.4049

Olivares, D., Lupiáñez, J. L., & Segovia, I. (2021). Roles and characteristics of problem solving in the mathematics curriculum: a review. *International Journal of Mathematical Education in Science and Technology*, *52*(7), 1079–1096. https://doi.org/10.1080/0020739X.2020.1738579

Ota, M. K., & Wali, M. (2019). Pembelajaran matematika berbasis budaya daerah ngada untuk melatihkan keterampilan berpikir kritis siswa kelas III sekolah dasar Inpres Turekisa [Regional culture-based mathematics learning in Ngada to train critical thinking skills of grade III students of Inpres Turekisa Elementary School]. *Wahana Matematika Dan Sains: Jurnal Matematika, Sains, Dan Pembelajarannya*, *13*(2), 14–26. https://doi.org/10.23887/wms.v13i2.19266

Parwati, N. N., Sudiarta, I. G. P., Mariawan, I. M., & Widiana, I. W. (2018). Local wisdom-oriented problem-solving learning model to improve mathematical problem-solving ability. *Journal of Technology and Science Education*, *8*(4), 310–320. https://doi.org/10.3926/jotse.401

Prasetyawan, W. (2023). *Willingness to Pay for Environmental Conservation of Peat and Aquatic Ecosystems in a Cash-Poor Community: A Riau Case Study*. Local Governance of Peatland Restoration in Riau, Indonesia: A Transdisciplinary Analysis, 193-209. Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-99-0902-5_9

Samura, A. O., & Juandi, D. (2022). Application of the PAKEM learning model to improve student learning outcomes in mathematics. *Journal of Didactic Mathematics*, *3*(1), 17–27. https://doi.org/10.34007/jdm.v3i1.1285

Suastra, I. W. (2017). Balinese local wisdoms and their implications in science education at school. *International Research Journal of Management, IT & Social Sciences*, *4*(2), 48–57. https://doi.org/10.21744/irjmis.v4i2.389

Supiyati, S., Halqi, M., Waluyo, E., & Rasidi, A. (2023). Development of collaborative based inquiry learning tools using local wisdom context to improve students metacognitive. *Jurnal Elemen*, *9*(1), 246–255. https://doi.org/10.29408/jel.v9i1.6969

Supriyanto Manurung, A., & Halim, A. (2021). Pengaruh model pembelajaran PAKEM terhadap prestasi belajar matematika siswa kelas V SDN Pondok Kelapa 05 Pagi Jakarta [The influence of the PAKEM learning model on the mathematics learning achievement of class V students at SDN Pondok Kelapa 05 Pagi Jakarta]. *Jurnal*

Ilmiah Kependidikan, *8*(1), 93–103. https://doi.org/10.30998/fjik.v8i1.8638

Susanto, Y. K., Rudyanto, A., & Rahayuningsih, D. A. (2022). Redefining the concept of local wisdom-based csr and its practice. *Sustainability (Switzerland)*, *14*(19), 1-23. https://doi.org/10.3390/su141912069

Wakhata, R., Mutarutinya, V., & Balimuttajjo, S. (2023). Relationship between active learning heuristic problem-solving approach and students' attitude towards mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(2), 1-19. https://doi.org/10.29333/ejmste/12963

Yulia, P., & Suhendra, B. (2017). Efektivitas model pembelajaran PAKEM masalah matematis siswa [The effectiveness of the PAKEM learning model is reviewed from the mathematical problem solving abilities of class VIII students at SMP Negeri 11 Batam]. *Pythagoras: Jurnal Program Studi Pendidikan Matematika*, *6*(1), 31–36. https://doi.org/10.33373/pythagoras.v6i1.623

Zulkarnain, R. S., Hartatiana, H., & Efriani, A. (2022). Penerapan model PAKEM (Partisipatif, Aktif, Kreatif, Efektif Dan Menyenangkan) terhadap hasil belajar matematika [Application of the PAKEM model (Participatory, Active, Creative, Effective and Enjoyable) to mathematics learning outcomes]. *JEMST (Jurnal of Education in Mathematics, Science, and Technology)*, *5*(1), 18–27. https://doi.org/10.30631/jemst.v5i1.69