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IMPLEMENTATION OF DESIGN THINKING IN GOOGLE SITES WITH TARL APPROACH TO IMPROVE MATHEMATICAL PROBLEM-SOLVING SKILLS

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ABSTRACT

The 21st century requires individuals to have the ability to think comprehensively, especially in critical and creative thinking. The result of the PISA study show that the literacy skills of Indonesian student are still relatively low, including in terms of numeracy or mathematical problem solving. Preliminary data shows that most students have a "normal" feeling about math lessons (45%) and feel less confident when learning maths (47.2%). Teachers also face difficulties in providing learning materials that are in accordance with the level of students' abilities due to heterogeneity in the classroom. This study aims to determine the effectiveness of google sites-based learning media with the integration of design thinking and ADDIE as a development approach, as well as using the Teaching at the Right Level (TaRL) method in media preparation. The stages of *empathize, define, ideate, prototype,* and *test* in design thinking are combined with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) cycle to produce media that suits the needs of students. The subject of this study is a grade XI student of State High School 4 Semarang. The results of data analysis showed an increase in the mathematical problem-solving ability of students with an N-Gain score of 0.7 (high category) and t-test results of 1.711 which is greater than the t-table of 1.67. In addition, the results of the analysis of the classical learning completeness test show that the proportion of completeness of materialistic problem ability is achieved. Theoretically, this research contributes to the study of technology-based learning with the application of TaRL, and is able to support constructivistic theory and effectively improve students' mathematical problem-solving skills.

Keywords: Design Thinking, Google Sites, TaRL, Mathematical Problem-Solving Skills

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PRELIMINARY

21st century learning requires learners to not only master the content, but also develop critical, creative, collaborative, and empathetic thinking skills. In dealing with this complexity, a human-centered, iterative, and adaptive approach is needed. Design Thinking (DT) is the right solution. According to Brown (2009), *"Design Thinking is a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for success."* This approach is not just design, but permeates the needs of users in creating innovative solutions. In the realm of education, DT has been proven to be able to improve students' problem-solving and creativity (Razzouk & Shute, 2012). The iterative process is *empathize, define, ideate, prototype, test* which provides space for teachers to design learning media that is responsive to the needs of students (Plattner et al., 2011).

In line with the spirit of design thinking that prioritizes real context and actual problems. On the other hand, the integration of design thinking in instructional design models has also been studied in the context of OER (Open Educational Resources). Laisema & Bangthamai (2025) developed a design thinking-based OER model that has been proven to significantly improve the competency of student innovators, showing that design thinking is not only a creative tool, but also effective in strengthening 21st century competencies. Through this approach, learning media is developed in a human-centered manner that can be realized, one of which is with Google Sites as an interactive and easily accessible digital platform.

The use of educational technology is also an important factor in increasing the effectiveness of learning. A number of recent studies show that the use of *Google Sites* in learning has a positive impact on various subjects and levels of education. Rahadian et al. (2024) found that the development of Google Sites-based e-learning with the TIME model has proven to be valid, practical, and effective to support digital learning activities. Similar findings were shown by Waraga et al. (2023) who reported that Google Sites-assisted learning tools on vibration and wave materials have a high level of validity and effectiveness, making them feasible to implement in science learning.

In addition, *Google Sites* has also been proven to make it easier for teachers to manage learning. Raharja et al. (2024) emphasized that the use of *Google Sites* as an administrative medium makes it easier for teachers to compile teaching tools systematically and easily accessible. Meanwhile, in terms of impact on student achievement, research by Pangesti et al. (2025) shows that Google Sites-based media in social studies subjects helps students understand the material more interactively. Lucia et al. (2023) found that the use of *Google Sites* in English learning had a positive effect on improving students' vocabulary mastery. In it, content can be compiled using the Teaching at the Right Level (TaRL) method to suit the level of ability of students.

In the classroom, teachers often face the challenge of the heterogeneity of diverse student abilities. According to Vygotsky (1978), the learning process will be optimal if the material is adjusted to the *student's zone of proximal development*. However, the reality is that teachers often have difficulty providing material that is in accordance with the level of individual ability of students. Research conducted by Hadi and Novaliyosi (2019) also shows that Indonesia's low PISA results are partly due to the fact that classroom learning emphasizes more on memorization and procedures than conceptual understanding and problem-solving. As a result, some students feel left behind, while others are not challenged. Preliminary data also showed that many students had a neutral attitude towards math and lacked confidence in learning new material. This condition reinforces the need for an adaptive learning approach to the differences in students' abilities.

The *Teaching at the Right Level (TaRL)* approach introduced by Banerjee et al. (2017) is present as an effective strategy to overcome class heterogeneity. TaRL focuses on adjusting learning materials and activities based on the actual level of students' abilities, not just following the curriculum in a linear manner. Pratham Education Foundation research (2018) shows that the implementation of TaRL can significantly improve students' literacy and numeracy skills in various educational contexts. In other words, TaRL allows teachers to develop learning strategies that are more targeted so that students do not feel left behind or bored too easily. In the context of mathematics learning, TaRL plays an important role in helping students build a gradual understanding of concepts, from mastering basic operations to solving more complex problems. This makes TaRL a strong foundation to improve students' mathematical problem-solving skills.

The National Council of Mathematics (NCTM, 2000) emphasizes that problem-solving is at the heart of effective mathematics learning because it can train students to think analytically and reflectively. However, in reality, the results of the *Programme for International Student Assessment* (PISA) survey show that the mathematical ability of Indonesian students is still below the international average. In PISA 2018, Indonesia's mathematics score was ranked 72 out of 79 countries with an average score of 379, far below the OECD average score of 489 (OECD, 2019). Similar results were also found in the 2015 Trends in International Mathematics and Science Study (TIMSS) which ranked Indonesia 45 out of 50 countries in mathematics ability (Mullis et al, 2016). This condition shows that the mathematical problem-solving ability of Indonesian students is still relatively low and requires more effective learning interventions.

Problem-solving requires students to identify problems, formulate solution strategies, apply relevant concepts and procedures, and re-evaluate the resulting solutions. According to Polya (1973), the process of solving mathematical problems includes four stages, namely understanding the problem, planning a strategy, implementing a plan, and re-examining the results obtained. The subject of this study is grade XI students of State High School 4 Semarang, where class XI-6 class is the control class and XI-2 is the experimental class.

Various studies show the importance of innovative learning models in improving students' mathematical problem-solving skills. For example, Febiyanti et al. (2024) in their quasi-experimental study found that the application of discovery learning to arithmetic row material increased students' problem-solving ability by around 40.56%, much higher than the control class which only increased by 16.53%. Furthermore, Noviyana et al. (2025) reported that the use of AI-assisted problem-based learning in grade V students resulted in significant improvements in all mathematical problem-solving indicators such as understanding problems, formulating plans, implementing solutions, and evaluating results. Obtained a high N-Gain score of around 0.78. In the broader realm of Indonesia, a meta-analysis by Ulya et al. (2024) shows that technology-based learning interventions have proven to be effective in improving mathematical problem-solving skills at various levels of education. Thus, empirical evidence suggests that methodological innovation through discovery models, as well as the use of technology, significantly encourages an improvement in students' mathematical problem-solving skills.

Based on this background, this study aims to examine the effectiveness of the application of Design Thinking in the development of Google Sites media with the Teaching at the Right Level (TaRL) approach to improve students' mathematical problem-solving skills. Through the application of this approach, it is hoped that students will not only gain a better understanding of mathematical concepts, but also be able to develop critical, creative, and adaptive thinking skills that are essential in facing the challenges of 21st century learning.

METHODS

The type of research used in this study is Research and Development (R&D) which is oriented towards the development of learning media and testing its effectiveness. The design of this study adapts the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model combined with the Design Thinking approach. This research aims to develop Google Sites-based learning media with a Teaching at the Right Level (TaRL) approach to improve the mathematical problem-solving skills of high school students. The research was carried out at State High School 4 Semarang by involving grade XI students as test subjects.

The stages of Design Thinking in this study consist of five stages, namely Empathize, Define, Ideate, Prototype, and Test. In the *Empathize stage*, the researcher conducted observations and distributed questionnaires to explore students' learning needs and perceptions of mathematics. The *Define stage* is used to analyze the results of observations and compile *user personas* based on heterogeneous student ability levels. In the *Ideate stage*, the researcher brainstormed to design a content structure in Google Sites that integrates the TaRL approach, so that the material can be adjusted to the student's level of understanding.

Furthermore, at the *Prototype stage*, Google Sites media was developed which contains advanced mathematics material (polynomials), multi-level problem exercises, and mathematical problem-solving instruments. The final stage, *namely Test*, was carried out by implementing Google Sites in an experimental class to measure the effectiveness of media in improving students' mathematical problem-solving skills. Students' mathematical problem-solving ability has four indicators according to Polya (1973), namely: (1) understanding problems, (2) drawing up plans, (3) implementing plans, (4) re-examination. Therefore, this ability needs to be honed through a relevant, contextual, and problem-solving-based learning process.

The research instruments included student response questionnaires and mathematical problem-solving tests. The initial data analysis was obtained through pretest scores, while final data used post test scores. Data were analyzed using normality tests, homogeneity tests, and t-tests to determine the effectiveness of learning media. The effectiveness criteria were based on an increase in the average score of the experimental class compared to the control class, as well as the achievement of a completeness of at least 75%.

RESULT AND DISCUSSION

At the *empathize stage*, an in-depth analysis of the mathematics learning problems experienced by students is carried out, as a basis for designing *an empathy map*. The common view that mathematics is a difficult subject, full of formulas, and only mastered by certain students, makes many students feel anxious when facing this subject (Muhtarom et al., 2017). To dig deeper, a survey was conducted on questionnaires distributed among three high schools in Semarang Regency, namely 1 Tuntang Senior High School, Sudirman Islamic Senior High School, and 1 Gas Senior High School.

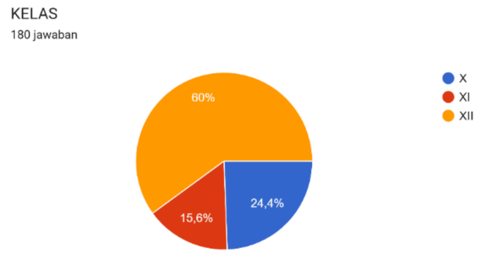

Figure 1. Showing Data on the Number of Student Respondents

The questionnaire was distributed through Google Form with a span of 2 weeks. The total number of student respondents was 180 people, consisting of 60% of respondents from class XII, 15.6% of respondents from class XI, and 24.4% from class X, while for education personnel, in this case mathematics teachers as many as 10 respondents.

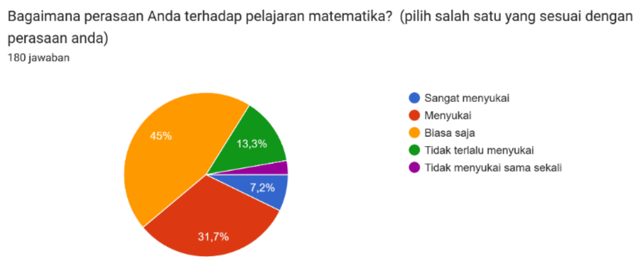

Figure 2. Students' Feelings Towards Mathematics Subjects

Based on the pie chart above, as many as 180 respondents gave responses about their feelings about mathematics subjects. The results showed that most of the respondents, namely 45% had a feeling of "Normal", while 31.7% of respondents "Liked", and only 7.2% of students "Very liked" mathematics. As many as 13.3% "dislike" and the remaining 2.8% said "not like at all". This data indicates that there are still challenges in fostering students' interest and interest in mathematics lessons.

Figure 3. Students' Difficulties in Learning Mathematics

The diagram above presents the results of a survey regarding obstacles or difficulties in learning mathematics which was followed by 180 respondents. Based on the data, as many as 57.8% of respondents stated that they had difficulty learning mathematics, which shows that more than half of the respondent population faces obstacles in understanding mathematics material. This indicates the need for more attention to the learning strategies used, both in terms of teaching methods and additional learning support. Furthermore, 36.7% of respondents chose the "Maybe" option, which can mean that there is doubt or uncertainty in assessing their math skills.

This response reflects the existence of a group of students who are in an ambivalent position, namely not fully feeling difficult, but also not fully confident in their abilities. This condition shows the need to strengthen learning motivation and a more adaptive pedagogical approach. Only 5.6% of respondents stated that they did not experience difficulties in learning mathematics. This small proportion indicates that the group of students who really do not have any barriers is a minority relative to the overall respondents.

Overall, the data shows that the majority of students face challenges in learning mathematics, both real and potential. Therefore, comprehensive pedagogical interventions are needed, such as the use of innovative learning methods, the application of differentiation strategies, and the provision of additional guidance that can increase students' understanding and confidence in mathematics.

From all these findings, it can be concluded that the main challenge in advanced mathematics learning lies in the teacher's approach in delivering the material and the lack of heterogeneity in dealing with various student characters. Therefore, it is important to design *human-centered* learning such as *the design thinking* and TaRL approaches so that students are not only passive recipients, but also active actors in the learning process. The following is the percentage of preliminary data research, which can be seen in table 1.

Table 1. Initial Data Assessment Percentage

Preliminary data research analysis	Number of Respondents
Number of Respondents	180
Feelings towards math (ordinary)	81
Difficulty learning math (Yes)	104

The next stage is the *definition* stage, the *definition* stage aims to formulate the main problem based on the results of observation and data from the *empathize stage*. And designing *user personas* to meet user needs (Jonathan, 2022). These findings became an important basis for designing *the Empathy Map*, a user-focused approach that aims to understand the experience from their own perspective (Bratsberg, 2019). By identifying what students think, feel, see, hear, say, and do in the process of learning math, *the Empathy Map* helps researchers get a complete picture of students' barriers and needs in learning. The design *of the Empathy Map* for this context is shown in Figure 4.

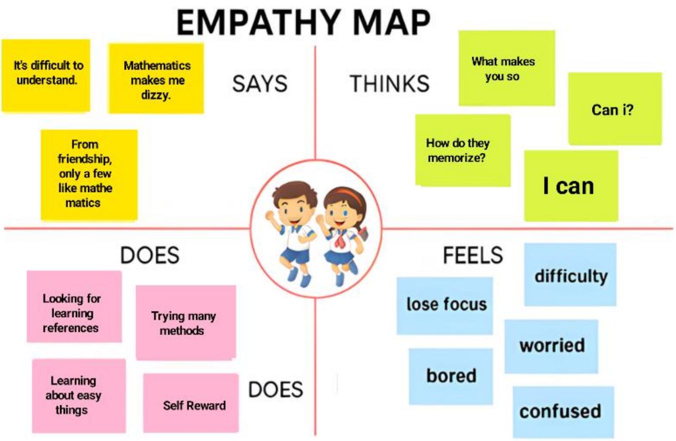

Figure 4. *Empathy Map*

From the results of *the empathize map*, students showed feelings such as easily losing *focus*, feeling *confused*, and anxious, and stating that they often did not understand the material well. They need a more fun, interactive, and pressure-free learning method to be able to *try hard* naturally. Therefore, a supportive and non-stressful learning environment, as well as adaptive assessment methods such as learning media using TaRL are important in creating a more meaningful learning experience and in accordance with the spirit *of the independent curriculum* and *the Pancasila Student profile*. By understanding this context, the formulation of problems in the *define* stage leads to how to design Mathematics learning interventions that are adaptive to the characteristics of high school students, minimize burnout, and increase focus and motivation through an approach based on students' real needs.

After going through the *define stage* that focuses on formulating the main problem from the user's perspective, the process proceeds to the *ideate* stage. This stage aims to explore various possible solutions through creative and open *brainstorming* activities . In line with the opinion of Kelley & Kelley (2013), "*The best way to get a good idea is to get a lot of ideas*," in this phase the researcher seeks to explore as many potential ideas as possible to answer the needs of students who have been previously identified through *empathy* maps.

From the various ideas developed, the final choice fell on the application of Design Thinking in Google Sites with the TaRL approach as a strategy to improve students' mathematical problem-solving skills. This idea was chosen because it was able to bridge the gap between the real conditions of students in the field and meaningful learning goals. The application of Design Thinking is seen in accordance with the context of the Independent Curriculum which emphasizes competency-based learning, collaboration, and innovation through the use of digital technology. The following are the indicators of TaRL according to Benerji & Chavan (2016) for the preparation of Google Sites learning media. It can be seen in table 2.

Table 2. Indicators Teaching at The Right Level (TaRL)

No	Indicators
1	A simple initial assessment to identify a student's basic ability level.
2	Classify (differentiate) students based on ability, not class.
3	Active and contextual learning methods that are appropriate to the student's level.
4	Repeated assessments to monitor progress and adjust strategies.

The researcher then designed a test based on four main indicators of mathematical problem-solving ability that was compiled to measure students' comprehensiveness of the applicable mathematical context. The four indicators are presented in Table 3.

Table 3. Criteria for Achieving Mathematical Problem-Solving Ability

Indicator	Score	Assessment Criteria
1. Understanding the Problem	0	It does not mention the known or questioned conditions.
	1	Mention some information, such as only what is known or only what is asked.
	2	Mention what is known and what is asked, but is less accurate.
	3	Mention what is known and what is asked appropriately.
2. Planning the Settlement	0	No settlement plan was made.
	1	There is a picture of the plan, but it is not precise.
	2	The plan is made in a precise and relevant manner.
3. Implementing the Plan	0	There are no answers or no settlement efforts.
	1	Answers are written, but most of them are incorrect or incomplete.
	2	The answer is half or mostly correct.
	3	Complete and correct steps and answers.
4. Checking Back	0	No conclusions or results checks.
	1	Interpreting results, but inaccurate conclusions.
	2	Interpret the results and draw conclusions appropriately.

The analysis was carried out quantitatively by grouping the results into three categories of ability, namely high, medium, and low. This category helps researchers in identifying general patterns of students' mathematical problem-solving abilities as well as aspects that still need to be improved. The categorization of ability levels refers to the interpretation guidelines proposed by Arikunto (2013), which classify percentage scores into qualitative levels ranging from very low to very high. The following is a percentage calculation for each indicator of students' mathematical problem-solving ability, with the category of ability level shown in Table 4.

Table 4. Mathematical Problem-Solving Ability Level

Interval Score (%)	Level categories
81 -100	Very high
61-80	High
41-60	Medium
0-40	Low

Next, there is the *prototype* stage, the researcher designs a Google Sites-based learning media developed in accordance with the Teaching at the Right Level (TaRL) indicator. This design is then realized in the form of interface design and learning content that contains interactive features, materials according to students' ability levels, and navigation that supports problem-solving-based mathematical learning. The results can be seen in the image below.

Figure 5. Diagnostic Assessment

The initial menu displays the initial diagnostic assessment feature on the polynomial material**,** which serves to map the student's initial abilities. This form is designed so that teachers can know the prerequisites for mastering polynomial concepts before students are directed to the appropriate learning level. This initial diagnosis reflects the principle of TaRL, which is to teach students according to their actual ability level. The data obtained from this assessment is then used as the basis for grouping and adjusting learning strategies, so that the learning process is more directed, relevant, and authentic.

Figure 6. Material Differentiation

The image above shows polynomial learning materials divided into five levels based on the Teaching at the Right Level (TaRL) **approach.** Each level is systematically designed to accommodate students' different abilities, so that they can learn according to their respective levels of mastery. This tiered structure is in line with the principles of TaRL, which is to provide a learning experience according to the real needs of students, not solely based on formal classes. Thus, students can start from a level that corresponds to the initial diagnostic results, then gradually move up to the next level after demonstrating mastery of the material.

Figure 7. Student Worksheets

The image above shows the Polynomial Level 1 Student Worksheet (LKPD) developed as part of Google Sites-based learning media with the Teaching at the Right Level (TaRL) approach. This LKPD is designed to facilitate students in understanding the basic concepts of polynomial through systematic activities, ranging from understanding the material, exercises, to application in problem solving.

There are also problem-solving-based assignments that encourage students to relate knowledge to real context. This is in line with the indicators of mathematical problem-solving ability according to Polya, namely understanding problems, drawing up plans, implementing plans, and re-examining the results of the solution.

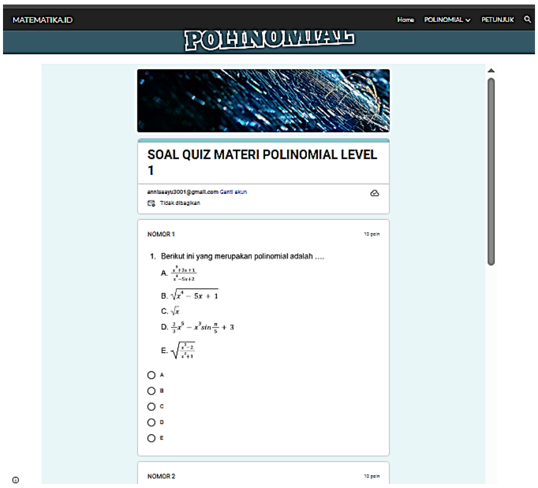

Figure 8. Post test or Polynomial Quiz

Multiple-choice quiz questions are arranged based on indicators of mathematical thinking ability, especially in identifying the correct polynomial shapes. The structure of the problem not only requires students to remember definitions, but also analyzes algebraic forms, distinguishing which ones include polynomials and which do not.

In the last stage, namely *the test* in *the Design Thinking procedure*, a pre-test was carried out on two groups of students, namely the experimental class (XI-2 which totaled 36 students) and the control class (XI-3 which totaled 36 students). This test was then carried out several data analyses to see its effectiveness.

Normality Test

The normality test aims to find out whether the sample taken comes from a normally distributed population or not. To determine the normality of samples from the population, it was carried out using *the Liliefors* test with a significant level of 5%. The criteria in the normality test for samples from normally distributed populations are $L_{count} \leq L_{table}$. The following is the calculation.

Tabel 5. Normality Test

Class	n	L_{hitung}	L_{tabel}	Conclusion
Experiment	36	0,06373	0,147	Normally Distributed
Control	36	0,02837	0,147	Normally Distributed

Based on the table above, L_{count} in the experimental class is 0.06373. For n = 36 with a significant level of 5%, the price based on the Lilliefors test critic value table is 0.147. This shows that $L_{count} \leq L_{table}$ yaitu 0,063 ≤ 0,147, thereby H_0 accepted. Based on these calculations, it can be concluded that the samples come from a normally distributed population. Based on these calculations, it can be concluded that the samples come from a **normally distributed population**.

Homogeneity Test

The homogeneity test was carried out to find out whether the experimental class and the control class had the same variance or not. The homogeneity test in this study used the *Fisher* test with a significance level of 5%. The criteria in the homogeneity test for the sample have the same variance if $F_{count} < F_{table}$. The results of the homogeneity test analysis can be seen in Table 6.

Table 6. Final Data Homogeneity Test Analysis Results

Class	F_{count}	F_{table}	Conclusion
Experiment **Control**	1,711281	1,7571	Variance Homogen

The table above shows that for a significant level of 5%, the value of F_{table} = 1,7571 and F_{count} = 1,75171. Hal tersebut menunjukan bahwa $F_{count} < F_{table}$ thereby H_0 accepted. This shows that the experimental class and the control class have the same variance (homogeneous).

Test of Students' Classical Learning Mastery

The learning achievement mastery of students is one of the indicators used to determine the effectiveness of the Google Sites learning media. This test is employed to examine whether students' mathematical problem-solving abilities have achieved classical mastery. The classical learning mastery is analyzed using a left-tailed *t*-test. The analysis results are presented in Table 8.

Table 8. Analysis Results of the Classical Learning Mastery Test

Class	n	t_{count}	t_{table}	Conclusion
Experiment	36	2,53	2,03	The proportion of problem-solving mastery has been achieved.
Control	36	-3,23	2,03	The proportion of problem-solving mastery has not been achieved.

Based on the table, for the experimental class with n = 36 nd a significance level of 5% obtained $t_{count} = 2{,}53$ and $t_{table} = 2{,}03$. This means that $t_{count} > t_{table}$ thereby H_0 accepted, while the t-test calculation for the control class with n = 36 and significant 5% Obtained $t_{count} = -3{,}23$ and $t_{table} = 2{,}03$. This means that $t_{count} > t_{table}$ so that H_0 rejected. Based on these calculations, it can be concluded that in the experimental class, the proportion of student learning completeness has been achieved compared to the control class with the proportion of student learning completeness has not been achieved.

N-Gain Test

After obtaining *pretest* and *posttest scores* from the experimental class and the control class, then the N-Gain test was carried out in each class. This *N-Gain* test aims to see an improvement in students' spatial abilities. The overall results of the improvement of mathematical problem-solving ability of students in the experimental class with the control class are presented in Table 9 below.

Table 9. N-Gain Test Results

Class	N-Gain	Category
Experiment	0,71	High
Control	0,04	Medium

Judging from table 10, the *N-Gain result of the* experimental class is better than that of the control class, i.e. for the experimental class is 0.71 while the control class is 0.04. It can be said that the spatial ability of students in the experimental class and the control class increased because it was at the interpretation of $0.7 < g$ in the high category **(quite effective).**

Right Tailed *T*-Test

The difference in means was analyzed using a right-tailed *t*-test to determine whether the mean mathematical problem-solving ability of students in the experimental class was higher than that of the control class. The criterion for the right-tailed *t*-test to conclude that the mean spatial ability of students in the experimental class is higher than that of the control class is $t_{count} > t_{table}$. The results of the right-tailed t-test analysis are presented in Table 10.

Table 10. Results of the Right-Tailed *t*-Test

Class	n	t_{count}	t_{table}	Conclusion
Experiment	36	1,711	1,67	The mean mathematical problem-solving ability of students in the experimental class is higher than that of the control class.
Control	36			

able 10 shows that for $n_1 = 36$ dan $n_2 = 36$ with a significance level of 5% after obtaining t_{count} = 1,711 and t_{table} = 1,67. This shows that the price $t_{count} > t_{table}$ $t_{count} > t_{table}$ thereby H_0 rejected. This finding implies that the learning treatment applied in the experimental class has a positive effect on students' mathematical problem-solving abilities. The use of innovative learning media and strategies enables students to better understand mathematical concepts, actively engage in the learning process, and apply problem-solving strategies more effectively. In contrast, students in the control class who received conventional instruction tended to be more passive and focused on procedural knowledge rather than conceptual understanding. Therefore, it can be inferred that the implemented learning approach in the experimental class contributes to improving students' higher-order thinking skills, especially in solving mathematical problems.

CONCLUSION

This research succeeded in developing Google Sites-based learning media with the Teaching at the Right Level (TaRL) approach which was designed through the Design Thinking stages and the ADDIE development model. The results show that the learning media developed is included in the category of very feasible to use. The implementation of TaRL-based Google Sites media has also been proven to be effective in improving students' mathematical problem-solving skills, as shown by the results of *the N-Gain test* of 0.7 (high category), the t-test of 1.711 which is greater than the t-table of 1.67, and The results of the analysis of the classical learning completeness test show that in the experimental class, the proportion of completeness of mathematical problem-solving ability is achieved, while in the control class, the proportion of completeness was not achieved. These findings indicate that the treatment given in the experimental classroom is effective in improving students' learning completeness.

The results of this study are in line with the opinion of Jonassen (1999) who emphasized that technology-based learning must be able to support *meaningful learning* by providing students with the opportunity to build understanding through authentic problem-solving. In addition, Bruner (1966) stated that learning will be more effective if it is arranged in stages (*spiral curriculum*), so that the integration of the TaRL approach in this media is very relevant because the material is presented according to the level of students' ability. Meanwhile, Piaget (1970) emphasized that students' cognitive development occurs through the process of assimilation and accommodation, so the use of interactive digital media can help students in constructing and reconstructing knowledge. In the context of differentiation, Tomlinson (2001) explained that learning that pays attention to the differences in students' abilities will increase motivation, participation, and learning outcomes.

As a follow-up, this research can be further developed by expanding the context of using Google Sites media in other subjects, involving a larger number of samples, or adding interactive features such as automated quizzes, gamification, and learning analytics to optimize the ability to improve mathematical problem-solving skills and other 21st-century skills.

REFERENCES

Aimin, F. N., Adamura, F., & Maduretno, W. (2024). Problem Based Learning (PBL): Penerapan Model Pembelajaran untuk Meningkatkan Hasil Belajar dengan Pendekatan Teaching at The Right Level (TaRL). *Journal on Education*, *7*(1), 5364-5374. https://doi.org/10.31004/joe.v7i1.6825

Arikunto, S. (2013). Prosedur Penelitian: Suatu Pendekatan Praktik (cet. 15). *Jakarta: Rineka Cipta.*

Ayu, A., Nursyahidah, F., & Prayito, M. (2023). Development of Learning Media Using Ethnomathematics-Based Augmented Reality on Cube and Block Material. *Phenomenon: Jurnal Pendidikan MIPA*, *13*(2), 207-225. https://doi.org/10.21580/phen.2023.13.2.17130

Azizah, Q., Sudarsono, A., & Sutarto, H. (2025). Problem based learning berpendekatan Teaching at the Right Level (TaRL) untuk meningkatkan kemampuan menyelesaikan soal cerita pada materi vektor kelas XI SMA. *Tirtamath: Jurnal Penelitian dan Pengajaran Matematika*, *6*(2). http://dx.doi.org/10.48181/tirtamath.v6i2.25713

Banerjee, A., Banerji, R., Berry, J., Duflo, E., Kannan, H., Mukerji, S., Shotland, M., & Walton, M. (2017). From proof of concept to scalable policies: Challenges and solutions, with an application. *Journal of Economic Perspectives*, 31(4), 73–102. https://doi.org/10.1257/jep.31.4.73

Brown, T., & Katz, B. (2009). Change by design: How design thinking transforms organizations and inspires innovation. *Harper Business*. https://opac.library.iiitk.ac.in/bib/1768?utm

Bruner, J. S. (1966). Toward a theory of instruction. *Harvard University Press*. https://catalogue.nla.gov.au/catalog/521255?utm

Damayanti, I. I., Ayu, A., Sariah, U. I., Mustaqfiroh, M., Oktaviani, I. A., & Nursyahidah, F. (2023). Development of Curved Three-Dimensional Shape Learning Media Ethnomathematics-Based Using Augmented Reality. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *14*(1), 86-96. https://doi.org/10.15294/kreano.v14i1.38845

Damayanti, I. I., Ayu, A., Sariah, U. I., Mustaqfiroh, M., Oktaviani, I. A., & Nursyahidah, F. (2024, May). Development of ethnomathematics-based curved three-dimensional shape learning media using augmented reality. In *AIP Conference Proceedings* (Vol. 3106, No. 1, p. 050006). AIP Publishing LLC. https://doi.org/10.1063/5.0215290

Darniyanti, Y., Sundahry, S., & Husni, R. (2023). Pendampingan dan penyuluhan pembuatan perangkat pembelajaran menggunakan web Google Sites bagi guru SDN 15 Koto Baru untuk meningkatkan kompetensi guru di era Kurikulum Merdeka. *Journal of Human and Education (JAHE)*. https://doi.org/10.31004/jh.v3i2.231

Dwijayanti, I. (2011). Pengembangan Perangkat Pembelajaran Matematika Humanistik Berbasis Konstruktivisme Menggunakan ICT Materi Segi Empat Kelas VII. *AKSIOMA: Jurnal Matematika dan Pendidikan Matematika*, *2*(2/Septembe). https://doi.org/10.26877/aks.v2i2/Septembe.34

Dwijayanti, I., & Andri Nugroho, A. (2023). Pengaruh model pembelajaran berbasis penemuan dan lingkungan terhadap kemampuan pemecahan masalah matematika melalui meta analisis. *AKSIOMA:Jurnal Program Studi Pendidikan Matematika*, *9*(1), 147-157. https://ojs.fkip.ummetro.ac.id/index.php/matematika/article/view/2659/pdf?utm

Dwijayanti, I. (2014). Efektivitas kelas Humanistik dalam pembelajaran matematika terhadap karakteristik peserta didik. *AKSIOMA: Jurnal Matematika dan Pendidikan Matematika*, *5*(1/MARET). https://doi.org/10.26877/aks.v5i1/MARET.554

Febiyanti, E. E. (2024). Penerapan Model Pembelajaran Discovery Learning Terhadap Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa. (*Doctoral dissertation, Universitas Nusantara PGRI Kediri).* https://repository.unpkediri.ac.id/id/eprint/16622/

Hadi, S., & Novaliyosi. (2019). TIMSS Indonesia (Trends in International Mathematics and Science Study). *Prosiding Seminar Nasional & Call for Papers Program Studi Magister Pendidikan Matematika Universitas Siliwangi*, 1, 562–569. https://jurnal.unsil.ac.id/index.php/sncp/article/view/1234

Harahap, A. N. S., & Imelda. (2024). Penerapan model pembelajaran PBL dengan pendekatan TaRL untuk meningkatkan kemampuan pemahaman konsep siswa SMP Negeri 9 Medan. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, 10(2). https://doi.org/10.23969/jp.v10i02.24584

Jonassen, D. H., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. *Educational technology research and development*, *47*(1), 61-79. https://link.springer.com/article/10.1007/BF02299477

Kusumaningrum, F., Fitrianawati, M., & Taqiyuddin, M. (2024). The influence of the TaRL approach on the critical thinking ability of elementary school students in mathematics. *Jurnal JPSD,* 12(1) https://doi.org/10.26555/jpsd.v12i1.a29248

Laili, I., Maulina, H., & Utami, S. (2024). Penerapan pendekatan TaRL dengan strategi diferensiasi proses dan konten untuk meningkatkan hasil belajar peserta didik kelas XI-1 SMAN 6 Surabaya pada materi matriks. *Journal of Mathematics Education Research (JMER)***,** 2(2). https://journalng.uwks.ac.id/jmer/article/view/210

Laisema, S., & Bangthamai, E. (2025). Integrating Open Educational Resources with design thinking: An instructional design model for enhancing innovator competencies. *International Journal of Information and Education Technology, 15*(5), 1072–1083. https://doi.org/10.18178/ijiet.2025.15.5.2311

Mukarramah, M., Nisa, F. K., Azizah, I., Manuharawati, M., & Utami, I. D. (2024). Peningkatan hasil belajar matematika melalui model PBL dengan pendekatan TaRL (Teaching at the Right Level). *Pendas : Jurnal Ilmiah Pendidikan Dasar*, 9(2). https://doi.org/10.23969/jp.v9i2.13992

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2016). TIMSS 2015 international results in mathematics. *TIMSS & PIRLS International Study Center*, Boston College. http://timssandpirls.bc.edu/timss2015/international-results

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. NCTM. https://www.nctm.org/uploadedfiles/standards_and_positions/pssm_executivesummary.pdf?utm

Nizaruddin, N., Muhtarom, M., & Nugraha, A. E. P. (2021). Pelatihan penggunaan quizizz sebagai media evaluasi pembelajaran daring. *E-Dimas: Jurnal Pengabdian Kepada Masyarakat*, *12*(2), 291-296. https://journal.upgris.ac.id/index.php/edimas/article/view/6417/4205

Nizaruddin, N., Muhtarom, M., & Sugiyanti, S. Learning mathematics with traditional game "jirak": Impact on mathematics disposition and students' achievement. *Proceeding ICMETA*, *1*(1). https://jurnal.uns.ac.id/math/article/viewFile/12040/10562?utm

Nizaruddin, N., Muhtarom, M., & Zuhri, M. S. (2019). Improving mechanical engineering students' achievement in calculus through problem-based learning. *Universal Journal of Educational Research*. https://eprints.upgris.ac.id/id/eprint/1953

Noviyana, H., Rahmawati, F., Kirana, A. R., & Tanod, M. J. (2025). Enhancing Elementary Students' Mathematical Problem-Solving Skills Through AI-Assisted Problem-Based Learning. *Journal of Integrated Elementary Education*, *5*(2), 254-268. https://doi.org/10.21580/jieed.v5i2.27576

Nurjannah, I., Suprihatin, & Ariyanto, L. (2024). Peningkatan kemampuan pemecahan masalah matematis melalui model PBL dengan pendekatan TaRL pada peserta didik kelas X PM 3 SMK Negeri 2 Semarang. *Jurnal Pendidikan Guru Profesional*, 2(2), 143–149. https://doi.org/10.26877/jpgp.v2i2.1629

Nuraini, Z., Dewi, N. K., & Indraswati, D. (2023). Pengembangan media pembelajaran berbasis web menggunakan Google Sites pada pelajaran IPS. *Journal of Classroom Action Research,* *5*(SpecialIssue), 279–284. https://doi.org/10.29303/jcar.v5iSpecialIssue.4007

OECD. (2019). *PISA 2018 results (Volume I):* What students know and can do. *OECD Publishing*. https://doi.org/10.1787/5f07c754-en

Plattner, H., Meinel, C., & Leifer, L. (Eds.). (2011). Design thinking: Understand – improve – apply. *Springer*. https://doi.org/10.1007/978-3-642-13757-0

Putri, R. N., & Nurafni, N. (2025). E-book development to improve spatial literacy in elementary geometry learning. *Mathline: Jurnal Matematika Dan Pendidikan Matematika*, *10*(3), 861-872. https://doi.org/10.31943/mathline.v10i3.1002

Pratham Education Foundation. (2018). *Teaching at the Right Level: Annual report 2018.* Pratham Education Foundation. https://www.pratham.org

Rahmawati, M., Malawi, I., & Soehartini. (2024). Implementasi model PBL dengan pendekatan TaRL untuk meningkatkan kemampuan pemecahan masalah matematika siswa kelas *IV*. Didaktik : *Jurnal Ilmiah PGSD STKIP Subang*, 10(2), 347–360. https://doi.org/10.36989/didaktik.v10i2.3612

Razzouk, R., & Shute, V. J. (2012). What is design thinking and why is it important? *Review of Educational Research,* *82*(3), 330–348. https://doi.org/10.3102/0034654312457429

Resqueta, M. C., Kartikasari, N. O., Fahimuddin, A., Ekawati, R., & Mardiani, A. (2024). Meningkatkan keterampilan pemecahan masalah matematika melalui model pembelajaran PBL dengan pendekatan TARL pada siswa kelas heterogen. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, 9(2). https://doi.org/10.23969/jp.v9i2.13980

Palihah, A., Warsodirejo, P. P., & Tanty, H. (2024). Penerapan pendekatan Teaching at the Right Level (TaRL) untuk meningkatkan kemampuan pemecahan masalah peserta didik pada materi eksponen kelas X SMA Negeri 2 Medan. *Journal on Education (JOE),* 7(1). https://doi.org/10.31004/joe.v7i1.7632

Puspitawati, P. D., Rukayah, R., & Yulisetiani, S. (2024). Analisis penggunaan media Google Sites dalam implementasi pembelajaran berdiferensiasi pada materi teks deskripsi kelas IV sekolah dasar. *Didaktika Dwija Indria, 12*(5). https://doi.org/10.20961/ddi.v12i5.88298

Rahadian, D., Ilham, S., Imania, K. A. N., & Nasrulloh, I. (2024). Development of Google Sites-based e-learning with TIME learning model. *In* Proceedings of the 4th International Conference on Education and Technology (ICETECH 2023). *Atlantis Press*. https://doi.org/10.2991/978-94-6463-554-6_54

Samsudin, S., Gunadi, F., Nurafifah, L., & Trapsilawati, E. (2024). Desain pembelajaran model PBL berbasis pendekatan TaRL terhadap pemahaman konsep refleksi pada materi transformasi geometri. *De Fermat : Jurnal Pendidikan Matematika*, 8(1). https://doi.org/10.36277/defermat.v8i1.2247

Sari, K. N., Utami, R. E., Ariyani, A., & Rasiman. (2024). Penerapan PBL-Flipped Classroom berbasis TaRL berbantuan Google Sites terhadap peningkatan literasi numerasi siswa kelas XI pada materi regresi linier. *Prosiding Seminar Nasional Pendidikan Profesi Guru*, 2(1), 154–161. https://conference.upgris.ac.id/index.php/psnppg/article/view/5861

Tomlinson, C. A. (2001). How to differentiate instruction in mixed-ability classrooms (2nd ed.). *Association for Supervision and Curriculum Development*.

Ulya, H., Sugiman, R., Rosnawati, R., & Retnawati, H. (2024). Technology-based learning interventions on mathematical problem-solving: A meta-analysis of research in Indonesia. *International Journal of Evaluation and Research in Education, 13*(1), 292–301. https://doi.org/10.11591/ijere.v13i1.26380

Utomo, H. N., Muhtarom, & Dwijayanti, I. (2023). Eksplorasi media interaktif Google Sites dengan alur merdeka berbasis Design Thinking. *Jurnal Riset dan Inovasi Pembelajaran*, 4(1). https://doi.org/10.51574/jrip.v4i1.1262

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. *Harvard University Press*. https://www.hup.harvard.edu/books/9780674576292?utm_source

Waraga, S. S., Abdjul, T., & Odja, A. H. (2023). Development of Google Sites-Assisted Learning Devices on Vibrations and Waves Material. *Jurnal Penelitian Pendidikan IPA, 9*(8), 6101–6110. https://doi.org/10.29303/jppipa.v9i8.4275

Yuliana, A., Syuhada, N., Nugraha, A. H., Robbianto, M. T., & Muchlis. (2025). Penerapan PBL dengan pendekatan TaRL dalam meningkatkan hasil belajar kognitif peserta didik kelas IX pada materi polinomial. *Jurnal Kolaboratif Sains*, 8(2). https://doi.org/10.56338/jks.v8i2.7104

Wirjana, I. M. A. Y., & Sumandya, I. W. (2023). Penerapan teaching at the right level (TARL) untuk meningkatkan partisipasi belajar matematika peserta didik kelas XI SMA. *Widyadari*, *24*(2), 263-275. https://doi.org/10.59672/widyadari.v24i2.3190