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ENHANCING STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY THROUGH THE PROBLEM POSING AND SOLVING LEARNING MODEL ASSISTED BY HEYZINE

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ABSTRACT

The integration of problem posing and problem-solving learning facilitates problem situations that require students to actively engage in tackling non-routine mathematical challenges. However, some students are still not well-adapted to this type of problem-solving, making it potentially less effective when applied simultaneously. This study aims to analyze students' mathematical problem-solving abilities through problem-posing and problem-solving learning assisted by *Heyzine*. This research employed a quasi-experimental method. The population consisted of eleventh-grade students from a senior high school in Bandung Regency, with classes XI D1, XI D2, and XI E1, each comprising 37 students selected through random sampling. The findings of this study include: (a) the design of the Jucama learning model was successfully implemented, resulting in a Heyzine-assisted student worksheet (LKPD) that met the criteria of being highly valid and suitable for use; (b) the implementation process of the Jucama learning activities assisted by Heyzine improved significantly and achieved a very good category; (c) there was a notable increase in problem-solving ability among students who received Heyzine-assisted Jucama learning compared to those who received Jucama learning without Heyzine.

Keywords: Heyzine, Jucama, Mathematical Problem-Solving Ability, Mathematics Learning, Self-Persistence.

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PRELIMINARY

In mathematics education, one of the most essential aspects to consider is students' ability to solve mathematical problems. Mastery of mathematics requires computational skills accompanied by logical and critical thinking abilities in analyzing and solving problems (Salwa et al., 2025). Students are expected to develop higher-order thinking skills, particularly in solving non-routine mathematical problems, due to their complex and often confusing characteristics (Wulandari et al., 2020). According to E. Susilawati et al., (2017), an individual's ability to complete and solve mathematical problems is referred to as *problem-solving ability*. An appropriate instructional approach to enhance such ability is

the *Problem Posing and Problem-Solving* learning approach, also known as *Jucama*. Jucama focuses on active learning activities that engage students in both proposing and solving mathematical problems (Prima, 2014).

In addition to appropriate learning methods, technological advancement must be utilized to make the learning process more effective and efficient (Sugilar et al., 2018). By leveraging such advancements, educators can create learning media that support the learning process in an effective and efficient manner, aiming to optimize students' learning outcomes. One digital platform that can support this process is *Heyzine*. The Heyzine Flipbooks application is designed to make learning more engaging and effective (Tofik Hidayat & Dewi, 2023). Teachers can use Heyzine to design interactive e-books by embedding images, videos, audio, graphics, and links. The Heyzine Flipbook also includes animation effects that simulate the experience of flipping through a real book, thereby encouraging students to read and explore more actively (Erawati et al., 2022). Due to its comprehensive features, this application is user-friendly and allows for effective digital learning (Mauliddiyah, 2021).

Unfortunately, results from a preliminary study conducted by the researcher among twelfth-grade students in a senior high school in Bandung City revealed that only 10 out of 32 students were able to demonstrate mathematical problem-solving ability. Several issues were identified, such as limited learning facilities—insufficient digital devices and poor internet connectivity (Jamila et al., 2021). Teachers also faced various challenges, including a lack of readiness and institutional support in implementing technology-based learning. Many teachers experienced technological anxiety and struggled with digital media integration due to inadequate technological literacy (Azhar et al., 2024).

The accuracy of selecting a learning approach plays a crucial role in improving students' problem-solving ability and persistence. Wardani et al., (2021) stated that the appropriateness of choosing the right learning model, approach, method, and strategy can help overcome these issues. Furthermore, learning success can be achieved when students are fully engaged in the stages of cognitive processing (Sugilar, 2013). Therefore, the choice of teaching strategies or models must be carefully considered to ensure effective application (Sugilar et al., 2018). Teachers can use Heyzine to design interactive e-books by embedding images, videos, audio, graphics, and links. The Heyzine Flipbook also includes animation effects that simulate the experience of flipping through a real book, thereby encouraging students to read and explore more actively. In addition to the model itself, the use of technology—specifically Heyzine Flipbooks—has the potential to make

learning more engaging and effective (Tofik Hidayat & Dewi, 2023). Heyzine's animation features create an immersive reading experience, allowing students to interact with content in a way that enhances understanding and motivation (Erawati et al., 2022).

Previous research has mostly focused on improving cognitive abilities through the Jucama approach alone, without the assistance of digital platforms or applications. For instance, the study by Prihatiningtyas & Rosmaiyadi (2020) found that critical thinking skills can significantly improve through the Jucama learning process, leading to higher student achievement. However, their study did not utilize any web-based support such as Heyzine. Research specifically addressing the enhancement of mathematical problem-solving skills through the Heyzine-assisted Jucama learning approach remains limited. Therefore, this study focuses on analyzing the improvement of mathematical problem-solving ability using the Heyzine-assisted Jucama approach at the secondary school level.

This research is expected to provide a comprehensive understanding of how mathematical problem-solving skills can be improved through the Heyzine-assisted Jucama approach. Consequently, it aims to contribute meaningfully to the development of more effective strategies for teaching mathematics.

METHODS

This study employed a quantitative approach using a quasi-experimental method, with the research design known as the *Nonequivalent Pretest-Posttest Control Group Design*. This research combined both quantitative and qualitative data. Quantitative data were obtained from the results of students' mathematical problem-solving by taking one of the indicators, namely using the strategy used to solve the problem. ability tests, while qualitative data were collected through students' observation sheets, validation sheets and authentic assessment forms Observation sheets are used to measure the trajectory of the implementation of the teacher and student learning process. This observation sheet contains statements covering all stages of learning implementation during the treatment. This sheet is filled in after every class meeting by the researcher as teacher and students in the experimental class. Then this sheet is analyzed whether teacher and student activity has increased or not. The validation sheet is used to determine the validity and feasibility of the product design that will be used in learning in the first experimental class. The validation that will be used in this class is IT expert validation to assess the validity and suitability of the Heyzine-assisted LKPD product used for learning, material expert validation is used to assess the validity and suitability of the Heyzine-assisted LKPD product material used for

learning, and language expert validation is used to assess the validity and suitability of the language of the Heyzine-assisted LKPD product used for learning. Authentic assessment is an assessment method that assesses students' abilities through tasks that demonstrate the application of skills and knowledge in the real world. This research uses authentic assessment in the form of a rating scale, with the teacher as a direct observer of student behavior during lessons so that results will be obtained whether students can master the learning material or not. The stages in authentic assessment include the pre-learning stage, preliminary stage, discussion stage and closing stage.

The population of this study consisted of all eleventh-grade students at one senior high school in Bandung Regency during the odd semester of the 2023/2024 academic year. The sample included three classes: two social science classes (XI D1 and XI D2) and one language class (XI E1) The population in this study was 111 people from 3 classes and samples were taken from the entire population. The sampling technique used was random sampling without stratification within the population. Due to the sampling method where each member in the population has exactly the same chance of being selected as part of the sample, without paying attention to certain strata or characteristics. This method was used because the samples were chosen randomly and did not choose saturated sampling because the number of samples was more than 100. This technique was chosen because each student had an equal opportunity to be selected, ensuring fair representation and unbiased sample collection (Firmansyah & Dede, 2022).

The research instruments used for data validation included: Mathematical problem-solving ability test, observation sheets for monitoring the implementation of the Heyzine-assisted JUCAMA learning process in this way, the teacher creates several groups of students, then the teacher gives a problem to the students, then the students can propose a problem that the teacher has given to another group, and another group solves the problem given by the group of students who proposed a problem, expert validation sheets covering aspects of IT, content, and language, and authentic assessment forms. Data collection techniques involved administering pretests and posttests, distributing *self-persistence* questionnaires, conducting classroom observations, performing authentic assessments, and validating the instruments through expert judgment.

The research procedure followed the steps proposed by (Setia, 2014), as described below:

1. Before applying any treatment, both the experimental and control classes were given a pretest to measure their initial mathematical problem-solving abilities.

2. The pretest results from both classes were analyzed using a Two-Way ANOVA test to ensure no significant differences existed between them. If the analysis showed no significant difference, the learning process continued according to each class's designated learning model. However, if a significant difference was found, the experiment was not continued due to the violation of the equivalence assumption.
3. After implementing the respective learning models in each class, a posttest was administered to all students. The posttest results from both experimental and control groups were then analyzed using Two-Way ANOVA to determine whether there were significant differences after the treatments.
4. The final stage involved analyzing the learning process by calculating *gain scores* and performing difference tests between pretest and posttest results. This analysis aimed to determine whether the implemented learning model significantly improved students' learning outcomes.

Data analysis as performed using SPSS version 25. The steps included calculating posttest scores and normalized gain (*N-Gain*) values. After obtaining the gain indices, prerequisite tests were conducted, including the Kolmogorov-Smirnov test for normality and Levene's test for homogeneity of variance. If the data were normally distributed and homogeneous, the analysis proceeded with Two-Way ANOVA. However, if the data were not normally distributed but homogeneous, a non-parametric test, specifically the Median Test, was used as an alternative. The test uses criteria:

If < 0.05, then H0 is rejected.

If sig > 0.05 then H0 is accepted.

RESULT AND DISCUSSION

1. The Design of the Heyzine-Assisted Jucama Learning Model to Improve Problem-Solving Ability

Based on the results of expert validation in the fields of IT, content, and language, the following findings were obtained:

Table 1. Validation Results of The Design

No	Source of Data	Percentage of Validity	Criteria
1	IT Expert	92,52	Very valid
2	Content	97,5	Very

No	Source of Data	Percentage of Validity	Criteria
3	Expert Languange Expert	81,04	valid Very valid

The validation results from the media expert, conducted by a lecturer of Mathematics Education at UIN Sunan Gunung Djati Bandung, showed an average score of **92.52%**, which falls under the *very valid* category. This indicates that the media and technology applied to the Heyzine-assisted student worksheet (LKPD) were well validated and deemed suitable for use in mathematics learning activities.

The validation conducted by the content expert— a mathematics teacher from one of the senior high schools in Bandung Regency — showed an overall score of 97.5%, also categorized as *very valid*. This means that the materials and exercises within the Heyzine-assisted LKPD were highly appropriate for use in mathematics learning.

Furthermore, the language validation, conducted by a Mathematics Education lecturer from UIN Sunan Gunung Djati Bandung, received a score of 81.04%, which also falls under the *very valid* category. Thus, the linguistic aspects of the Heyzine-assisted LKPD met the required standards and were suitable for instructional use.

In addition to expert validation, data from authentic assessment were obtained through three classroom sessions. The results of this assessment are presented below:

Table 2. Authentic Assessment Results

No	Stage	Percentage	Criteria
1	Before Activity	70	Fairly Mastered
2	Intoduction	85	Fairly Mastered
3	Discussion	87	Fairly Mastered
4	Closing	95	Highly Mastered
	Average	84	Fairly Mastered

. Based on Table 2, the percentage of students' mastery of the material in each session was in the *fairly mastered* category for the topic of geometric transformations, with an average of **84%**. This indicates that students demonstrated adequate engagement during the learning process, particularly in teacher-led instruction, peer discussions, group presentations, and activities involving problem posing and problem solving. Moreover, students displayed perseverance in seeking alternative solutions to the problems presented.

2. The Implementation Pathway of the Heyzine-Assisted Jucama Learning Process

To answer the research questions, data analysis was carried out through teacher observation sheets filled in by supervising teachers, who evaluated the researcher's teaching performance over three meetings, as well as student observation sheets filled in by the researcher during the same sessions. The results are presented below:

Table 3. Observation Results of The Learning Process Implementation

No	Activity	Percentage of Result	Criteria
Teacher's Activity Implementation			
1	First Meeting	81	Excellent
2	Second Meeting	86	Excellent
3	Third Meeting	89	Excellent
Average (Teacher)		85	Excellent
Student's Activity Implementation			
1	First Meeting	77	Good
2	Second Meeting	83	Excellent
3	Third Meeting	93	Excellent
Average (Students)		84	Excellent

Based on the observation results, an improvement in teacher activity was observed throughout the learning process—from 81% in the first meeting to 89% in the third—an increase of 8%. The overall average score of 85% falls into the *excellent* category. This improvement was achieved due to constructive feedback from observers, allowing the researcher to enhance the learning implementation in subsequent sessions.

Similarly, student activity also showed improvement—from 77% in the first session to 93% in the third—an increase of 16%. The overall average of 84% is categorized as *excellent*. This progress resulted from students' collaboration and their ability to implement the feedback provided by observers, leading to better performance in the following sessions.

3. Differences in the Improvement of Problem-Solving Ability among Students Using the Heyzine-Assisted Jucama Model, the Jucama Model, and Conventional Learning

Before conducting the Two-Way ANOVA test, the *N-Gain* data were required to meet normality and homogeneity assumptions. The first step was to test for normality using the Kolmogorov–Smirnov Test with the assistance of SPSS version 25.

The results showed that the *N-Gain* data for all three groups—students receiving the Heyzine-assisted Jucama model, students using Jucama without any application, and those under conventional learning—were normally distributed. The next step, the Levene's Test for Homogeneity, revealed that the data did not meet the homogeneity assumption, as the variances among the groups were not homogeneous.

Since one of the parametric test assumptions was violated (non-homogeneous variances), the data analysis proceeded with a non-parametric test, specifically the Median Test, as an alternative to Two-Way ANOVA.

The significance value (2-tailed) obtained was 0.001, which is lower than the significance level of 0.05. This indicates that H_0 was rejected, meaning there were significant differences in the improvement of mathematical problem-solving ability among the three classes. Therefore, students who received Heyzine-assisted Jucama learning demonstrated a significantly higher improvement in problem-solving skills compared to those who received the Jucama model without Heyzine and those taught through conventional methods.

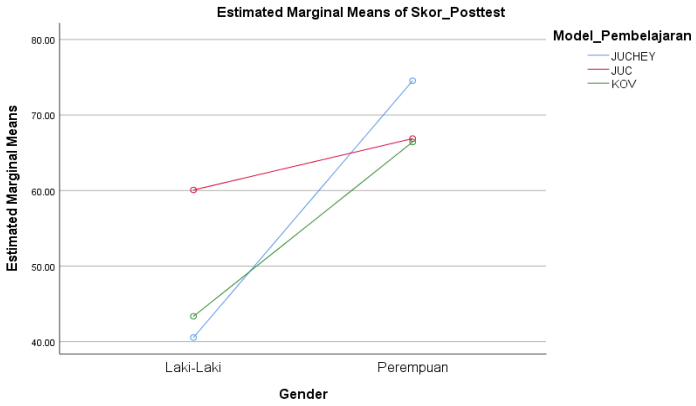

Figure 1. Interaction Graph of the Three Models Based on N-Gain Score

In the two-way ANOVA test interaction graph, it can be concluded that there is an increase in problem solving abilities with female students from the three classes being better than male students because there are more female students quantitatively than male students, female students are more thorough and focused on solving mathematical problems.

Discussion

There were several notes regarding the teacher's implementation from the first meeting, namely that during the implementation of the lesson at the first meeting there was still a lack of classroom management by the researcher, at the second meeting the shortcomings raised by the observer could be corrected, at the third meeting the researcher was given special notes to routinely present the results of student discussions, and at the last meeting, the researcher was not given special notes by the observer indicating that the researcher was good at carrying out learning in the classroom. There were several notes regarding student implementation from the first and second meetings, namely that there were still students who were not used to studying the material that would be presented and the students' focus was often diverted. At the third meeting, students had to be more confident in expressing opinions in class and at the last meeting, the researcher did not give special notes by the observer indicating that students were good at learning in class. In the authentic assessment sheet per meeting, there was an increase from the first meeting to the fourth meeting due to the students' fairly good involvement in learning, especially in the provision of material by the teacher, discussions, involvement in student presentations and being persistent in looking for other answers to the problems posed.

Based on the results of the analysis, the design of the Heyzine-assisted Jucama learning model was effectively implemented and produced a valid and appropriate product in the form of a Heyzine-assisted student worksheet (LKPD). This worksheet supported the *Problem Posing and Problem-Solving* learning process in mathematics, fulfilling the “very valid” category, while its authentic assessment results showed that students moderately mastered the learning material provided by the teacher. This finding aligns with research by (Nurfazri, 2024), which showed that a Heyzine-assisted e-module received a *very valid* rating from expert validators—including media, IT, and language experts—and that the product was deemed suitable for use in the field without further revision. Similarly, (Jamiludin, 2023) found that a mathematics e-module assisted by Canva and Heyzine software on statistical material was also categorized as *very valid*.

These results are consistent with the statements of Choi & Johnson, (2005) and W. Susilawati et al., (2021), who reported that the implementation of multimedia-based learning contributed to enhancing learning motivation and strengthening the meaningfulness of learning processes. Furthermore, (Henningsen & Stein, 1997; Nohda, 2000) suggested that developing learning materials should promote students’ autonomy in classroom management, encourage project-based learning using media, improve thinking

skills, and engage students in activities relevant to their real-life contexts. Similarly Shabiralyani et al., (2015) and Surijah et al., (2019) emphasized that learning media play a vital role in supporting academic achievement, with both educators and students demonstrating positive perceptions of media-based learning implementation.

The observation data also showed that both teacher and student activities improved across each session of Heyzine-assisted Jucama learning. Teacher activity increased from 81% in the first session to 89% in the third, while student activity rose from 77% to 93%. These findings are in line with the study conducted by (Munggaran, 2023), which revealed improvements in teacher and student engagement during the implementation of the Schoology-assisted Jucama learning model.

Based on the results of the Two-Way ANOVA test of pretest and posttest data, it was found that the improvement in problem-solving ability among students who received Heyzine-assisted Jucama learning was significantly higher than that of students who received Jucama learning without Heyzine. This aligns with the findings of (Munggaran, 2023), which indicated that there were differences in metacognitive ability improvements between the experimental and control classes, with the experimental group performing better. Furthermore, Wilkie, (2024) demonstrated that instruction integrating problem-solving and problem-posing tasks that intentionally consider aesthetic elements can foster creative thinking and enhance students' learning of algebra. Similarly, (Dows, 2005) argued that students' visualization skills can develop as they improve their ability to gather relevant and sufficient information.

CONCLUSION

Based on the results and analysis, it can be concluded that the Heyzine-assisted Problem Posing and Problem-Solving (Jucama) learning model effectively improved students' mathematical problem-solving ability and persistence in learning mathematics among eleventh-grade students during the even semester of the 2024/2025 academic year, particularly on the topic of geometric transformations. In summary:

1. The design of the Jucama learning model was successfully implemented and resulted in a valid and feasible product — the Heyzine-assisted LKPD — categorized as *very valid* for use in mathematics learning.
2. Authentic assessment results showed that students demonstrated adequate mastery of the material, actively participating in discussions, group presentations, and problem-posing activities while exhibiting persistence in finding alternative solutions.

3. The implementation of the Heyzine-assisted Jucama learning process showed consistent improvement in both teacher and student performance, achieving the *excellent* category.
4. There was a statistically significant improvement in mathematical problem-solving ability among students who received Heyzine-assisted Jucama instruction compared to those who received the Jucama model or conventional learning.
5. Gender-based analysis revealed differences in achievement levels, with female students outperforming male students in problem-solving tasks.

Suggestions

Based on the discussion and conclusions presented above, the following recommendations are proposed:

1. Teachers are encouraged to promote active student participation through innovative learning strategies, one of which is the Heyzine-assisted Problem Posing and Problem-Solving (Jucama) model.
2. The Heyzine-assisted Jucama learning model can serve as an alternative instructional approach that provides students with opportunities to formulate and solve different types of mathematical problems. This fosters critical and creative thinking, enabling students to move beyond mere replication of example solutions.
3. As many students are still not accustomed to problem-solving–oriented learning, mathematics instruction in schools should incorporate more non-routine and contextual problems. This will help students develop familiarity and confidence in tackling complex mathematical tasks, thereby enhancing their problem-solving abilities.
4. Future studies are encouraged to continue exploring the topic of geometric transformations using different learning models and instructional media, fostering a variety of innovative approaches to mathematics education.

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