JURNAL ABSIS
Jurnal Pendidikan Matematika dan Matematika
Vol. 7 No. 1, August 2024

DEVELOPMENT OF PROBLEM-POSING AND SOLVING WORKSHEETS TO FACILITATE STUDENTS' MATHEMATICAL CREATIVE THINKING

Annisa Rahmaini[1], *Elfis Suanto[2], Syofni[3]
[1,2,3] Universitas Riau, Indonesia
elfis.suanto@lecturer.unri.ac.id

ABSTRACT One of the goals of mathematics education in the *Kurikulum Merdeka* is to develop students' creative thinking skills in mathematics. However, current evidence shows that students' creative thinking skills remain low. This issue arises because students are not regularly exposed to contextual problems that require creativity, argumentation, and reasoning. Moreover, the use of Student Worksheets is still limited and does not adequately foster students' mathematical creative thinking skills. In response, this research aims to develop a Student Worksheet based on the Problem Posing and Solving Learning Model, commonly known as the Jucama model, focused on the Pythagorean theorem content to enhance the mathematical creative thinking skills of phase D students. The research follows a development approach using the 4D model, which includes the stages of define, design, develop, and disseminate. Data were collected using questionnaires, involving 15 ninth-grade students from SMP 22 Pekanbaru in a small group trial. The validity of the worksheet, as evaluated by experts, averaged 92.5%, categorizing it as very valid. The practicality of the worksheet was rated at 83.33%, also categorized as very practical. These results indicate that the worksheet developed using the Jucama model on the Pythagorean theorem content is both valid and practical for facilitating the creative thinking skills of phase D students.

Keywords: mathematical creative thinking skills, jucama learning model, students worksheets, development.

ABSTRAK Salah satu tujuan pendidikan matematika dalam *Kurikulum Merdeka* adalah mengembangkan keterampilan berpikir kreatif siswa dalam matematika. Namun, bukti saat ini menunjukkan bahwa keterampilan berpikir kreatif siswa masih rendah. Masalah ini muncul karena siswa tidak secara teratur dihadapkan pada masalah kontekstual yang memerlukan kreativitas, argumentasi, dan penalaran. Selain itu, penggunaan Lembar Kerja Peserta Didik (LKPD) masih terbatas dan belum cukup mendukung keterampilan berpikir kreatif matematika siswa. Oleh karena itu, penelitian ini bertujuan untuk mengembangkan

https://doi.org/10.30606/absis.v7i1.2582

LKPD berbasis *Problem Posing and Solving Learning Model* yang dikenal sebagai model Jucama, dengan fokus pada materi teorema Pythagoras untuk meningkatkan keterampilan berpikir kreatif matematika siswa fase D. Penelitian ini menggunakan pendekatan pengembangan dengan model 4D, yang meliputi tahap define, design, develop, dan disseminate. Pengumpulan data dilakukan dengan menggunakan kuesioner, melibatkan 15 siswa kelas IX dari SMP 22 Pekanbaru dalam uji coba kelompok kecil. Validitas LKPD, sebagaimana dievaluasi oleh para ahli, rata-rata sebesar 92,5%, dikategorikan sangat valid. Praktikalitas LKPD dinilai sebesar 83,33%, juga dikategorikan sangat praktis. Hasil ini menunjukkan bahwa LKPD yang dikembangkan menggunakan model Jucama pada materi teorema Pythagoras valid dan praktis untuk memfasilitasi keterampilan berpikir kreatif matematika siswa fase D.

Keywords: kemampuan berpikir kritis matematis, model pembelajaran jucama, teorema pythagoras.

INTRODUCTION

Mathematics is a subject that plays a crucial role in education, as it is not only taught for understanding its content but also for training students' thinking patterns to solve problems logically (Sulistiyawati & Susanah, 2013). In the Kurikulum Merdeka, one of the goals of mathematics education is to equip students with creative thinking skills in mathematics (Wicaksono et al., 2022). These creative thinking skills in mathematics are essential because they help students solve mathematical problems more easily (Muthaharah et al., 2018). Supardi (2012) explains that there is a positive correlation between students' creative thinking skills and their academic performance in mathematics. Therefore, creative thinking skills in mathematics are vital for every student to possess in order to solve mathematical problems effectively.

However, the importance of creative mathematical thinking skills is not reflected in the achievements of Indonesian students. This is evident from the 2018 Programme for International Student Assessment (PISA) results, which show that Indonesia ranked 73rd out of 79 countries in the mathematics category, with an average score of 379, below the international average of 489 (Tohir, 2019). Previous studies have also confirmed that students' creative thinking skills are low. Research findings by Arista & Mahmudi (2020) indicate that the creative mathematical thinking skills of tenth-grade students in East Lampung Regency are categorized as sufficient in high- and low-level schools, while in medium-level schools, they are categorized as lacking. Another study by Handayani et al. (2018) also states that overall, students in class IX at MTsN 6 Banyuwangi are at a less creative level when solving PISA adoption questions. Similarly, Sugianto et al. (2018) found that the creative mathematical thinking skills of students in class VIII at SMP Islam As-Shofa Pekanbaru need improvement, particularly in fluency and flexibility indicators.

Educators can enhance students' creative mathematical thinking skills by implementing appropriate learning models (Faturohman & Afriansyah, 2020). One

https://doi.org/10.30606/absis.v7i1.2582

learning model that is expected to improve students' mathematical creativity is the problem-posing and problem-solving learning model, known as the jucama model (Yenni & Maharani, 2021). Several previous studies have proven that the jucama model can enhance students' creative thinking skills, such as those conducted by Khaulah (2019) and Fajrizal et al. (2019).

The jucama model, which stands for problem-posing and problem-solving learning, is a mathematics learning model that focuses on solving and formulating mathematical problems as the core aspect of learning. It emphasizes active mental engagement with the goal of enhancing creative thinking skills (Siswono, 2018). The jucama learning model is structured with five syntaxes: 1) stating the objectives and preparing the students, 2) orienting students towards the problems and organizing them for learning, 3) guiding problem-solving both individually and in groups, 4) presenting the results of problem-solving and problem-posing, and 5) checking students' understanding and providing feedback as a reflection (Siswono, 2018). Therefore, learning that employs the jucama model is considered effective in facilitating students' creative thinking skills.

In the Kurikulum Merdeka, one of the components found in teaching modules is the student worksheet. These worksheets can be used to assess the success of enhancing students' creative mathematical thinking skills (Juwita et al., 2019). A student worksheet is a teaching material in the form of sheets that encompass a series of learning activities systematically arranged to assist students in the learning process (Mukti & Medriati, 2018). Using worksheets in the learning process encourages active student participation and can develop their potential for creative mathematical thinking (Wahyu & Madlazim, 2018).

One of the essential topics in mathematics learning is the Pythagorean theorem, as it can be used to solve various other mathematical problems (Karim, 2020). I agree with Azimi et al. (2017) that to solve geometry problems, the Pythagorean theorem is often used in the solutions. The content of the Pythagorean theorem is also a subject in mathematics oriented towards 21st-century competencies, where one of the indicators is creative thinking (Karim, 2020). Researchers also referred to a study by Sulistiyawati & Susanah (2013), which found that implementing the jucama learning model in Pythagorean theorem content significantly enhances students' creativity.

Based on observations at SMPN 22 Pekanbaru, it was found that during the learning process, the teacher primarily used the lecture method, relying solely on the mathematics textbook provided by the school as a learning resource, explaining the material, providing example problems, and finally giving students exercises as practice. The use of worksheets was limited to assigning tasks, so the learning process did not allow students to discover the material concepts independently. Thus, there is a need to develop student worksheets that can facilitate students' creative mathematical thinking skills.

The development of student worksheets based on the jucama learning model has also been conducted by previous researchers, such as Yenni & Maharani (2021), Fitriyana et al. (2021), and Anisa (2021). However, the difference lies in the content used and the skills that can be facilitated. This research focuses on the Pythagorean theorem, with student worksheets containing indicators of creative thinking skills. Based on the presentation above, the aim of this research is to produce student worksheets based on the jucama learning model for the content of the Pythagorean theorem to facilitate students' creative mathematical thinking skills, while also meeting the requirements of being valid and practical.

METHODS

This research is a development study that follows the 4D model, which consists of four stages: define, design, develop, and disseminate (Thiagarajan et al., 1974). In the define stage, activities include initial analysis, student analysis, concept analysis, task analysis, and learning objective analysis. The design stage involves creating the product by preparing criterion tests, selecting media and formats, and designing the initial product. The development stage involves formative evaluation, adapting Tessmer's (1993) steps of expert review, one-to-one evaluations, and small group evaluations. Finally, the disseminate stage involves distributing the validated and practical student worksheets to schools.

The research trial subjects were 15 randomly selected students from class IX of SMP 22 Pekanbaru, taking into account their skill levels and gender. Data collected included qualitative feedback from validators and quantitative data from validation and practicality questionnaires. The data collection instruments used were validity and student response questionnaires, which employed a Likert scale with five options ranging from 5 (Strongly Agree) to 1 (Disagree). The data were then analyzed by calculating the average scores from expert validations and student responses. The student worksheets were considered valid if they achieved a validity score of 61% or higher, which allowed them to proceed to practicality testing. If the score was below 61%, revisions were necessary. The worksheets were deemed practical if the practicality score exceeded 60% (Riduwan, 2015).

The flowchart for the 4D model development procedure in the research is structured into four main stages: Define, Design, Development, and Disseminate. In the Define stage, the focus is on initial and final analyses, which include analyzing the students, the concepts, and the tasks, as well as specifying the learning objectives. These analyses provide a foundation for developing the educational product. The Design stage involves preparing validation sheets and practicality questionnaires, selecting appropriate media and formats, and creating an initial product design, referred to as Prototype 1. This stage is critical as it lays out the structure and content of the educational material.

https://doi.org/10.30606/absis.v7i1.2582

Moving to the Development stage, the initial product undergoes a formative evaluation. This includes an expert review, one-to-one student evaluations, and small group trials. Based on the feedback and data from these evaluations, revisions are made to produce Prototype 2, ensuring the product's validity and practicality. Finally, in the Disseminate stage, the validated and practical product is finalized and ready for distribution to schools. This stage marks the completion of the development process, making the product available for educational use. Overall, this flowchart systematically guides the development process from initial analysis to final product dissemination, ensuring that the educational material is both effective and practical for classroom use.

FINDING AND DISCUSSION

This development research was conducted to create a student worksheet based on the problem-posing and solving learning model, known as Jucama, focusing on the Pythagorean theorem content to enhance students' creative thinking skills. The development process followed the 4D model, which includes the stages of define, design, development, and dissemination.

The first stage, defining, involved five key activities: initial-final analysis, learner analysis, content analysis, task analysis, and learning objective analysis. These activities helped identify and establish the initial problems in the learning process. Observations at SMPN 22 Pekanbaru revealed that teachers mainly relied on school-issued mathematics textbooks as learning resources, with the worksheets used in class failing to demonstrate students' conceptual understanding. The literature review highlighted the low level of students' creative thinking skills when solving contextual mathematics problems.

The analysis of students' activities aimed to understand the characteristics of students aged 12 to 14, who, according to Piaget, are capable of abstract thinking, logical reasoning, and drawing conclusions from available information. However, these abilities need to be nurtured through appropriate educational methods. Observations showed that students were less engaged and enthusiastic during mathematics lessons, largely due to the lecture-based method and overreliance on textbooks and worksheets. Implementing the Jucama learning model was deemed necessary to encourage more active and independent learning, ultimately fostering the development of students' creative mathematical thinking skills. Additionally, the concept analysis activity led to the creation of a concept map for the Pythagorean theorem, providing a clearer structure for the content to be taught.

In the concept analysis activity, an analysis is conducted on the content or material that will be taught. From this activity, a concept map was created for the content of the Pythagorean theorem, which is presented in the following Figure 1.

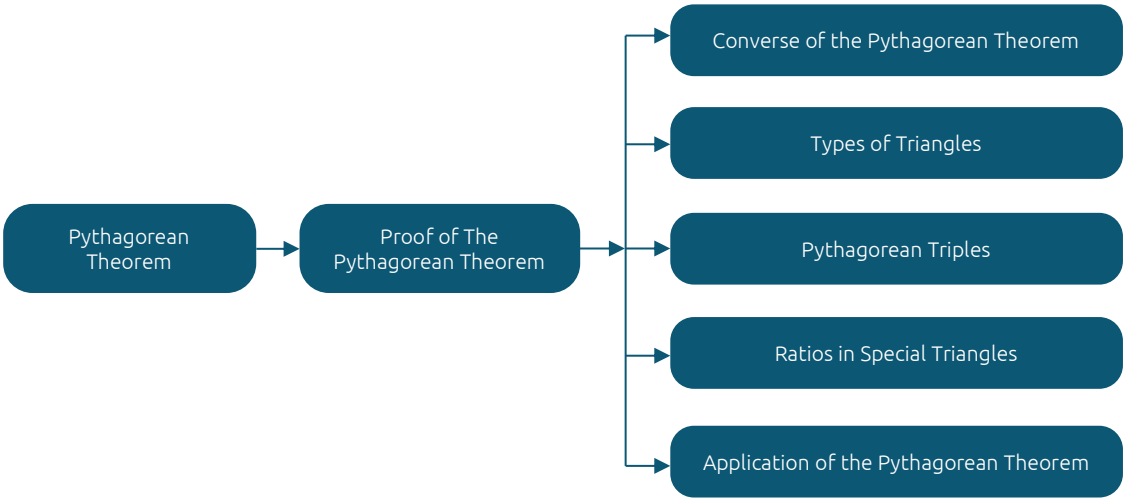

Figure 1 Concept Map of the Pythagorean Theorem Content

In the task analysis activity, an analysis of the Learning Outcomes contained in the Ministry of Education and Culture Regulation Number 008 of 2022 was conducted to produce the Learning Objective Flow. The analysis of student learning outcomes focuses on their ability to prove the truth of the Pythagorean Theorem and apply it in various contexts, such as determining the distance between two points on the Cartesian coordinate plane. Throughout this process, students are expected to achieve specific learning objectives laid out in the different learning units. Each unit has detailed goals, such as enabling students to prove and apply the Pythagorean Theorem, classify triangles based on side lengths, determine the values of Pythagorean triples, and use these concepts in practical scenarios. These learning objectives guide students not only in understanding theoretical concepts but also in applying them accurately in real-world situations, ultimately enhancing their creative mathematical thinking skills.

The second stage is the design phase, where the process involves preparing test instruments, selecting media and formats, and designing the initial product (referred to as prototype-1) of the student worksheet. This worksheet is based on the problem-posing and problem-solving learning model, known as the Jucama model, specifically tailored to the content of the Pythagorean theorem to enhance the creative thinking skills of students in phase D.

During the test instrument preparation, a validation sheet is developed, encompassing four key criteria: content feasibility, language feasibility, presentation feasibility, and graphic feasibility. Additionally, a practicality instrument is created with three criteria: ease of use, time management, and implementation practicality.

In selecting the media and format, printed media is chosen, designed using Microsoft Office Word, and structured to include a cover page, an introduction page, and the content sections of the worksheet. The initial product design, termed prototype-1, emerges from this phase. The worksheet is divided into sub-sections as follows: the

https://doi.org/10.30606/absis.v7i1.2582

first section focuses on proving the Pythagorean theorem and determining the length of a right triangle's sides; the second section deals with the converse of the theorem and classifying triangles; the third section covers Pythagorean triples and special triangles; and the final section addresses the application of the Pythagorean theorem in Cartesian coordinates.

The third stage is the development phase, where prototype-1 undergoes formative evaluation. This involves an expert review where specialists validate the initial design. The results of the validation process are presented in table 1.

Table 3. Results of Student worksheet Validation

Criteria	Average Assessment of 3 Validators				Average	Category
	1	2	3	4		
Aspects of content feasibility	94,28%	95,24%	95,24%	99,05%	95,95%	Very valid
Aspects of language feasibility	88,89%	86,67%	89,63%	91,85%	89,26%	Very valid
Aspects of presentation feasibility	92,5%	90%	88,33%	88,33%	89,79%	Very valid
Aspects of graphic feasibility	90%	96,67%	96,67%	96,67%	95%	Very valid

Based on Table 1, it is known that the average validation result of the student worksheet is 92.5%, which is categorized as very valid. This indicates that the student worksheet can be tested after making improvements based on suggestions from the validator. In terms of content feasibility, an average score of 95.95% was obtained, also categorized as very valid, meaning that the content feasibility aspects are in line with the Curriculum and Learning Outcomes. The validator commented that some components presented are still not optimal in providing supporting information to the students, thus suggesting further improvements.

The language feasibility aspect received an average score of 89.26% from three validators, categorized as very valid, indicating that the language used in the student worksheet complies with the rules of the Indonesian language. In the presentation feasibility aspect, the average score was 89.79%, also categorized as very valid, indicating that the presentation of the student worksheet aligns with the learning model used, which is the problem-posing and problem-solving learning model (Jucama). Validators suggested paying closer attention to the steps in the Jucama learning model to ensure they are well adapted into the student worksheet. For the graphic feasibility aspect, a score of 95% was obtained, categorized as very valid, meaning the design of the student worksheet complies with applicable regulations.

According to Riduwan (2015), a student worksheet is considered valid if it achieves a validity score of 61% or higher. The results of this study align with Yenni & Maharani (2021), who also found that worksheets based on the Jucama learning model are valid in terms of validity. However, in the study conducted by Yenni & Maharani (2021), only two indicators of mathematical creative thinking skills were applied, whereas this research applies four indicators of mathematical creative thinking skills and is stated to be very valid in the validity questionnaire regarding the feasibility of presentation.

Prototype-1 was also given to three students from SMPN 22 Pekanbaru during the one-to-one stage. The one-to-one trial is conducted before the student worksheet is given to a small group, which is useful for determining the readability of the student worksheet. The results of the one-to-one trial revealed errors in the writing of Worksheet-2. Based on suggestions and comments from the expert review and one-to-one stage, the student worksheet was revised, resulting in Prototype-2. Prototype-2 was then tested on a small group to assess the practicality of the developed student worksheet. The subjects of the small group trial, consisting of 15 students from phase D of class VIII at SMPN 2 Pekanbaru, were also asked to fill out a student response questionnaire. The results from the student responses show that the average score on the student respondents' questionnaire is 83.33%, categorized as very practical. According to Riduwan (2015), this score indicates that the developed student worksheet is practical since its practicality value is above 60%.

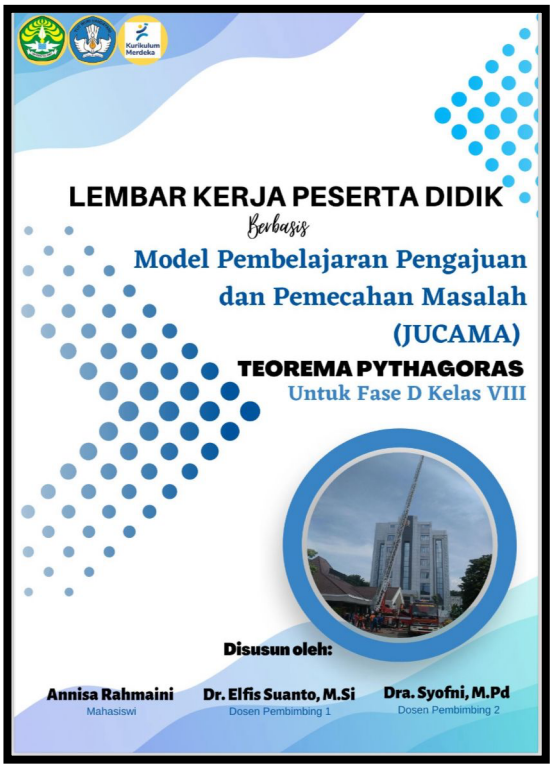

Figure 2 Final Product Cover of worksheet

https://doi.org/10.30606/absis.v7i1.2582

Thus, the small group trial of the student worksheet developed based on the Jucama learning model on the content of the Pythagorean theorem to facilitate the creative thinking skills of students in phase D has met the practical requirements for use. This result is in line with the research by Nurlaili (2023), which found that the student worksheet based on the Jucama learning model is considered very practical. Based on the validity and practicality analysis that has been conducted, the Jucama model-based student worksheet on the Pythagorean theorem to facilitate creative thinking skills has met the valid and practical criteria, allowing it to proceed to the final development stage.

The fourth and final stage is dissemination, which involves packaging by printing the student worksheet and distributing it by handing over the student worksheet to the schools that have contributed. The following Image 4 shows the final product cover of the student worksheet based on the Jucama learning model on the content of the Pythagorean theorem for students in phase D.

CONCLUSIONS AND RECOMMENDATIONS

This research produced a mathematics student worksheet based on the problem-posing and solving (Jucama) learning model, specifically focused on the Pythagorean theorem content to facilitate the mathematical creative thinking skills of students in phase D. The development followed the 4D model, which includes the stages of defining, designing, developing, and disseminating. Based on the validation results and small group trials, it was concluded that the student worksheet met the criteria for being both valid and practical. Therefore, this worksheet can be effectively used to study the Pythagorean theorem.

However, since the research only reached the stage of practicality testing, it is recommended that future researchers continue this study by conducting large group trials to assess the effectiveness of the student worksheet further. It is also suggested that the Jucama learning model be applied to different content areas to explore its broader applicability.

REFERENCES

Anisa, L. (2021). Pengembangan e-modul matematika berbasis model pembelajaran Jucama pada materi aritmatika sosial kelas VII SMP Islam Sabilal Muhtadin Banjarmasin. *Undergraduate thesis*. Universitas Islam Negeri Antasari Banjarmasin.

Arista, E. D. W., & Mahmudi, A. (2020). Kemampuan berpikir kreatif matematis dalam penyelesaian soal open-ended jenis PISA berdasarkan level sekolah. *Jurnal Pendidikan Matematika, 15*(1), 87–99. https://doi.org/10.21831/pg.v15i1.34606

Azimi, S. N., Purwanto, & Abadyo. (2017). Penalaran analogi peserta didik dalam menyelesaikan masalah keliling dan luas segiempat. *Jurnal Kajian Pembelajaran*

Matematika, 1(2), 144–154.

Fajrizal, R., & Fadila, A. (2019). Penerapan model pembelajaran Jucama untuk meningkatkan kemampuan berpikir kreatif peserta didik ditinjau dari kemandirian belajar. *Jurnal Pendidikan Matematika, 5*(2), 72–80.

Faturohman, I., & Afriansyah, E. A. (2020). Peningkatan kemampuan berpikir kreatif matematis peserta didik melalui creative problem solving. *Mosharafa: Jurnal Pendidikan Matematika, 9*(1), 107–118. https://doi.org/10.31980/mosharafa.v9i1.562

Fitriyana, N., Widada, W., & Dharmayana, I. W. (2021). Pengembangan bahan ajar matematika berbasis model pembelajaran Jucama untuk meningkatkan kemampuan pemecahan masalah dan kemampuan komunikasi matematis peserta didik. *Jurnal Pendidikan Matematika (Judika Education), 4*(1), 25–33. https://doi.org/10.31539/judika.v4i1.2204

Handayani, U. F., Sa'dijah, C., & Susanto, H. (2018). Analisis kemampuan berpikir kreatif matematis peserta didik SMP dalam menyelesaikan soal adopsi 'PISA.' *Jurnal Math Educator Nusantara, 4*(2), 143–156. https://doi.org/10.29407/jmen.v4i2.12109

Juwita, R., Utami, A. P., & Wijayanti, P. S. (2019). Pengembangan LKS berbasis pendekatan open-ended untuk meningkatkan kemampuan berpikir kreatif matematis peserta didik. *Jurnal Pendidikan Matematika, 3*(1), 35–43. https://doi.org/10.31000/prima.v3i1.814

Karim, G. S. (2020). Analisis proses berpikir kreatif peserta didik dalam menyelesaikan soal teorema Phytagoras. *Undergraduate thesis*. Universitas Islam Sultan Agung Semarang.

Khaulah, S. (2019). Penerapan model pembelajaran Jucama dengan menggunakan blok aljabar untuk meningkatkan kemampuan berfikir kreatif peserta didik pada materi persamaan kuadrat. *Jurnal Pendidikan Matematika, 5*(2), 75–83.

Mukti, F., Connie, & Medriati, R. (2018). Pengembangan lembar kerja peserta didik (LKPD) pembelajaran fisika untuk meningkatkan kemampuan berpikir kreatif peserta didik SMA Sint Carolus Kota Bengkulu. *Jurnal Kumparan Fisika, 1*(3), 57–63. https://doi.org/10.33369/jkf.1.3.57-63

Muthaharah, Y. A., Kriswandani, & Prihatnani, E. (2018). Analisis kemampuan berpikir kreatif matematis peserta didik SMP dalam menyelesaikan soal bangun ruang sisi datar. *Jurnal Mitra Pendidikan, 2*(1), 63–75.

Nurlaili, F. (2023). Pengembangan lembar kerja peserta didik berbasis model pembelajaran pengajuan dan pemecahan masalah (Jucama) pada materi garis dan sudut untuk peserta didik SMP. *Undergraduate thesis*. Universitas Islam Negeri Sultan Syarif Kasim Riau.

https://doi.org/10.30606/absis.v7i1.2582

Riduwan. (2015). *Belajar mudah penelitian untuk guru-karyawan dan peneliti pemula*. Alfabeta.

Siswono, T. Y. E. (2018). *Pembelajaran matematika berbasis pengajuan dan pemecahan masalah*. PT Remaja Rosdakarya Offset.

Sugianto, Hayati, F., & Junitasari. (2018). Analisis kemampuan berpikir kreatif matematis peserta didik SMP pada materi persamaan garis lurus. *Jurnal Pendidikan Tambusai, 2*(6), 1678–1688.

Sulistiyawati, & Susanah. (2013). Penerapan model pembelajaran Jucama pada materi teorema Pythagoras. *Jurnal Mahasiswa Universitas Negeri Surabaya*.

Supardi. (2012). Peran berpikir kreatif dalam proses pembelajaran matematika. *Jurnal Formatif, 2*(3), 284–262.

Tessmer, M. (1993). *Planning and conducting formative evaluations: Improving the quality of education and training*. Taylor & Francis.

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children*. ERIC.

Tohir, M. (2019). Hasil PISA Indonesia tahun 2018 turun dibanding tahun 2015.

Wahyu, J. A., & Madlazim. (2018). Pengembangan lembar kerja peserta didik (LKPD) berbasis inkuiri terbimbing untuk meningkatkan keterampilan berpikir kreatif peserta didik. *Inovasi Pendidikan Fisika, 7*(3), 413–419.

Wicaksono, A. B., Khabibah, S., & Masriyah. (2022). Konsepsi guru matematika SMA tentang berpikir kreatif. *Jurnal Pendidikan Matematika, 12*(3), 249–255.

Yenni, & Maharani, T. (2021). Pengembangan LKS berbasis Jucama untuk meningkatkan berpikir kreatif matematis. *Jurnal Pendidikan Indonesia, 1*(2), 14–23.