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Development of Student Worksheets Using Question Probing Scaffolding with Perplexity AI to Enhance Creative Thinking Skills and Mathematical Problem-Solving Abilities

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ABSTRACT. The main objective of this study is to develop teaching materials in the form of Student Worksheets using Question Probing Scaffolding with Perplexity AI to encourage creative thinking and mathematical problem-solving skills in the subject of Relations and Functions. The type of research used was Research and Development (R&D) using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development procedure. This research was conducted in two schools, namely SMP Muhammadiyah 3 Bandar Lampung and SMPN 1 Menggala Timur in the 2024/2025 academic year. The research instruments used were validation questionnaires, tests, and documentation. The data obtained was then analyzed using quantitative and qualitative data analysis techniques. Based on the feasibility test by the validator, the student worksheets using Question Probing Scaffolding was categorized as very feasible. Based on the student response questionnaire, the student worksheets using Question Probing Scaffolding was categorized as very interesting. The N-Gain calculation results show that the use of student worksheets based on Question Probing Scaffolding produces an increase in creative thinking and problem-solving abilities in the high category. The t-test also shows a significant difference between the pre-test and post-test scores, proving that the developed student worksheets is feasible and effective for use in Relations and Functions material. Overall, this student worksheets is considered practical, easy to implement, and able to improve the learning outcomes of junior high school students.

Keywords: perplexity AI; question probing scaffolding; relation and function; student worksheet

ABSTRAK. Tujuan utama penelitian ini untuk mengembangkan bahan ajar berupa Lembar Kerja Peserta Didik (LKPD) menggunakan *Question Probing Scaffolding* dengan *Perplexity AI* untuk mendorong kemampuan berpikir kreatif dan kemampuan pemecahan masalah matematika pada materi Relasi dan Fungsi. Jenis penelitian yang digunakan adalah pengembangan *Research and Development* (R&D) dengan menggunakan prosedur pengembangan ADDIE (*Analysis, Design, Development, Implementation, Evaluation*). Penelitian ini dilakukan di 2 sekolah yaitu di SMP Muhammadiyah 3 Bandar Lampung dan SMPN 1 Menggala Timur tahun Pelajaran 2024/2025. Instrumen penelitian pengembangan data berupa angket validasi, tes, dan dokumentasi. Data yang diperoleh kemudian dianalisis dengan teknik analisis data kuantitatif dan data kualitatif. Berdasarkan uji kelayakan oleh validator, LKPD menggunakan *Question Probing Scaffolding* dengan kategori sangat layak. Berdasarkan angket respon peserta didik, LKPD menggunakan *Question Probing Scaffolding* dengan kategori sangat menarik. Hasil perhitungan *N-Gain* menunjukkan bahwa penggunaan LKPD berbasis *Question Probing Scaffolding* menghasilkan peningkatan kemampuan berpikir kreatif dan pemecahan masalah pada kategori tinggi. Uji beda (*t-test*) juga memperlihatkan perbedaan signifikan antara nilai *pre-test* dan *post-test*, sehingga LKPD yang dikembangkan terbukti layak serta efektif digunakan pada materi Relasi dan Fungsi. Secara keseluruhan, LKPD ini dinilai praktis, mudah diimplementasikan, dan mampu meningkatkan hasil belajar siswa tingkat SMP.

Kata kunci: lembar kerja peserta didik; *perplexity AI*; *question probing scaffolding*; relasi dan fungsi

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INTRODUCTION

One of the supporters of a nation's progress in human resources is education as an absolute necessity for the nation's future generation (Septian dkk., 2019). The law states that every member of society has the right to obtain high-quality education (Septina dkk., 2018). In the 21st century, educators are required to have strong skills in teaching and learning. The interactions in the teaching and learning process between teachers and students must include aspects that align with the vision of learning (Dinda dkk., 2021). To realize the vision of learning, educators need various forms of innovation to support guidance and mentoring for students. One effort that can be developed is the provision of learning tools, such as Student Worksheets, as well as other media that can encourage active engagement and a more optimal understanding of learning. According to the Ministry of National Education (Diana dkk., 2022), a Student Worksheet is a sheet containing questions that students must complete. A Student Worksheet is a learning tool that can facilitate learning, help students acquire knowledge, and provide explanations of the material (El Widad dkk., 2023). Student Worksheets can take the form of guides for educational development in the cognitive domain or in other areas of knowledge, such as experimental or demonstration guides (Listari & Yennita, 2019).

In developing this student worksheets, the question-probing scaffolding technique was used. Probing questions are defined as questions from the educator that are sequentially given to the students after they answer previous questions, serving as directional guidance so that students can answer correctly and improve the quality of their written responses, which require students to explain their understanding more deeply through coherent and argumentative sentences (Gumay, 2018). Meanwhile, scaffolding refers to the assistance educators provide in the teaching and learning process, serving as a stimulus and a means to build students' knowledge at the initial stage. In addition, scaffolding also encourages students' stimulus to make learning more meaningful (El Widad dkk., 2023). Therefore, question-probing scaffolding is a teaching technique in which the educator provides a series of guiding questions to stimulate students' knowledge.

In this era of increasingly advanced technology, technology has become an essential aspect of human life. One technology based on artificial intelligence is Perplexity AI. Perplexity AI is an AI-based communication engine that can help find information about a subject accurately (Falah & Nerisma Eka Putri, 2023). Besides searching for information, Perplexity AI functions as a conversational companion and can provide reference sources that users are looking for (Rusli dkk., 2024). In a study conducted by Akhyar dkk. (2023), Perplexity AI was found to be a tool that could assist postgraduate PAI students at UIN Imam Bonjol Padang. According to three first-semester PAI students who were creating an article as an assignment, Perplexity AI was used as a literature reference, and they completed it in a very short time, allowing them to focus on the analysis and writing.

Current skills are essential, especially for students, including creative thinking and problem-solving. Creative thinking is thinking in a stable, repetitive manner to produce something creative and valid for the task at hand (Wasahua, 2021). According to Munandar (Utami dkk., 2020), creative thinking is the ability to find potential solutions to a problem, with an emphasis on the quality, efficiency, and diversity of solutions. The skill of creative thinking provides many benefits for students in discovering, reflecting on, and directing their genius ideas to find solutions to or ways out of problems encountered while learning mathematics, whether complex or straightforward (Putri & Alberida, 2022). However, in the field, the ability to think creatively is not optimally developed due to students' lack of determination and their perception that mathematics is a complex subject (Astria & Kusuma, 2023). Therefore, educators' roles are essential for students to develop creative thinking skills in learning mathematics. Students who possess these abilities can think fluently, flexibly, initially, and elaboratively (Putra dkk., 2018).

Then, problem-solving skills are students' efforts to resolve issues, especially in mathematics lessons, which emphasize methods, steps, and rules in an accurate, structured manner (Rahmatiya & Miatun, 2020). Mastery in solving mathematical problems is indeed tricky, not only requiring

students to choose the correct answer but also enabling them to develop problem-solving skills, overcome challenges, organize the sequence of solutions, arrange problems within a planned scheme, and review the obtained answers (Septianingsih dkk., 2022). According to the National Council of Supervisors of Mathematics (NCSM), problem-solving ability is one of the main reasons why students need to learn mathematics from an early age. Problem-solving is seen as the core of mathematical activity because, through this process, students not only seek answers but also learn to understand situations, develop strategies, and evaluate the solutions they find. Problem-solving skills are essential, as Sumarmo emphasizes that the purpose of teaching and the heart of mathematics are problem-solving (Sriwahyuni & Maryati, 2022). Besides solving math problems, problem-solving skills can also help address issues in everyday life. However, in reality, students' problem-solving abilities remain relatively low; for example, when working on math problems, they are often careless or may misunderstand the content (Fatimah dkk., 2019)

The development of innovative and creative teaching materials has become an important need in learning, prompting researchers to design a Student Worksheet based on question-probing scaffolding. The student worksheets is intended to improve students' abilities, such as creativity and problem-solving. The material chosen for the development of this student worksheets is relations and functions, as research by Sari dkk. (2022) shows that student achievement in this material remains low, with an average score of 55.65.

Several previous studies have also emphasized that integrating scaffolding strategies and probing questions can enhance students' higher-order thinking processes, including creativity and mathematical problem-solving. However, most of these studies have not used AI-based technology to enhance the quality of the questions or the depth of the guidance.

Thus, the position of this research is to fill that gap by developing student worksheets that combines a question-probing scaffolding approach with Perplexity AI. The developed product is aimed to be valid, feasible to use, and engaging, so that it can serve as a teaching material that encourages the improvement of students' creative thinking skills and mathematical problem-solving in the topic of relations and functions.

METODHS

This research uses the Research and Development (R&D) method through a development flow that adapts the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). However, its principles also align with Plomp's model, which emphasizes three core stages: preliminary research, prototyping, and assessment. Due to the compatibility between the two models, the student worksheets development process is carried out gradually and iteratively, including needs analysis, design, product development, trials, and evaluation to ensure its quality and effectiveness.

After going through the development stages, the final product not only produces a valid and engaging Student Worksheet but also demonstrates its usefulness in learning. Therefore, in addition to feasibility testing, this study also assesses effectiveness by comparing learning outcomes before and after student worksheets use. N-Gain analysis and difference tests are used to observe improvements in students' creative thinking and problem-solving abilities. The findings show that the developed student worksheets is not only valid in design but also effective in supporting learning activities and has a tangible impact on improving learning outcomes compared to the conditions before its use. Development using the ADDIE model involves systematically designing and creating tools to address students' needs and characteristics in the teaching and learning process. In the analysis stage, the researcher identifies the problems occurring in learning, particularly in mathematics, and what is needed for the research. In the design stage, the researcher uses Perplexity AI to develop materials and test instruments for the Question Probing Scaffolding-based student worksheets product. Then, in the development stage, it is the stage of compiling the previously designed materials and test questions, developing them into a Question Probing

Scaffolding-based student worksheets product, and carrying out a feasibility assessment (validation) by validators. Next, the implementation stage involves testing to examine the quality of the student worksheets product. The final stage is evaluation, which involves reviewing overall development outcomes, including product validity, student responses, and the effectiveness of student worksheets in enhancing creative thinking and problem-solving skills. At this stage, the researcher analyzes pre-test and posttest scores, N-Gain results, and student feedback to determine the extent to which the Question Probing Scaffolding-based student worksheets truly meets the learning objectives in the topic of Relations and Functions. This evaluation serves as the basis for concluding the product's success and determining whether the student worksheets can be recommended as an effective teaching material.

This research was conducted in 2 schools, namely SMP Muhammadiyah 3 Bandar Lampung and SMPN 1 Menggala Timur. The trial subjects were validators, including material experts, test item experts, and media experts. In addition, the subjects included 30 eighth-grade students from SMP Muhammadiyah 3 Bandar Lampung and 30 from SMPN 1 Menggala Timur, with the small group consisting of 10 students and the large group of 20. The instruments used in the research were validation questionnaires, tests, and documentation. The validation questionnaires included material, test-item, and media questionnaires, which were used to assess the feasibility of the student worksheets. Then, learning outcomes were measured using pre- and post-tests for the student groups that served as trial subjects. This study did not include a control group, so the analysis of improvement in ability focused on pre- and post-use comparisons. This approach directly assesses the product's effectiveness by observing changes in creative thinking and problem-solving abilities after implementing the Question Probing Scaffolding-based student worksheets. Documentation involves direct observation to gather information during the research (Prawiyogi dkk., 2021) on the research subjects, in the form of written notes, images, and videos.

Table 1. Percentage Scores of Feasibility and Attractiveness Assessment

No	Assessment	Feasibility	Attractiveness
1	$81\% \leq P \leq 100\%$	Very Feasible	Very Attractive
2	$61\% \leq P < 81\%$	Feasible	Attractive
3	$41\% \leq P < 61\%$	Quite Feasible	Quite Attractive
4	$21\% \leq P < 41\%$	Not Feasible	Not Attractive
5	$0\% \leq P < 21\%$	Very Not Feasible	Very Not Attractive

Source: Percentage Score of Feasibility and Attractiveness Assessment (Septina dkk., 2018)

Table 2. N-Gain Categories

No	N-Gain Assessment	Category
1	$g > 0{,}70$	High
2	$0{,}70 > g \geq 0{,}30$	Medium
3	$g \leq 0{,}30$	Low

Source: N-Gain Categories (Kurniawan & Hidayah, 2021)

RESULT AND DISCUSSION

At the analysis stage, the researcher observed the dynamics of the teaching and learning process at the research site. From observations and interviews with teachers, the main problem that emerged was that the teaching materials used were still limited to government-issued textbooks. This situation has led to a decline in students' interest in learning, especially in mathematics. Furthermore, the pretest results showed that most students had low creative thinking abilities and problem-solving skills in mathematics. The pretest scores were very low, providing a clear picture that an innovation in teaching materials is needed to address these weaknesses. Based on these findings, the research focuses on developing more engaging teaching materials that are responsive to students' needs, namely a Student Worksheet with an age-appropriate design. In this, the

questions are accompanied by guidance based on question-probing scaffolding, designed to help students answer questions independently and think critically/creatively.

Entering the design stage, the researcher developed instruments in the form of materials and questions; to support this process, the researcher used artificial intelligence assistance (perplexity-AI) as part of the design. The prepared instruments included questionnaires for validating content experts, question experts, and media experts, which would later be used to assess the feasibility of the developed student worksheets product. In addition, the researcher also created questions designed to measure students' creative thinking abilities and problem-solving skills. The student worksheets framework was also designed with the characteristics of junior high school students in mind to ensure relevance and alignment with their cognitive level.

Next, during the development stage, the student worksheets product is further developed to meet the criteria for feasibility and validity as teaching material. This process includes preparing parts within the student worksheets, such as the cover, preface, table of contents, concept map, basic competencies, learning objectives, material on relations and functions, usage instructions, and posttest questions. The purpose of the posttest is to evaluate improvements in students' creative thinking and mathematical problem-solving abilities. Thus, it is expected that the results of this development will produce an student worksheets ready for use by educators in the teaching and learning process.

A range of previous studies supports the discussion of the development results. Research on scaffolding-based student worksheets has demonstrated validity, practicality, and effectiveness in improving students' numeracy literacy in plane-figure materials (Nari & Mardhiyah, 2024). Similarly, studies using the creative problem-solving model and digital-based student worksheets tools show significant improvements in students' mathematical problem-solving abilities (Nainggolan dkk., 2024). That aligns with the findings of this study, which demonstrate that when students receive engaging learning materials and are provided with scaffolding guidance, they are better able to think creatively and solve math problems more effectively. In addition, scaffolding strategies not only support concept understanding but also promote students' independence in thinking and problem-solving (Suryaningsih dkk., 2021).

Thus, the development of scaffolding-based student worksheets tailored to age levels shows strong potential as an innovative teaching material that can enhance students' interest in learning, creative thinking, and mathematical problem-solving skills in junior high school.

Figure 1. Front and Back Cover of Student Worksheet

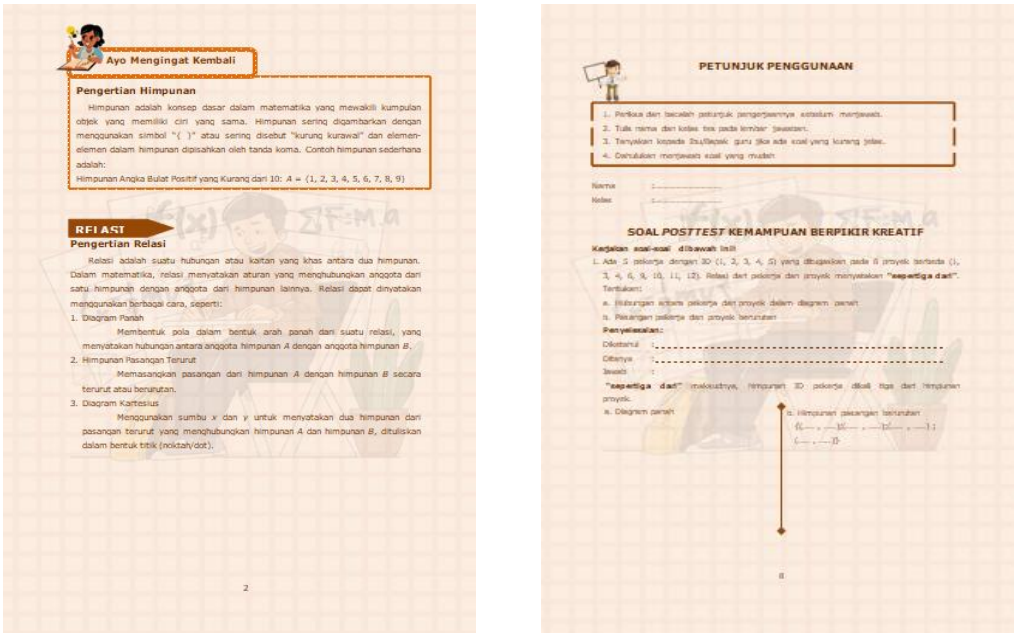


Figure 2. Material and Questions

At the development stage, the researchers not only compiled and finalized the Student Worksheet design but also conducted validation to ensure the developed product is truly feasible for use. Validation was conducted through a questionnaire completed by eight validators, including material experts, test item experts, and media experts. These validators came from the Mathematics Education lecturers at UIN Raden Intan Lampung and mathematics teachers from SMP Muhammadiyah 3 Bandar Lampung and SMPN 1 Menggala Timur.

Through this validation process, the experts provided assessments and input that were very helpful in improving the Student Worksheet. Some of the revision notes presented included corrections of writing errors, adjustments to size and font consistency, punctuation corrections, and improvements to the wording of several questions to make them more transparent and aligned with the indicators of creative thinking and problem-solving skills. Additionally, the content experts suggested adding more contextual illustrations and simplifying certain parts of the material explanations to make them easier for junior high school students to understand.

The researcher then made revisions according to the validators' recommendations. After these improvements, the Student Worksheet's structure became more organized, its language was more communicative, and its visual appearance was more appealing. These changes enhanced the overall quality of the Student Worksheet before it was used in the field trial stage. The following presents the assessment results from the content experts as part of the validation process.

Table 3. Results of Material Validation Assessment

No.	Component	Total Score	Criteria
1.	Material suitability	96,25%	Very feasible
2.	Material accuracy		
3.	Material currency		
4.	Presentation technique		
5.	Feasibility		
6.	Language		

Based on the validation results for the material on relations and functions in Table 3 above, a total score of 96.25% was obtained, indicating it is very feasible. This assessment result shows that only minor revisions are needed in certain parts of the Student Worksheet, such as typographical errors, font, symbols, and questions, as well as slight additions to the material. The

Student Worksheet design should be attractive so that students are interested in learning, starting from the colors, images, and language used; with this presentation, students become enthusiastic about completing the Student Worksheet. The assessment results by the test item experts are as follows.

Table 4. Results of Test Validation Assessment for Creative Thinking Ability Questions

No.	Component	Total Score	Criteria
1.	Basic Competence and Indicators		
2.	Question Grid	94,4%	Very feasible
3.	Language		

Table 5. Results of Test Validation Assessment for Problem-Solving Ability Questions

No.	Component	Total Score	Criteria
1.	Basic Competence and Indicators		
2.	Question Grid	91,6%	Very feasible
3.	Language		

Based on the assessment results, the validation of the creative thinking ability test questions in Table 4 above yielded a total score of 94.4%, meeting very feasible criteria. Then, in Table 5 above, the validation assessment of the problem-solving ability test questions yielded a total score of 91.6% and met very feasible criteria. The test question validation by the validators provided revisions, including changing the questions into story form and adding more questions. After making the revisions, the test questions could finally be used to measure students' creative thinking abilities and problem-solving skills. The following are the media expert's evaluation results.

Table 6. Media Validation Assessment Results

No.	Component	Total Score	Criteria
1.	Student Worksheet Size		
2.	Student Worksheet Cover Design	96,590%	Very feasible
3.	LKPD Content Design		

The implementation stage is the product's trial phase after the student worksheets product has been deemed feasible by the validator. The purpose of the student worksheets product trial is to assess the appeal of the student worksheets. The trial subjects were students from SMP Muhammadiyah 3 Bandar Lampung and SMPN 1 Menggala Timur. The small group had 10 students, and the large group had 20. To evaluate the product's appeal, a student response questionnaire was used. The following are the responses from the small and large student groups.

Table 7. Results of Student Responses in Small Groups

No.	School Name	Total Score	Criteria
1.	SMP Muhammadiyah 3 Bandar Lampung	98%	Very interesting
2.	SMPN 1 Menggala Timur	97%	Very interesting

Table 8. Results of Student Responses in Large Groups

No.	School Name	Total Score	Criteria
1.	SMP Muhammadiyah 3 Bandar Lampung	92,25%	Very interesting
2.	SMPN 1 Menggala Timur	96,37%	Very interesting

Based on Table 7, the results of student responses at SMP Muhammadiyah 3 Bandar Lampung show a total score of 98% with an exciting category, and at SMPN 1 Menggala Timur, a total score of 97% with an exciting category. Then, in Table 8, the results of student responses at SMP Muhammadiyah 3 Bandar Lampung show a total score of 92.25% with an exciting category,

and at SMPN 1 Menggala Timur, a total score of 96.37% with an exciting category. Furthermore, to assess students' creative thinking and problem-solving skills, the researcher administered a posttest comprising 8 questions to the 8th-grade class at SMP. The following are the results of the posttest assessment using N-Gain.

Table 9. Posttest Assessment Results of Creative Thinking Ability Test

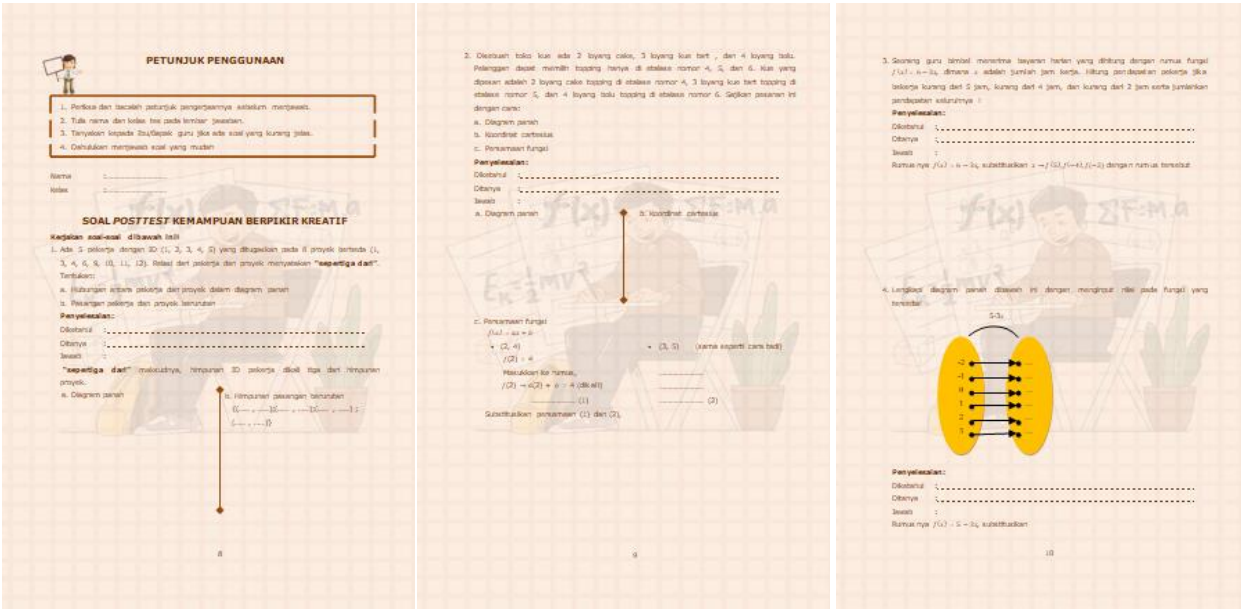
Mean			
Pretest	*Posttest*	*N-Gain Score*	Description
SMP Muhammadiyah 3 Bandar Lampung Small Group			
30,2	93,6	0,910021	High
SMP Muhammadiyah 3 Bandar Lampung Large Group			
37,45	92,05	0,85636584	High
SMPN 1 Menggala Timur Small Group			
34	93,6	0,8869885	High
SMPN 1 Menggala Timur Large Group			
25,25	92,05	74,75	High

Table 10. Posttest Assessment Results of Problem-Solving Ability Test

Mean			
Pretest	*Posttest*	*N-Gain Score*	Description
SMP Muhammadiyah 3 Bandar Lampung Small Group			
43	92,8	0,8688095	High
SMP Muhammadiyah 3 Bandar Lampung Large Group			
56,25	88,85	0,7095	High
SMPN 1 Menggala Timur Small Group			
34	89,8	0,8627877	High
SMPN 1 Menggala Timur Large Group			
25,25	88,85	0,85198866	High

However, this high category does not automatically indicate effectiveness without supporting statistical evidence. Therefore, this study also included a difference test between pre-test and posttest scores to ensure that the improvement was truly attributable to the use of the Student Worksheet. The difference test results showed a significant difference between initial abilities and abilities after using the student worksheets, indicating that the Question Probing Scaffolding-based student worksheets is not only valid and engaging but also effective in improving students' mathematical abilities, even though this study did not include a control group.

The final stage is evaluation, conducted after expert validation and field testing of the student worksheets product. The Question Probing Scaffolding-based student worksheets for mathematics lessons on relations and functions was deemed valid by experts across three areas. Similarly, a trial using a student response questionnaire showed that the student worksheets was very interesting to use. Furthermore, there was an improvement after the student worksheets was used, with students achieving high scores in creative thinking skills and problem-solving abilities in the posttest. Below is a display of the questions found in the Question Probing Scaffolding-based student worksheets.



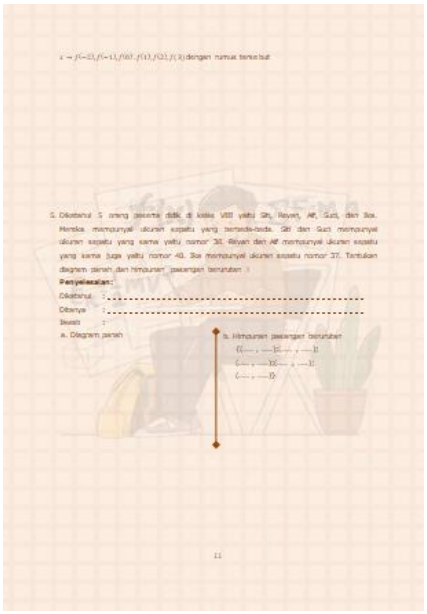


Figure 3. Creative Thinking Ability Questions

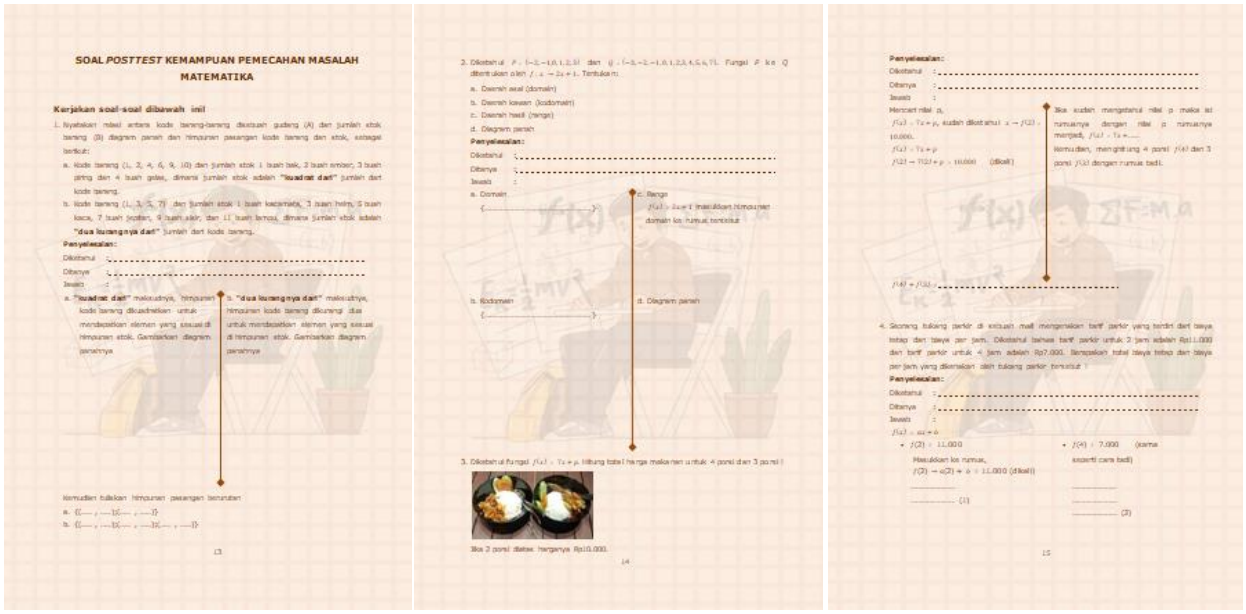


Figure 4. Problem-Solving Ability Questions

CONSLUSION

Based on the data collected during the development of the Question Probing Scaffolding-based Student Worksheet for the topic of Relations and Functions, the product meets the criteria of feasibility, attractiveness, and effectiveness. From a feasibility standpoint, the validation results show that the Student Worksheet is considered highly feasible by experts, with material feasibility at 96.25%, creative thinking ability test feasibility at 94.4%, problem-solving test feasibility at 91.6%, and media feasibility at 96.59%.

The aspect of attractiveness also showed very positive results. Responses from students at both schools indicated that the student worksheet was considered very appealing. At SMP Muhammadiyah 3 Bandar Lampung, the small group achieved an attractiveness score of 98%, while the large group achieved 92.25%. Meanwhile, at SMPN 1 Menggala Timur, the small group scored 97% and the large group 96.37%.

The effectiveness of the student worksheet is evident in improvements in creative thinking skills and problem-solving abilities, as shown by N-Gain analysis. In creative thinking skills, the N-Gain scores at SMP Muhammadiyah 3 reached 0.91 (small group) and 0.85 (large group), while at SMPN 1 Menggala Timur, they reached 0.88 (small group) and 0.74 (large group), all of which are in the high category. The same applies to problem-solving abilities, with a high category in all groups, both at SMP Muhammadiyah 3 (0.86 for the small group and 0.70 for the large group) and at SMPN 1 Menggala Timur (0.86 for the small group and 0.85 for the large group).

Considering all these findings, it can be concluded that the student worksheet based on Question Probing Scaffolding developed is not only highly feasible and engaging but also effective in enhancing students' creative thinking and problem-solving skills on the topic of Relations and Functions.

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