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THE ROLE OF HEUTAGOGY APPROACH IN RELATION TO CHILDREN'S CREATIVITY IN MATHEMATICAL PROBLEM SOLVING IN ELEMENTARY SCHOOL

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ABSTRACT
This research explores the implementation of the heutagogy approach in mathematics learning to enhance creativity and independence among elementary students. Using a descriptive qualitative method, the study was conducted with grade VI students at SDN 010 Tanjungpinang Timur to evaluate its effectiveness in solving high-level math problems (HOTS). Results indicate that only one out of 30 students answered correctly, with misconceptions persisting even among students with high creative thinking skills, particularly regarding the semicircle circumference formula. Many students struggled to verify their answers despite the application of student-centered learning. The findings suggest that heutagogy requires thorough planning, suitable learning media, and sufficient teacher guidance to achieve its objectives. Effective strategies include providing exercises with progressive difficulty, leveraging interactive media, and emphasizing conceptual understanding. Further investigations are needed to address the root causes of misconceptions. This study underscores the importance of teacher facilitation in helping students move beyond rote memorization to deep comprehension. When implemented effectively, heutagogy can significantly enhance students' creative thinking and problem-solving abilities in mathematics.
Keywords: creativity, heutagogy, HOTS, mathematics

ABSTRAK
Penelitian ini mengeksplorasi implementasi pendekatan heutagogi dalam pembelajaran matematika untuk meningkatkan kreativitas di kalangan siswa sekolah dasar. Dengan menggunakan metode kualitatif deskriptif, penelitian ini dilakukan pada 30 siswa kelas VI di SDN 010 Tanjungpinang Timur untuk mengevaluasi efektivitas pendekatan heutagogi dalam memecahkan masalah matematika tingkat tinggi (HOTS). Hasil penelitian menunjukkan bahwa hanya satu dari 30 siswa yang menjawab dengan benar, dengan miskonsepsi yang masih ada bahkan di antara siswa dengan kemampuan berpikir kreatif yang tinggi, terutama mengenai rumus keliling setengah lingkaran. Banyak siswa yang kesulitan untuk memverifikasi jawaban mereka meskipun telah menerapkan pembelajaran yang berpusat pada siswa. Temuan ini menunjukkan bahwa heutagogi membutuhkan perencanaan yang matang, media pembelajaran yang sesuai, dan bimbingan guru yang cukup untuk mencapai tujuannya. Strategi yang efektif termasuk memberikan latihan dengan tingkat kesulitan yang semakin meningkat, memanfaatkan media interaktif, dan menekankan pemahaman konseptual. Investigasi lebih lanjut diperlukan untuk mengatasi akar penyebab miskonsepsi. Penelitian ini menggarisbawahi pentingnya fasilitasi guru dalam membantu siswa bergerak melampaui hafalan menuju pemahaman yang mendalam. Jika diterapkan secara efektif, heutagogi dapat secara signifikan meningkatkan kemampuan berpikir kreatif dan pemecahan masalah siswa dalam matematika.
***Kata kunci**: heutagogi, HOTS, kreativitas, matematika*

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Introduction

In the era of modern education, the learning paradigm has undergone a significant shift from a teacher-centered approach to one that emphasizes the active role of students. One of the innovative approaches that responds to this change is heutagogy, which is a learning approach that focuses on self-determined learning by students. Heutagogy encourages learning independence, where students are not only recipients of information but also directors of their own learning processes according to their individual capacities and needs (Moore, 2020). Heutagogy, or self-determined learning, shifts the control of the learning process to the learner, enabling flexibility, capacity building, and learner agency in complex environments (Blaschke & Hase, 2016).

In line with the principles of the Independent Curriculum, student-centered learning has become a top priority to support the holistic growth of learners. In this context, the heutagogical approach becomes highly relevant as it provides space for students to set learning goals, choose appropriate methods and learning resources, and conduct self-evaluations of their learning progress (Stoten, 2020; Wahyudin et al., 2024). In the field of mathematics education, this approach has proven to enhance student engagement and independence, especially when combined with contextual activities such as real-world-based projects (Zakaria et al., 2024). According to Anderson and Krathwohl (2001), higher-order thinking skills (HOTS) encompass not only analysis and evaluation, but also creation—abilities essential for preparing students to face 21st-century challenges. These cognitive processes align with the goals of heutagogy, which empowers students to manage and direct their own learning paths (Maia et al., 2023). Brookhart said designing effective HOTS questions involves asking students to make connections, explain reasoning, and consider alternatives—all of which are enhanced when students have autonomy over their learning (Zhong et al., 2022).

Previous studies have proven that the application of student-centered learning approaches has a positive impact on the development of students' cognitive and affective abilities. Heutagogy has been used to enhance students' learning motivation, collaboration, and problem-solving skills at various educational levels (Tajudin et al., 2020; Cheng & Yang, 2023). The creative problem solving learning model is a variation of problem-based learning that applies systematic steps to organize creative ideas in order to solve a problem (Oktaviana, et al, 2017)

However, most of these studies are still limited to secondary and higher education levels, and there has been little examination of the mathematics learning context in elementary schools, especially when students have diverse abilities. This gap indicates the need for further exploration regarding the effectiveness of the heutagogical approach in mathematics learning at the elementary level, especially in facing real challenges in the field. These challenges include limited resources, teachers' readiness to implement technology, and resistance to changes in teaching methods (Chaudhary, 2024). Moreover, many teachers still tend to use traditional approaches that place students as passive recipients of information (Woods & Copur-Gencturk, 2024).

In addition to the aspect of autonomy, creative thinking is also an important part of the heutagogical approach. The ability to think creatively plays an

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important role in learning, especially in the context of solving mathematical problems. In this model, the learning process begins with presenting real-life problems whose solutions require collaboration (Vahlia & Agustina, 2016).

According to Tanjung et al. (2022), creative thinking encompasses several indicators such as fluency, flexibility, elaboration, and originality, all of which are important to develop early in primary education. The heutagogical approach provides space for students to hone these abilities through the freedom to determine strategies, explore alternative solutions, and dare to try unconventional approaches in solving mathematical tasks (Tanjung et al., 2022). Additionally, the student-centered learning approach has also been proven to enhance collaborative skills and problem-solving abilities. Cheng and Yang (2023) emphasize that this strategy allows students to exchange ideas, work in teams, and build a deeper understanding of the learning material. Thus, heutagogy not only supports individual learning but also encourages social interaction and cooperation as part of meaningful learning (Cheng & Yang, 2023).

Based on the aforementioned issues, the solution proposed in this research is to implement a heutagogical approach in mathematics learning for elementary school students with diverse abilities. This approach aims to enhance students' learning autonomy, self-confidence, and creative thinking abilities through self-directed learning processes. The objective of this research is to analyze the outcomes of implementing the heutagogical approach in elementary school mathematics education, particularly for students with diverse abilities. This research is expected to contribute to the development of learning practices that support student autonomy and creativity, as well as serve as a reference for teachers in designing responsive and inclusive learning strategies.

Research Methods

This study uses a qualitative method with a descriptive approach, and a case study design was chosen to deeply examine the process and outcomes of mathematics learning based on the heutagogy approach among elementary school students. The research was conducted at SDN 010 Tanjungpinang Timur with 30 sixth-grade students as subjects, who had varying levels of mathematical ability. The main focus is directed towards students with high, moderate, and low creative thinking abilities. This research aims to describe how students respond to mathematics learning through the heutagogy approach, as well as how they solve problems based on the classification of those creative thinking abilities.

Data collection was carried out using several techniques, namely written tests, interviews, and questionnaires. The main instrument used is problem-solving-based HOTS questions designed to reveal students' creative thinking abilities in the context of mathematics. HOTS questions that require analysis, evaluation, and synthesis encourage students not just to answer, but also to trace the thinking processes they use. This is in line with the opinion of Zohar and Dori (2003) who state that higher-order thinking is closely related to metacognitive skills, as both involve conscious decision-making during the thinking process (Alanazi et al., 2024). The questions are structured in the form of narrative stimulus, as shown in the Table 1 below.

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Table 1. HOTS Question Instrument

Stimulus	Question
Mr. Farmer has several materials available to make a fence around the fish pond. The materials are material A measuring 11 meters, material B measuring 20 meters, material C measuring 32 meters, and material D measuring 16 meters. Mr. Farmer wants to make a fence for the fish pond in the shape of a semicircle, with a distance of 1 meter between the fish pond and the fence. The diameter of the fish pond is 5 meters.	Help Mr. Farmer choose the material to be used for making the fence (only one material) and, Explain your reason for choosing the material and the remaining amount of that material!

The case of "Pak Tani" who has to choose materials to make a semicircular fish pond fence, considering the length of the materials and the geometric shape of the pond. This test aims to see the extent to which students can integrate conceptual knowledge and creative thinking skills in solving contextual problems. In addition, interviews were conducted with the class teacher to identify the initial classification of students' abilities based on observations during the learning process. Interviews and follow-up questionnaires were also conducted with the students after they completed the test to delve deeper into the strategies and thought processes they used.

In analyzing the data, the researchers used qualitative descriptive analysis techniques referring to the problem-solving stages according to Polya, namely understanding the problem, planning the solution, executing the plan, and reviewing the obtained solution (Astutiani et al., 2019). The results of the tests and interviews were analyzed based on indicators of creative thinking abilities such as fluency, flexibility, elaboration, and originality. The indicators of creative thinking ability are as follows in the table below, based on the opinion of Tanjung et al. (2022) in Table 2.

Table 2. Creative Thinking Ability (Tanjung et al., 2022)

Type of Creative Thinking	Ability Measured Indicators
Fluency	1. Asking questions about a problem. 2. Smoothly articulating ideas for solving a problem.
Fleksibilitas	3. Providing different perspectives on a problem. 4. Offering differing opinions during the discussion process.
Elaborasi	5. Presenting opinions with new ideas. 6. Thinking of various new ways and working to solve them.
Originality	7. Taking detailed steps in solving a problem. 8. Trying to test the details in determining the direction to be taken.

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The assessment of the indicators is conducted by the class teacher who has accompanied the students throughout the learning process and has an understanding of each student's characteristics. The teacher uses a scoring guideline with a range of 1 to 3. A score of 1 is given if the student shows a low or inadequate response to the indicator; a score of 2 if the response is considered sufficient or moderate, although not fully detailed; and a score of 3 if the response shows a high level, with a complete, relevant, and creative explanation. Each student is assessed based on eight indicators, so the maximum score is 24. The classification of creative thinking abilities is determined based on the average obtained by the students. All the data collected is reduced, categorized, and interpreted to draw conclusions about the effectiveness of the learning approach applied to students with varying abilities. Flexibility and elaboration are not only signs of creativity but also key aspects of independent learning, as they enable students to modify strategies and deepen their understanding (De Boer et al., 2018). Creativity involves fluency, flexibility, originality, and elaboration, reflecting one's ability to generate and enrich ideas. It is associated with divergent thinking, which allows for broader and more varied responses, rather than convergent thinking that seeks a single solution. Furthermore, creative individuals are generally intelligent, although high intelligence does not guarantee creativity (Rofi'ah et al., 2023)

Conclusion and Suggestion

The researcher has conducted written tests, interviews with teachers, and asked students to fill out questionnaires and answer several questions regarding problem-solving conducted with 30 sixth-grade students at SD Negeri 010 Tanjungpinang Timur. The test, which consisted of HOTS questions about the circumference of a circle, was administered to the students in the form of essay questions or what can be referred to as stimulus-response questions. After the students completed it, the researcher collected the students' answer sheets and graded them using the answer key prepared by the researcher. Student Test Resultsas shown in the Table 3 below.

Table 3. Student Test Results

Sample	Result
1 Student	Student Answered, Material Correct, and Method Correct
11 Students	Students Answered, Material Correct, and Method Incorrect
16 Students	Students Answered, Material Incorrect, and Method Incorrect
2 Studens	Students Did Not Answer or Did Not Complete

Based on the table above, a comprehensive overview of the test results obtained. Out of the 30 students who took the test, only 1 student managed to solve all the problems correctly. Meanwhile, the other 29 students did not provide answers that fully met expectations. Of that number, 11 students gave correct answers, but they did not meet the criteria set by the researcher. Additionally, there are 2 students who did not provide any answers at all or did not complete the given problems. Next, the researcher asked the teacher to fill out a form containing an assessment of the students' creative thinking abilities, to differentiate their skill levels based on the problem-solving results that had been conducted. The table below contains data from 6 students selected by the

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researcher. This selection includes 2 students from each category of creative thinking ability, namely high, medium, and low. The results of the assessment by the teacher regarding the creative thinking ability of the students chosen by the researcher are as follows. Student's Creative Thinking Ability shown in the Table 4 below.

Table 4. Student's Creative Thinking Ability

Creative Thinking Indicators	**Students**					
	1	2	3	4	5	6
I.1	3	3	2	2	1	1
I.2	3	3	3	2	2	2
I.3	3	3	2	3	2	2
I.4	2	2	2	3	2	1
I.5	3	3	2	2	2	1
I.6	2	3	2	2	1	1
I.7	3	3	3	2	2	2
I.8	3	2	2	2	1	1
Student Categories	**T**	**T**	**S**	**S**	**R**	**R**

Note: T: High, S: Medium, and R: Low

Based on Table 4. the analysis of students' creative thinking ability, which was measured through eight indicators (I.1–I.8), reveals noticeable variation across the six participants. Out of the total, two students were classified as having a high level of creative thinking, two were at a medium level, and the remaining two were at a low level. This distribution highlights the diversity of students' creative capacities within the group and indicates that not all learners demonstrate the same degree of originality, flexibility, and fluency in their thinking processes.

Students in the high category (Students 1 and 2) consistently obtained the highest possible score on nearly all indicators. Their responses suggest that they are able to generate multiple ideas, adapt their thinking when encountering new situations, and express their ideas with clarity and confidence. These students also showed strength in elaboration, meaning they were not only able to come up with ideas but also capable of developing and refining them into more detailed and meaningful outcomes. Such performance reflects strong potential for engaging in more complex problem-solving and creative tasks in future learning activities.

On the other hand, students in the medium category (Students 3 and 4) achieved mixed results, generally alternating between scores of 2 and 3. This pattern demonstrates that while these students possess certain creative thinking skills, their abilities are less consistent compared to those in the high category. For example, they were able to generate ideas but often struggled to develop them further, or they demonstrated flexibility but lacked fluency in presenting a variety of responses. These inconsistencies indicate that students at this level still require targeted support and practice to strengthen specific aspects of creative thinking.

Finally, students in the low category (Students 5 and 6) mostly obtained scores of 1 or 2 across the indicators. This suggests limited ability to produce original or diverse ideas, as well as difficulties in elaborating or extending their thoughts. Their performance indicates that they tend to rely on simple or conventional responses rather than exploring alternative or innovative solutions.

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This group of students may benefit from guided activities and scaffolding designed to stimulate curiosity, encourage experimentation, and gradually enhance their creative confidence.

Taken together, the findings emphasize that creative thinking ability among the students is not evenly distributed. While a few students display strong creative potential, the majority remain at the medium or low level. This implies that teaching strategies should be differentiated, providing enrichment opportunities for high-ability students while also offering structured support for those who are still developing their creative skills. The data ultimately demonstrate the importance of nurturing creativity in diverse ways to ensure that all students can progress toward higher levels of creative thinking.

Analysis of Student Problem-Solving Results Based on High Creative Thinking Categories

The following are the problem-solving results or answers of student 1 on the HOTS question in Figure. 1.

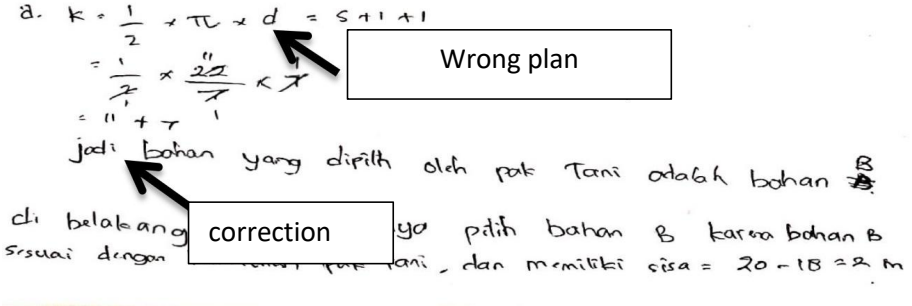

Figure 1. Student 1's answer in solving the HOTS problem

Based on Figure 1, student 1's answer to the HOTS problem shows that the student understands the given problem. The student was able to plan the solution using the correct formula, although there was an error in writing the formula for the circumference of a semicircle. When executing the plan and substituting the known values into the formula, the student did not show any misconceptions regarding the stimulus. Additionally, the student corrected the error in writing the formula for the circumference of a semicircle by adding it to the final result, indicating that the student reviewed the solution that had been made. The reasoning provided to answer the second question also aligns with the research guidelines, so it can be concluded that the student is capable of understanding the student-centered learning approach implemented by the teacher. Not only student 1 has high creative thinking skills. Here are the problem-solving results of student 2, which differ from those of student 1 on the given HOTS question in this Figure 2.

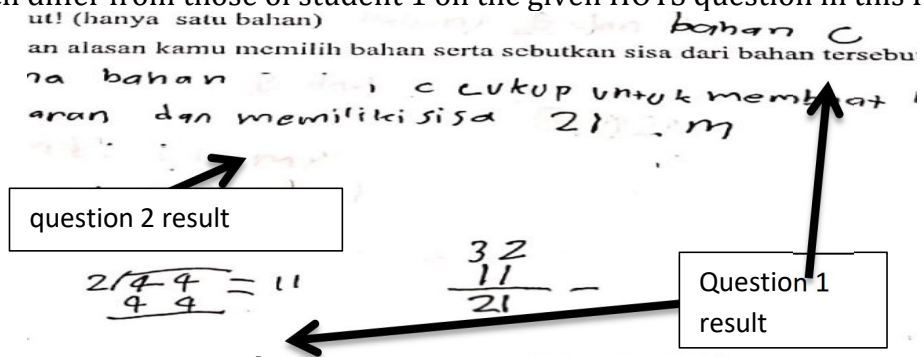

Figure 2.Student 2's answer in solving the HOTS question

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Student 2's answer, as seen in Figure 2, has a different choice of answer compared to student 1. The problem-solving results of student 2 do not show the known information written in the stimulus. However, the student wrote the same formula as student 1, allowing the student to plan in solving the problem. In carrying out the planning, the student can substitute what is known in the stimulus correctly, even though they do not write it down in an orderly manner. Although Student 2 was correct in identifying one of the "materials" that was asked. Student 2 did not recheck the problem-solving they did, thus Student 2 was not correct in solving the problem. It can be concluded that the student has a misconception about the formula for the circumference of a semicircle in the learning applied by the teacher.

Analysis of Student Problem-Solving Results Based on Moderate Creative Thinking Category. Here is Figure 3, student number 3's answer to the HOTS question categorized as moderate creative thinking.

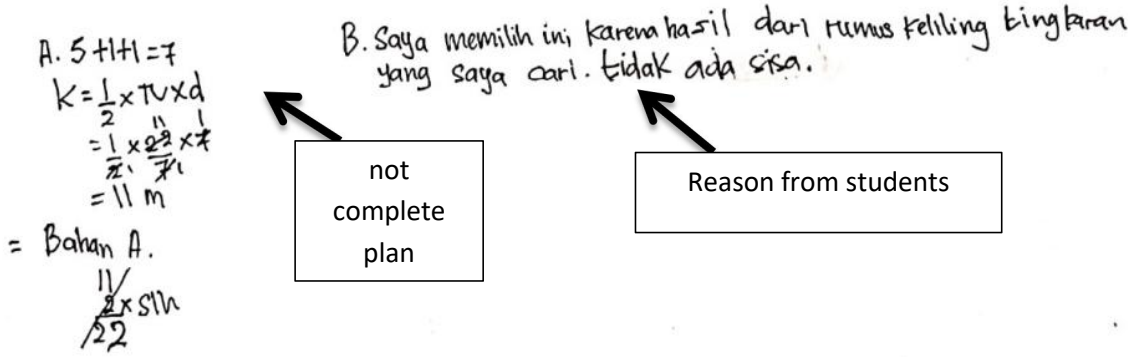

Figure 3. Student 3's Answer in Solving the HOTS Problem

Figure 3 is Student 3's answer; the student made the same mistake. The student could not accurately write the formula for the circumference of a semicircle. Although the students can recognize and understand the given stimulus. So that students understand the lessons given by the teacher, but students have misconceptions about the circumference of a semicircle. Due to that mistake, the student incorrectly determined the appropriate material. The reason given by student 3 also does not fit the criteria set by the researcher. From that mistake, it can also be stated that the student did not review the solution that had been done.
The following Fig 4. are the answers of student 4 in solving the given HOTS problem. Student 4 also has a moderate level of creative thinking.

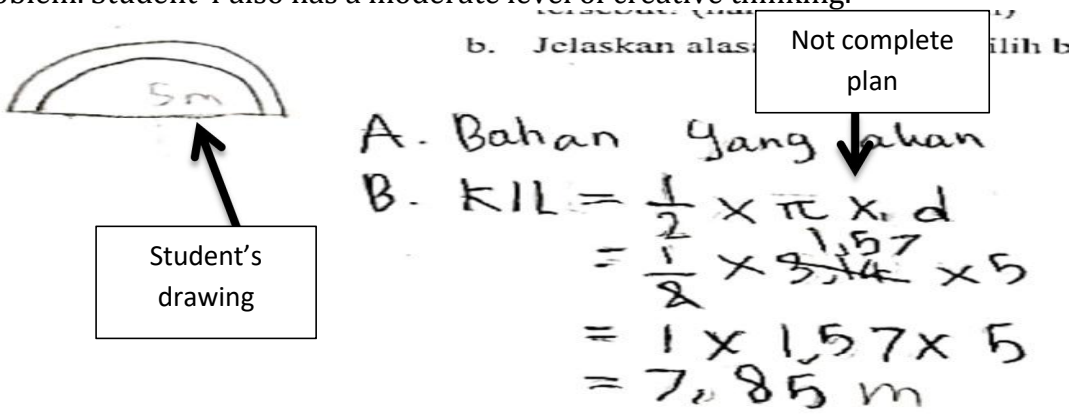

Figure 4. Student 4's answer in solving HOTS problems

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From Figure 4, it can be seen that Student 4 made the same mistake as Students 2 and 3. The student did not correctly write the formula for the circumference of a semicircle. Students also misunderstood the stimulus. Although students wrote down or even illustrated to understand the diameter from the stimulus, they could not accurately substitute the diameter into the written formula. Thus, the student can be declared unable to understand the problem correctly. Due to the mistakes made, the students incorrectly determined the appropriate materials according to the instructions in the question. Thus, the students can be indicated as not fully understanding the problem or experiencing misconceptions in the formula for the circumference of a semicircle and the concept of diameter when used in everyday life, even though student-centered learning has been implemented by the teacher.

Analysis of Student Problem-Solving Results Based on Low Creative Thinking Category. Below is Figure 5, student number 5's answer to the HOTS question categorized as low creative thinking.

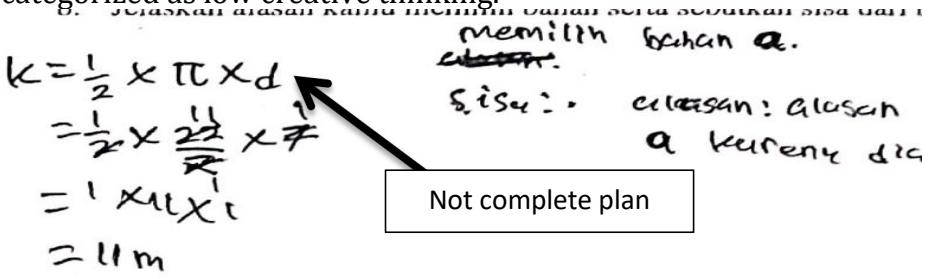

Figure 5. Student 5's answer in solving the HOTS problem

The student understood the given stimulus but incorrectly used the formula for the circumference of a semicircle. Because of the initial mistake, the student incorrectly determined the appropriate material as requested in the problem. With that mistake, the student can also be said to not have reviewed the solution that had been done. This mistake indicates a misconception related to the formula. This indicates that the students have not fully understood the student-centered learning implemented by the teacher.

Student 3, who has problem-solving results like the one above, falls into the category of low-level creative thinking. Here are the problem-solving results or answers from student 6 on the HOTS question. Student 6's answer in solving HOTS problems shown in the Figure 6 4 below.

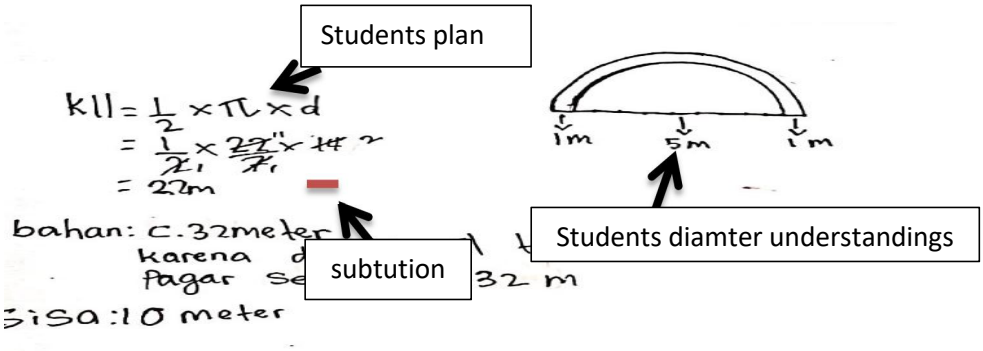

Figure 6. Student 6's answer in solving HOTS problems

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Student 6's answer can be seen in Figure 6, the student poorly understood the problem as evidenced by writing an incomplete formula. Students also cannot accurately determine what is known in the stimulus. Because the formula used is incomplete, it can be indicated that the student is unable to plan the solution correctly. Even though the execution of their plan involved correct mathematical operations, the students were still deemed incorrect in solving the problem because they experienced misconceptions at the beginning of the problem-solving process. It can be seen that the students did not realize or recheck the problem-solving they had done, even though student 6 correctly identified the appropriate materials to use.

Discussion

Analysis of six students with varying levels of creative thinking ability reveals several important findings. Students 3, 4, 5, and 6 made mistakes in writing and using the formula for the circumference of a semicircle. Students 3 and 4 fall into the moderate ability category, while students 5 and 6 fall into the low category in creative thinking. Although they are able to follow the problem-solving steps, they are not able to solve HOTS questions in depth.

Student 2, who falls into the high category, experiences misconceptions in understanding the formula for the circumference of a semicircle. However, according to the teacher, this student is considered good at explaining detailed steps. This indicates that the students' understanding is still weak because they rely too much on memorization and the teacher's examples (Oktarisa et al., 2022).

These findings differ from previous research which stated that students only failed at the verification stage (Cahya et al., 2022). In this study, five out of six students did not realize their mistakes and felt confident with their answers. This contradicts the teacher's assessment, which places them in the moderate to high category. These findings highlight a recurring issue among students—misconceptions regarding fundamental mathematical concepts, such as the semicircle circumference formula. Suwarno and Hartono (2021) emphasize that such misconceptions often stem from rote-based learning and insufficient conceptual grounding. Even with student-centered approaches, the absence of deep conceptual understanding may hinder effective problem-solving in HOTS tasks (Siregar et al., 2024).

These results indicate that the heutagogy approach or student-centered learning has not been implemented optimally. Thorough planning, appropriate learning media, and strategies tailored to the material are needed (Manulang et al., 2023). HOTS questions indeed demand high creativity, starting from understanding concepts, creating strategies, to evaluating results (Darwanto, 2019). According to Torrance, creativity is the ability to sense problems, gaps in information, or missing elements; to form ideas or hypotheses; to test these hypotheses; and to communicate the results. In this view, creativity arises as a response to obstacles or discontinuities in one's life (Wechsler et al., 2018).

Therefore, teachers need to evaluate their teaching approaches. Students should not only memorize but also need to understand concepts in depth. Interactive media can help students explore the material in a more contextual manner (Hayya', 2023). In addition, teachers can provide tiered exercises and conduct interviews or more in-depth observations to identify the causes of

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students' misconceptions. The low understanding of students is also caused by the monotonous way the teacher delivers the material. Teachers need to design more effective interventions so that students' creative thinking abilities and problem-solving skills can be improved (Wahyuni et al., 2024).

Conclusion and Recommendations

This study aims to evaluate the effectiveness of the heutagogical approach in elementary school mathematics education, particularly in fostering students' creative thinking and problem-solving skills on higher-order thinking skills (HOTS) questions. The research results indicate that the implementation of heutagogy has not been fully effective. Out of 30 students, only one student was able to correctly answer the HOTS question. Even students with high creative thinking abilities still experience misconceptions, especially in understanding the concept of the circumference of a semicircle. Moreover, most students do not review their solutions, indicating a less than optimal internalization of the problem-solving stages comprehensively.

In general, these findings indicate that the success of the heutagogical approach heavily relies on thorough lesson planning, the selection of appropriate media and methods, as well as directed guidance from teachers. Although heutagogy gives students freedom, gradual guidance is still necessary so that students can develop independence while deepening their conceptual understanding. Conceptual errors, such as the misapplication of formulas, often stem from a lack of deep understanding rather than simple calculation mistakes. Goos (2002) refers to this as metacognitive failure—when students are unaware that their approach is flawed and thus unable to self-correct (Goos, 2002).

As a suggestion, teachers are advised to design gradual and structured exercises to hone students' creative thinking skills, while also ensuring conceptual understanding, not just procedural. This study also suggests the importance of strengthening self-reflection strategies in learning, such as providing explicit space for students to review their answers. For future research, it is recommended to examine the implementation of heutagogy over a longer duration, as well as to combine it with other learning approaches (such as problem-based learning or project-based learning) to observe its impact more deeply on various cognitive aspects of students, especially in the context of elementary school mathematics.

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