



Do Goal-Free Problems with Guided Questions Affect Retention, Transfer, and Cognitive Load?

Fika Aprillia^{1*}, Endah Retnowati²

^{1*,2}Universitas Negeri Yogyakarta, Indonesia

E-mail*: fikaaprillia.2022@student.uny.ac.id

Abstract

This study aimed to examine the effects of problem presentation and guided questions on students' retention, transfer, and cognitive load. The study used a 2×2 factorial design with two factors: problem presentation (goal-free vs. goal given) and guided questions (with vs. without). The subjects consisted of 150 seventh-grade students from a public junior high school in Sleman Regency, who were randomly assigned to four experimental groups. The instruction was carried out in three phases: introduction, acquisition, and testing. Data were analyzed using two-way ANOVA at a significance level of 0.05. The results showed that problem presentation did not have a significant effect on retention and transfer but had a significant effect on cognitive load. Guided questions did not have a significant effect on any of the dependent variables. A significant interaction was found between problem presentation and guided questions on retention, transfer, and cognitive load in the retention test. Goal-given problems were more effective without guided questions for improving retention and transfer, while guided questions were more effective when combined with goal-free problems. Cognitive load on the retention test was higher for goal given problems with guided questions because goal given problems and guided questions led to means-end analysis and deep information processing.

Keywords: cognitive load; goal given; goal-free problems; guided questions; retention and transfer.



INTRODUCTION

Mathematics learning cannot be separated from the active participation of students in overcoming various challenges and problems faced, problem-solving is usually used for problems with a high level of complexity, one of which material that has high complexity is geometry (Irwansyah & Retnowati, 2019). In addition, Kemendikbudristek BSKAP (2022) states that mathematics learning aims to develop students' abilities in problem solving, applying and modifying effective strategies, and building and developing mathematical understanding through the problem-solving process. Solving mathematical problems is a basic competency in the mathematics learning process, playing a role in developing analytical thinking skills, stimulating students' critical and creative thinking, and improving other mathematical skills (Jones et al., 2015; Novita & Putra, 2016). This ability also involves the skill to relate mathematical concepts to real-world situations and apply solutions to similar problems in general (Intaros et al., 2014). Wilkerson-Jerde & Wilensky (2011) state that expertise in mathematics is not determined by the amount of knowledge that has been learned, but by students' ability to build and integrate new knowledge into previous knowledge. This means that when learning mathematics, students are expected to be able to apply the knowledge they learn in solving more complex problems. The ability to apply learned knowledge to solve new and unfamiliar problems is known as transferability (Mayer, 2002). In other words, transfer ability is included in problem-solving ability. However, transfer skills are difficult for students to master. Tanudjaya & Doorman (2020) conveyed the low percentage of students who were able to determine strategies to solve problems. Although students have been able to build mathematical models, students face difficulties in transferring this knowledge to new situations that students have never encountered before. This difficulty is thought to be caused by students' inability to integrate various information that has been learned into a single unit of knowledge that can be used effectively to solve problems.

In an effort to solve a problem, the availability of prior knowledge owned by individuals is a very important aspect. Prior knowledge refers to the knowledge or understanding that individuals already have in a particular domain before learning new material (Gupta & Zheng, 2020). Dochy et al. (1999) revealed that the development of skills in integrated problem solving is based on the knowledge that students already have. This is also related to the expertise level of students. Students who have prior knowledge or experience in learning and solving problems in a particular domain are categorized as experts, while failure in transferring knowledge is thought to be caused by a lack of knowledge that can be accessed and utilized when facing new problems, a condition often associated with the novelty of the problem (Kalyuga, 2012). The failure to transfer knowledge is thought to be caused by the learning process that does not support the formation of a knowledge schema. The limitation of the knowledge schema hinders the application of organizing principles in the problem-solving process. A lack of knowledge schema can prevent students from utilizing knowledge to solve problems (Sweller et al., 2011). Therefore, learning designs need to be developed to support the development of deeper and more adaptive knowledge schemas, so that students are able to transfer that knowledge to both familiar and new problem situations.

Based on cognitive load theory, prior knowledge reduces cognitive load, facilitates understanding, and accelerates learning. If the individual faces limited prior knowledge, the task given will become a problem that requires solving (Foster, 2021). Students with limited prior knowledge tend to have insufficient working memory capacity to construct, identify, and process complex new information, which can lead to high cognitive load when learning and solving problems, making it important to pay attention to students' prior knowledge in every learning material (Sugiman et al., 2019). Working memory capacity determines the extent to which information can be actively processed and manipulated, which ultimately affects retention ability, which is the ability to store information in long-term memory, where the information can be retained if it is considered useful or eliminated if it is considered useless (Chen et al., 2018). By considering the capacity of working memory, students who want to understand new or complex material will be helped more by learning approaches that reduce cognitive load in working memory.

Cognitive Load Theory divides cognitive load into three types: intrinsic, extraneous, and germane, which mutually affect working memory capacity, so that learning strategies are needed that can minimize extraneous cognitive load so that the process of schema formation and material understanding runs optimally (Sweller, 2010). Goal-free problems are one of the effective approaches in reducing extraneous cognitive load to improve the ability to solve problems (Ayres, 1993). The use of goal-free problems in mathematics learning has been proven effective in improving students' flexible thinking and problem-solving skills, as it encourages students to use their knowledge in various contexts and face non-routine problems (Maulidya et al., 2017). If the given problem uses goal given problems, such as the question “determine the value of x ”, then in goal-free problems it will change the question to “determine the value that you can determine as much as possible”.

Novice learners tend to choose to solve problems from behind or use means-ends analysis strategies. Sweller et al. (2011) means-ends analysis is effective for novice learners but increases cognitive load because it focuses attention on the final goal, while goal-free problems reduce cognitive load and allow free exploration, although they still require guidance to build deep understanding. One guidance technique that can be used to support students' understanding of goal-free problems is guided questions, which encourage deep thinking, cognitive engagement, and systematic monitoring of the problem-solving process (King, 1991). Bradshaw (2008) research shows guided questions have a significant effect on unstructured problem-solving. Students who received direction, guidance showed better performance in solving problems compared to students who did not receive direction, guidance. In addition, research findings Purnama & Retnowati (2020) show that the use of goal-free problems increases students' knowledge retention and transfer, and reduces cognitive load. While individual learning resulted in higher transfer scores, the use of goal-free problems still had a positive impact on collaborative learning. Although goal-free problems are effective in both individual and collaborative learning, there is no empirical evidence on their effect when combined with guided questions. This approach is thought to reduce cognitive load and help students think more systematically in solving problems. Therefore, this study aims to obtain empirical evidence on the significant effect of presenting mathematical problems with guided questions on students' retention, transfer, and cognitive load.

METHOD

Experimental design

This study uses a 2×2 factorial design with the presentation of goal-free problems (GF) vs. goal-given (GG) problems with the use of guided questions (GQ) vs. without guided questions (GQ) so that there are four treatment groups formed, namely: (1) goal-free problems with guided questions; (2) goal-free problems without guided questions; (3) goal-given with guided questions; (4) goal-given without guided questions.

Participants

A total of 150 students from 5 grades VII in one of the public junior high schools in Sleman Regency, Yogyakarta, participated in the study, as per ethics clearance B/5918/UN34.13/TU.01/2024. Students were randomized to participate in the four experimental groups designed in this study. Participants were randomized by assigning serial numbers to all participants who met the research criteria, then placing them into four experimental groups using a random number generator. This process aimed to control external variables and ensure uniformity of initial characteristics between groups, so that differences in results could be interpreted as a result of the treatment given. Details of the number of students for each group in this study are presented in Table 1.

Table 1. Experimental Group

	Goal-free problems	Goal given
With guided questions	39 (25 M, 14 F)	39 (16 M, 23 F)
Without guided questions	36 (17 M, 19 F)	36 (13 M, 23 F)
Totally	75	75

The participants in this study are students who have not learned the material of the relationship between angles formed when two parallel lines are cut by a transversal line involving auxiliary lines, classically.

Procedure

The research implementation went through three phases, namely (1) introductory phase; (2) acquisition phase; and (3) test phase. The introductory phase began with activating prior knowledge or apperception. Apperception is done by recalling the material that has been learned. In the acquisition phase, students learn to use the LKS according to the division of the experimental group. After the acquisition phase, learning is complete, continued with the test phase. The test phase, the assessment phase, by giving tests of retention ability and transfer ability, followed by self-rating in each question.

Introductory Phase

In this phase, all students start by learning the prerequisite materials listed in Table 2. These materials are given before the implementation of the acquisition phase, as a foundation of understanding that students need to master to follow the process in the acquisition phase properly.

Table 2. Prerequisite Materials

No.	Prerequisite Materials
1.	Definition and types of angles
2.	Relationships between angles (right angles, angles with a right angle, angles that are opposite)
3.	Measures of angles in a triangle
4.	Angle measures in quadrilaterals
5.	Relationship between angles due to two parallel lines cut by a transversal line

Prerequisite material aims to recall previous knowledge as a basis for building new understanding. At this stage, students review the material by solving problems about lines and angles due to two parallel lines cut by a transversal line.

Acquisition Phase

In this phase, learning is carried out in accordance with the experimental group, with the allocation of learning time being 42 minutes. Students learn to use the LKS to determine the magnitude of the angle between two parallel lines cut by a transversal using auxiliary lines.

Look at the following figure. Determine the size of all unknown angles.

Guided Questions:

1. Identify how many angles are formed between the lines above?
2. How do you determine the size of another angle if you know the size of one angle in the picture?
3. Are there any angles that are always the same size? What causes this to happen?
4. What theorem is used to determine the size of an angle?
5. Double-check to make sure your calculations are correct?

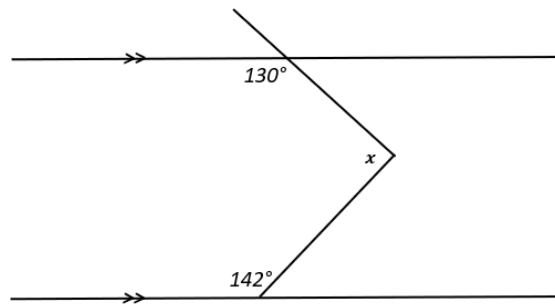
Figure 1. Example of Goal-Free Problems Worksheet with Guided Questions

Each experimental group will be given a different worksheet. The difference lies in the presentation of the problem and the use of guided questions. The figure is a goal-free problems worksheet with guided questions, while in the experimental group, the goal is given more specific questions related to the specified angle.

Test Phase

This phase is the assessment phase through retention and transfer tests. The retention test lasted for 15 minutes to measure students' ability to recall material from the acquisition phase to solve similar problems.

Look at the following figure. Determine the size of angle x .



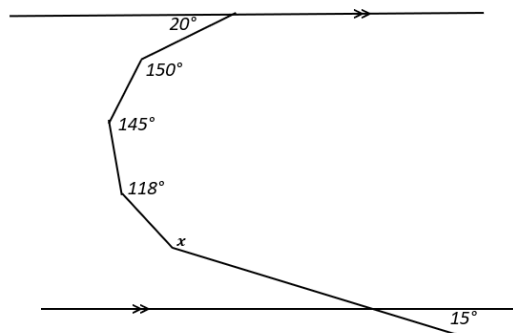
How easy or difficult is this problem to solve? (Circle your answer in the column below)

1	2	3	4	5	6	7	8	9
Very, very easy	—————▶							Very, very difficult

Figure 2. Retention Test Sample Problem

The 20-minute transfer test tests the ability to solve problems that have been modified to be more complex than previously learned problems. Another aspect assessed is cognitive load, which refers to the cognitive load of students when solving each test problem. It is measured using a scale from 1 to 9 (from very easy to very difficult), where students are asked to circle the number that reflects the difficulty level of the problem.

Look at the following figure. Determine the size of angle x .



How easy or difficult is this problem to solve? (Circle your answer in the column below)

1	2	3	4	5	6	7	8	9
Very, very easy	—————▶							Very, very difficult

Figure 3. Sample Transfer Test Questions

Validity and Reliability

The validity of the instrument was obtained through expert judgment from expert lecturers at Yogyakarta State University and revised accordingly. Validation in this study refers to content validity. According to Allen & Yen (1979), there are two main aspects of content validity, namely face validity and logical validity. Face validity is obtained from examining the format of the instrument, while logical validity is obtained from examining the instrument items and their relevance to the indicators used to measure a particular aspect. The instrument used to measure students' retention and transfer abilities consists of essay questions. Retention test questions have a structure similar to those studied during the learning phase. Transfer test questions have a different structure and bear no resemblance to those studied during the learning phase. Reliability was estimated with Cronbach's Alpha. The results of the instrument reliability estimation are shown in Table 3.

Table 3. Reliability Test Results of Research Instruments

Research Instrument	Cronbach's Alpha Coefficient
Retention Ability	0.825
Transfer Ability	0.795
Cognitive Load Retention Test	0.836
Transfer Test Cognitive Load	0.789

The assessment scale used in this study consisted of two types. In the retention and transfer ability tests, a scoring scale with three categories was used, namely: a score of 0 for answers that were completely wrong or inappropriate, a score of 0.5 for answers that were partially correct but incomplete or still contained errors, and a score of 1 for answers that were completely correct according to the criteria. Meanwhile, the cognitive load measurement scale in the retention and transfer tests uses self-rating questions with a Likert scale, which has been used by several researchers, such as Leppink et al., (2013) & Paas, (1992) with a scale of 1 (very, very easy) to 9 (very, very difficult). Based on these results, the test instrument in this study is considered reliable enough to be used.

Data Analysis

Data analysis used Two-Way ANOVA to test the main effect of each independent variable and interaction effect, followed by a simple effect test using an independent sample t-test. Hypothesis testing uses a significance level of 0.05.

RESULTS

Retention and Transfer

The assessment of retention, transfer ability is based on test scores. Descriptively, when viewed from the mean value of the retention test, students who learn with the presentation of goal-free problems are higher ($M = 1.296$; $SD = 0.708$) than students who learn with a goal given ($M = 1.193$; $SD = 0.805$). when viewed from the mean value of the transfer test, students who learn with goal-free problem presentation are higher ($M = 0.289$; $SD = 0.385$) than students who learn with goal-free problems with guided questions ($M = 0.280$; $SD = 0.452$).

The results of the main effect analysis on retention ability show that there is no significant effect between the presentation of goal-free problems and goal-given problems, as presented in Table 4.

Table 4. Main Effect Results of Problem Presentation Factors on Retention Ability

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Retention ability	3	147	0,547	3,469	0,461	0,004

Similarly, in the transfer ability test, there was no significant effect between the presentation of goal-free problems and goal-given problems. The results of the main effect analysis on transfer ability are presented in Table 5.

Table 5. Results of the Main Effects of Problem Presentation Factors on Transfer Ability

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Transfer ability	3	147	0,001	0,167	0,970	0,000

Cognitive Load

Descriptively, when viewed from the mean value of the cognitive load of the retention test, students who learn with goal-free problems experience lower cognitive load ($M = 4.675$; $SD = 1.938$) than students who learn with a goal given ($M = 6.391$; $SD = 1.898$). Likewise, when viewed from the mean value of the cognitive load transfer test, students who learn with goal-free problems experience lower cognitive load ($M = 6.487$; $SD = 1.781$) than students who learn with a goal given ($M = 7.636$; $SD = 1.605$).

The results of the main effect analysis on the cognitive load retention test are presented in Table 6, which shows that there is a significant effect between the presentation of goal-free problems and goal-given problems.

Table 6. Main Effect Results of the Cognitive Load Retention Test

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Cognitive load retention test	3	147	30,790	3,469	0,000	0,173

The analysis continued to further tests, the average cognitive load test retention score of students who studied with goal-free problems ($M = 4.67$; $SD = 1.938$). While the average of students who learn with goal given problems ($M = 6.39$; $SD = 1.898$). This means that the cognitive load of the retention test of students who learn with a goal given is 1.72 times higher.

The results of the main effect analysis on the cognitive load transfer test presented in Table 7 show that there is a significant effect between the presentation of goal-free problems and goal-given problems.

Table 7. Main Effect Results of the Cognitive Load Transfer Test

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Cognitive load transfer test	3	147	16,940	2,852	0,000	0,103

The analysis continued to further tests, the average cognitive load transfer test scores of students who learned with goal-free problems ($M = 6.49$; $SD = 1.781$). While the average of students who learn with goal given problems ($M = 7.64$; $SD = 1.605$). This means that the cognitive load of the transfer test of students who learn with a goal given is 1.15 times higher.

Interaction Effect between Problem Presentation and Guided Questions on Retention, Transfer, and Cognitive Load of Retention Tests

The analysis results show that there is an interaction effect between problem presentation and guided questions on retention, transfer, and cognitive load of the retention test. The interaction effect values between problem presentation and guided questions on retention ability are presented in Table 8.

Table 8. Results of the Interaction Effect of Problem Presentation and Guided Questions

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Retention ability	3	147	13,05	3,469	0,000	0,082

These results indicate that 8.2% of the difference in retention ability is due to the interaction between problem presentation and guided questions. The figure shows the interaction effect between problem presentation and guided questions on retention ability.

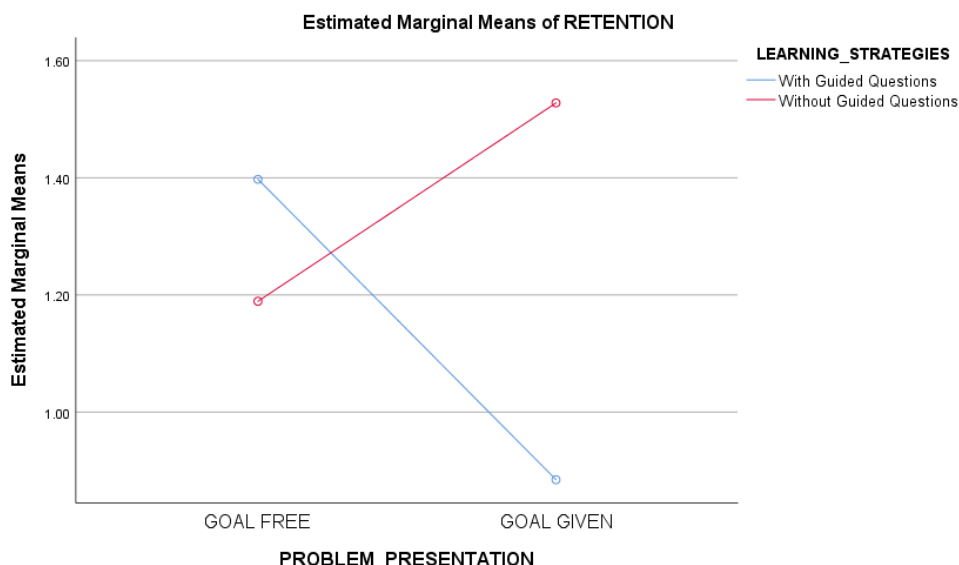


Figure 4. Plot of the interaction effect between the problem presentation factor and guided questions on Retention Ability

The figure shows the interaction effect between problem presentation and guided questions. The effect of guided questions differs depending on the type of problem presentation. The average retention is higher without guided questions on the goal given, but the presentation of goal-free problems is higher with guided questions. Thus, guided questions are more suitable for goal-free problems, while guided questions are more suitable for goal-given given.

Followed by a further test, an independent sample t-test. The results showed that when students learned using guided questions, there was a significant difference between students with goal-free problems and goal-given problems ($t = 3.090$; $p = 0.003$), where students with goal-free problems obtained higher mean scores ($M = 1.397$; $SD = 0.727$) than students with goal given ($M = 0.885$; $SD = 0.739$). Whereas students who studied without guided questions, there was a difference between students with goal-free problems and goal given ($t = -2.027$; $p = 0.046$), where students with goal given obtained higher mean scores ($M = 1.528$; $SD = 0.746$) than students with goal-free problems ($M = 1.189$; $SD = 0.681$). In terms of transfer ability, the interaction effect between problem presentation and guided questions is presented in Table 9.

Table 9. Results of the Interaction Effect of Problem Presentation and Guided Questions

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Transfer ability	3	147	8,141	0,167	0,005	0,052

These results indicate that 5.2% of the difference in transfer ability is due to the interaction between problem presentation and guided questions. The figure shows the interaction effect between problem presentation and guided questions on transfer ability.

Figure 5 shows the interaction effect between problem presentation and guided questions. The average transfer ability is higher without guided questions on goal given, and the use of guided questions is higher on goal-free problems. Thus, guided questions are more appropriate for goal-free problems, while no guided questions are more appropriate for a goal given.

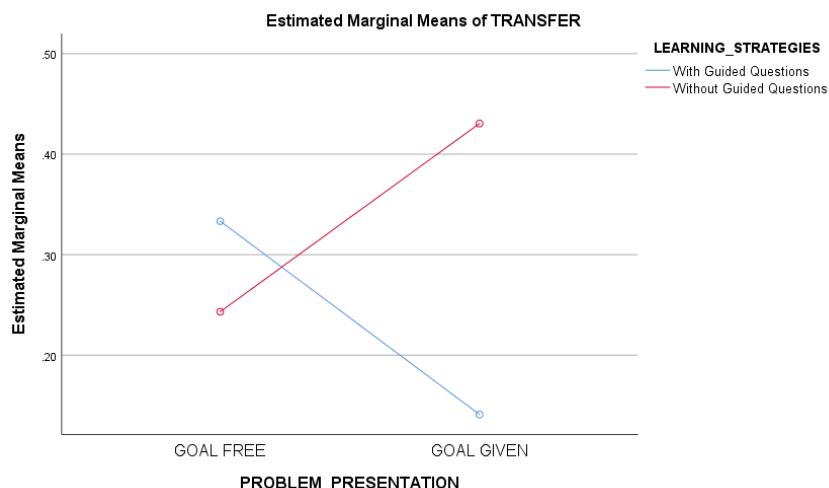


Figure 5. Plot of the Interaction Effect Between the Problem Presentation Factor and Guided Questions on Transferability

Followed by a further test, an independent sample t-test. The results showed that when students learned using guided questions, there was a significant difference between students with goal-free problems and goal-given problems ($t=2.449$; $p=0.017$), where students with goal-free problems obtained higher mean scores ($M=0.333$; $SD=0.419$) than students with goal given ($M=0.141$; $SD=0.255$). Whereas students who studied without guided questions, there was no difference between students with goal-free problems and goal-given problems ($t=-1.719$; $p=0.090$).

In the cognitive load retention test, the interaction effect values between problem presentation and guided questions are presented in Table 10.

Table 10. Results of the Interaction Effect of Problem Presentation and Guided Questions

	<i>df1</i>	<i>df2</i>	<i>F</i>	<i>MSE</i>	<i>p</i>	<i>Partial eta-sq</i>
Cognitive load retention test	3	147	9,114	3,469	0,003	0,058

These results indicate that 5.8% of the difference in cognitive load of the retention test is due to the interaction between problem presentation and guided questions. The figure shows the interaction effect between problem presentation and guided questions on the cognitive load of the retention test.

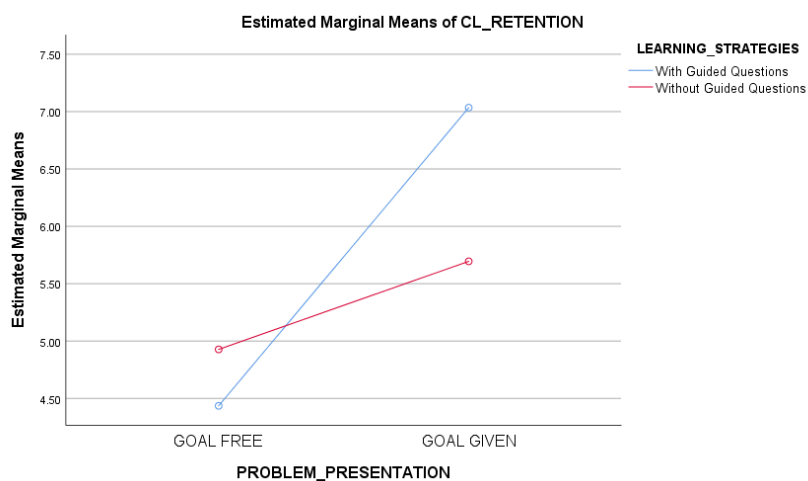


Figure 6. Plot of the Interaction Effect Between the Problem Presentation Factor and Guided Questions On Cognitive Load of Retention Test

Figure 6 shows the interaction effect between problem presentation and guided questions. The average cognitive load score of the retention test with goal-given presentation is higher with guided questions. Whereas when using the presentation of goal-free problems, the cognitive load of the retention test is higher without guided questions.

Followed by a further test, an independent sample t-test. The results of the analysis showed that when students learned using guided questions, there was a significant difference between students with goal-free problems and goal given ($t=-6.488$; $p=0.000$), where students with goal-free problems obtained higher mean scores ($M=1.397$; $SD=0.727$) than students with a goal given ($M=0.885$; $SD=0.739$). While students who studied without guided questions, there was no difference between students with goal-free problems and goal-given problems ($t=-1.674$; $p=0.099$).

DISCUSSION

The results showed that there was no significant effect of presenting goal-free problems and goal-given problems on retention and transfer skills. Although the average value of retention and transfer ability on the presentation of goal-free problems is higher than goal given. The presentation of the problem does not have a significant effect because goal-free problems and goal-given given have advantages and disadvantages that can interact with learning elements such as element interactivity and means-end analysis problem-solving strategies. Goal-free problems are more effective than goal-given given because they can reduce unnecessary cognitive load. Without a clear end goal, students can focus more on understanding the relationships in the problem, rather than simply finding answers (Sweller et al., 2011). However, presenting a goal-free problem increases the interactivity element because students have to determine all the unknown angles. High element interactivity can increase intrinsic cognitive load, which is beneficial if students have an adequate initial schema (F. Paas & Ayres, 2014). Conversely, if the schema is underdeveloped, students may experience excessive extraneous cognitive load, hindering retention and transfer (Sweller et al., 2019). The goal given provides a specific end question; students tend to use a means-end analysis-based learning strategy (Kirschner & Merrienboer, 2008). The means-end analysis strategy helps students solve problems by comparing the initial and goal conditions and then determining the steps needed. However, excessive focus on procedures can increase cognitive load and hinder concept understanding (Sweller et al., 2011). On the other hand, the looking back process in means-end analysis also involves an element of interactivity, as students have to connect new information with existing information. Retention and transfer skills did not show a significant effect between the presentation of goal-free problems and goal given. This is thought to be due to the high interactivity element in the problem, which causes unintentional difficulties, because students have to connect many elements, such as concepts, procedures, and additional information (Chen et al., 2018). The presentation of goal-free problems and goal-given problems indirectly causes high element interactivity, which actually burdens students' working memory. As a result, information transfer to long-term memory is disrupted and impacts retention and transfer abilities. Although designed with different purposes, both risk increasing cognitive load and inhibiting knowledge schema formation.

This study shows that there is a significant effect of presenting goal-free problems and goal-given problems on the cognitive load of the retention test and the cognitive load of the transfer test. In goal-free problems, the unrepresented end goal gives students freedom of thought and encourages the development of problem-solving strategies independently, so that the focus is more on understanding the concept rather than simply reaching the final answer (Sweller et al., 2011). In addition, goal-free problems facilitate students to solve problems flexibly and improve problem-solving skills, including their implications in classroom learning (Maulidya et al., 2017). Specific goals, as in a goal given, tend to limit students' strategies and increase cognitive load. In contrast, non-specific goals in goal-free problems encourage schema formation and concept generalization, thus improving learning outcomes with lower cognitive load (Purnama & Retnowati, 2020; Wirth et al., 2009). Purnama & Retnowati's research (2020) conveyed that students who learn with goal-free problems achieve higher scores in retention and transfer tests with lower cognitive load.

The results showed that there was an interaction between problem presentation with guided questions on retention, transfer, and cognitive load of the retention test. When the test was continued in

the independent sample t-tests, the presentation of goal-free problems did not have a significant effect, either with guided questions or without guided questions. The presentation of goal-free problems gives students problems without specific goals, so that students can develop their own understanding. Although it gives freedom of exploration, its effect on retention and transfer in this study is limited, presumably because it is difficult for students to understand the core of the problem without a clear goal. Guided questions serve as a tool that provides additional direction, allowing students to break down complex problems into smaller steps that are easier to understand and manage (Zumbach et al., 2020). However, in this study, the difference between the groups with and without guided questions on the presentation of goal-free problems was not significant, indicating that guided questions were not strong enough to influence students' retention and transfer, so empirical evidence of the effect of guided questions in the context of presenting goal-free problems is still needed.

The results showed that the presentation of goal given problems without guided questions was superior to the strategy of presenting goal given problems using guided questions. Providing specific instructions facilitates students in organizing and focusing attention on the steps needed to achieve the goal (Sweller & Levine, 1982). In addition, students can directly connect information relevant to the goal and store it in their working memory more efficiently (Wirth et al., 2009). Providing guided questions in the presentation of goal given problems increases students' cognitive load. Guided questions aim to provide additional guidance that can assist students in understanding the steps to achieve the goal (King, 1991). However, the presence of this additional instruction forces students to divide their attention between the existing goal and the guided questions. This can cause overload in working memory, which in turn reduces students' ability to store information in long-term memory (Cowan, 2009). The presentation of goal given problems without guided questions gives students a clearer focus on the steps that need to be taken to solve the problem. A clear explanation of the desired goal allows students to easily connect new information with the knowledge that students already have, thus facilitating the transfer of knowledge to other contexts (Meguerdichian et al., 2016).

Ge & Lands (2003) research suggests that guided questions are effective in helping students direct their attention to the important things in the problem being studied, even if there is no explicit goal. In contrast, when guided questions are used, although the goal is to help students think more deeply, they add cognitive load because students have to divide their attention between processing objectives and additional instructions, which can reduce the effectiveness of knowledge transfer to a broader context (Merriënboer & Sweller, 2005). The researcher suggested the use of guided questions should be used in the presentation of goal-free problems, non-specific questions make students have to find out for themselves the relationship between various elements of information while trying to understand relevant concepts, by using guided questions students can more easily integrate information from guided questions because students' attention is not divided, but rather directed directly to important elements relevant to the learning objectives. However, further research is needed to provide empirical evidence regarding the effect of guided questions in the context of presenting goal-free problems.

CONCLUSION

The presentation of goal-free problems is more effective when accompanied by guided questions, as this combination supports comprehension and reduces cognitive load. Guided questions are more effective when applied in the context of goal-free problem presentation, as they can provide clearer direction and enhance students' understanding even without predetermined goals. In contrast, goal-given presentation is more effective without guided questions in improving students' retention and transfer skills, because the presentation of goal-given problems has already provided a clearer focus and facilitated students in directly connecting information. The interaction between these two variables shows the importance of matching the learning strategy with the type of problem presentation used.

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Statement : publication of this article
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Interest
Additional : Additional information is available for this paper.
Information

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