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How Goal Free Problems Affect for Students with Learning Experiences?

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ABSTRACT: This brief research aims to see whether there are significant changes in higher order thinking skills and cognitive load of students who have learning experiences, before and after being exposed to the goal free problems approach. This quasi-experimental research used the One-Group Pre-test Post-Test Design which carried out through four phases: prior knowledge activation phase; pre-test phase; acquisition phase and post-test phase. There were 33 students (average age 19.27 years) who were actively involved. A valid standardized essay test with Cronbach's alpha = 0.669 was used to collect higher order thinking skills data, while cognitive load used a 9-point Likert scale which already valid and reliable due to adopted from previous expert research. The results confirmed the hypothesis where: 1) There is a significant difference (p = 0.00) between the average higher order thinking skills of students before learning through the goal free problems approach ($\bar{X} = 45.14, SE = 4.12$) and the average higher order thinking skills of students after learning through the goal free problems approach ($\bar{X} = 61.52, SE = 4.03$); and 2) There is a significant difference (p = 0.00) between the average cognitive load of students before learning through the goal free problems approach ($\bar{X} = 8.44, SE = 0.13$) and the average cognitive load of students after learning through the goal free problems ($\bar{X} = 4.65, SE = 0.34$). This research concluded that the goal free problems approach is effective in improving higher order thinking skills and reducing cognitive load among students with prior mathematics learning experience. Furthermore, it was also found that goal free problems had a major effect on increasing higher order thinking skills (r = 0.64) and reducing cognitive load (r = 0.91).

Keywords: CLT, goal-free, problems.

ABSTRAK: *Penelitian singkat ini bertujuan untuk melihat apakah terdapat perubahan signifikan pada keterampilan berpikir tingkat tinggi (higher order thinking skills) dan beban kognitif (cognitive load) mahasiswa yang memiliki pengalaman belajar, sebelum dan sesudah diberikan pendekatan goal free problems. Penelitian kuasi-eksperimental ini menggunakan desain One-Group Pre-test Post-Test yang dilaksanakan melalui empat tahap: tahap aktivasi pengetahuan awal; tahap pre-test; tahap akuisisi; dan tahap post-test. Sebanyak 33 mahasiswa (rata-rata usia 19,27 tahun) secara aktif terlibat dalam penelitian ini. Instrumen tes esai baku yang valid dengan nilai Cronbach's alpha = 0,669 digunakan untuk mengumpulkan data keterampilan berpikir tingkat tinggi, sedangkan beban kognitif diukur menggunakan skala Likert 9 poin yang telah terbukti valid dan reliabel karena diadaptasi dari penelitian pakar sebelumnya. Hasil penelitian mengonfirmasi hipotesis bahwa: 1) Terdapat perbedaan yang signifikan (p=0,00) antara rata-rata keterampilan berpikir tingkat tinggi mahasiswa sebelum pembelajaran dengan pendekatan goal free problems ($\bar{X}$=45,14, SE=4,12) dan setelah* *pembelajaran dengan pendekatan tersebut ($\overline{X}$=61,52, SE=4,03); dan 2) Terdapat perbedaan yang signifikan (p=0,00) antara rata-rata beban kognitif mahasiswa sebelum pembelajaran dengan pendekatan goal free problems ($\overline{X}$=8,44, SE=0,13) dan setelahnya ($\overline{X}$=4,65, SE=0,34). Penelitian ini menyimpulkan bahwa pendekatan goal free problems efektif dalam meningkatkan keterampilan berpikir tingkat tinggi dan mengurangi beban kognitif pada mahasiswa yang memiliki pengalaman belajar matematika sebelumnya. Selain itu, ditemukan bahwa pendekatan goal free problems memberikan pengaruh besar terhadap peningkatan keterampilan berpikir tingkat tinggi (r=0,64) dan penurunan beban kognitif (r=0,91).*

Kata kunci: *CLT, goal-free, masalah.*

INTRODUCTION

Mathematics learning can be defined as a conscious effort made to facilitate students in understanding the concepts, procedures and applications of mathematics (Blegur, 2018; Retnowati, 2016). Mathematics as knowledge has its own characteristics, basically studies the results of abstraction represented in symbols and notations and consists of operations and deductive thinking patterns where the definition; axioms, or theorems are used to solve problems (Blegur & Retnowati, 2018). Therefore, learning mathematics is a cognitive activity hence, creating good mathematics learning must be based on human cognitive architecture.

One of the learning theories based on this principle is Cognitive Load Theory (CLT). This theory states that the learning process is most effective in conditions that are in harmony with human cognitive architecture. Working memory, which plays a role in facilitating students' thinking processes, has a limited capacity and duration in receiving and processing complex or new information (Miller, 1956; Peterson & Peterson, 1959). Especially for novice learners who do not have sufficient prior knowledge to recognize and process new or complex information, the working memory's ability to organize knowledge becomes increasingly low.

Considering the working memory capacity, students who will learn new or complex materials should be facilitated with learning designs that minimize cognitive load in working memory. Sweller (2010) stated that cognitive load in working memory can be caused by two sources, namely: (1) from the complexity of elements in the teaching materials (intrinsic cognitive load); (2) from the presentation of teaching materials (extraneous cognitive load). Both loads are accumulative in working memory. If the accumulation of intrinsic and extraneous cognitive load is minimized, then working memory will have the capacity for germane cognitive load, namely the capacity to think to understand the material and construct it into structured knowledge.

Goal free problems are one of the learning strategies developed by CLT by considering the principles above. Goal free problems are also known as no goal problems, a problem presentation technique that does not determine a specific end goal of the problem given (Sugiman et al., 2019; Sweller, 1988; Sweller et al., 2011). For example, in general mathematics learning, students are often asked to solve problems with the end goal being " find *x* value". The value of *x* in this case is called the specified goal. In goal free problems, students are asked to solve as

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many values as possible. In other words, students are asked to develop their own problem solving according to the information provided.

There has been some empirical studies (Ayres, 1993, 1998; Blegur, 2018a; Bobis et al., 1994; Maulida et al., 2022; Purnama & Retnowati, 2020; Sugiman et al., 2019) stating that goal-free problems are effective in facilitating novice students (students who have no experience in learning). However, there are still few studies to see the effect of goal free problems for students with learning experience. In fact, other CLT-based learning strategy studies show that students' learning experiences also influence the learning strategies used (Kalyuga, 2007; Kalyuga et al., 2001). The worked example strategy, for example, is not recommended for students with learning experience because it presents a high cognitive load. On the other hand, the problem solving and faded example strategies are highly recommended for students with learning experience.

Students' learning experiences will contribute to their prior knowledge (Plass et al., 2010; Sweller et al., 2011). Prior knowledge is the basic foundation for an effective learning process which is certainly greatly influenced by the learning approach used. According to Kalyuga (2009) effective learning approach for novice learners can be ineffective for learners who already have experience, and vice versa. Therefore, empirical research related to the effectiveness of goal free problems for students with learning experience is still very much needed. These empirical results will contribute to the development of theory: under which conditions will goal free problems be more effective to use, whether for students with or without learning experience. In addition, other factors that influence the effectiveness of goal free problems for students with prior learning experience will certainly appear in these empirical results. These results will certainly contribute to the Cognitive Load Theory development

On the other hand, learning outcomes are another important factor that must be considered. In mathematics learning, students' higher order thinking skills (HOTS) are one of the intended learning outcomes. This is because HOTS is a skill needed for solving non-routine problems (Nitko & Brookhart, 2011) which is the heart of mathematics (Bradbury, 2010; NCTM, 2000; Toumasis, 1997). HOTS is so important in daily life also because can help someone to find solutions when facing the new problems or difficult situations, to make decisions, to make predictions, and to create new ideas (Brookhart, 2010; Gulistan Mohammed Saido et al., 2015; King et al., 2010; Lewis & Smith, 1993; Saido et al., 2015; Zohar et al., 2017). The cognitive categories of analyzing, evaluating and creating in the revised Bloom's Taxonomy table by Anderson & Kratwohl (Krathwohl, 2002) can be used to measure HOTS.

In previous studies, the effectiveness of goal free problems was measured from some mathematics learning outcomes: problem solving abilities (Ayres, 1993, 1998; Sweller & Levine, 1982), transfer and reasoning abilities (Maulida et al., 2022; Purnama & Retnowati, 2020; Sugiman et al., 2019) and also higher order thinking skills (HOTS) (Blegur, 2018a). So it can be seen that there is still view research about the effectiveness of goal free problems seen from HOTS, that's why more empirical evidence is needed. Furthermore, this research is a follow-up

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reseacrh from Blegur (2018a). The distinguishes is the characteristics of the sample used. As previously mentioned, the prevoius research looked at the effectiveness of goal free problems on HOTS in students without learning experience, while in this current research, the effectiveness of on HOTS was seen in students with learning experience. Indeed, the current results will complement the previous results because it can provide an overview of how the differences in the effectiveness of goal free problems on HOTS are seen from two conditions: for students with or without learning experience. Which of course will also contribute to the development of Cognitive Load Theory as previously stated.

Based on those things above, this research is deemed necessary to be conducted because the results can contribute to the development of a learning theory. This research aims to measure the extent of the influence of the treatment (goal free problems) on higher order thinking skills (HOTS) and cognitive load of a group of students (who already have prior learning experience) before and after being given the treatment. HOTS was chosen because it is an ability needed in problem-solving activities (which is the heart of mathematics learning) while cognitive load was also measured because it is one of the factors that influences someone in learning mathematics. Therefore, this research aims to test 2 hypotheses: 1) Goal free problems are effective in improving higher order thingking skills for students with learning experience; 2) Goal free problems are effective in reducing cognitive load for students with learning experience.

RESEARCH METHOD

As previously explained, this research is a continuing research from (Blegur, 2018a) and also is part of results that has been published by Samo et al., (2024). In Blegur (2018a), the effectiveness of goal free problems seen by HOTS and cognitive load in students without learning experience, mean while in Samo et al., (2024) the effectiveness of goal free problems seen by HOTS and cognitive load in students with learning experience, same as this current reasearch. The difference is in the research design, where Samo et al., (2024) uses a control group research design, mean while this research doesn't. Therefore, this study uses the same materials and instruments, no changes were made except in the design, subject and research procedures, the differences of which will be explained below. So that the validity and reliability tests of the instruments in the current reasearch are the same as the two previous research.

Experimental Design and Subjects

The research used a naturally formed group (not placing someone randomly) as the group of the sample, therefore this is included in the type of quasi-experimental research (Creswell, 2016). This is because students are already in a certain class determined by the school, therefore randomization is carried out on behalf of the class. This research aims to measure the influence magnitude of the treatment (goal free problems) on higher order thinking skills and cognitive load of a group of students before and after being given the treatment. Therefore, One-Group Pre-test Post-Test Design (Creswell, 2016) is used. Table 1 shows a

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summary of the experimental design. This study did not choose a non-equivalent control group design because the research design had been carried out in Samo et al., (2024). The researcher wanted to try to see what kind of results would emerge if the research was conducted with a One-Group design.

Table 1. Experimental Design

Group	*Pre-test*	(*Treatment*)	*Post-Test*
Goal Free	O_1	X	O_2

There were two meetings in the even semester of 2024 involved 33 students (average age 19.27 years) in the Mathematics Education department, FKIP Nusa Cendana University Kupang, Indonesia to conducted the data. These students were selected because fit with the characteristics of the subjects included in the research population: students who are over 15 years old and have had learning experience related to the research material classically. Determining research participants with this technique is called a convenience sampling technique (Creswell, 2016). This technique is the most appropriate and possible technique to be carried out in quasi-experimental research, where this technique facilitates access and permission to participate for previously grouped samples, such as classes, organizations and family units (Creswell, 2016).

Material and Procedure

This is a continuation of previous research by Blegur (2018) and Samo et al., (2024) therefore all materials and instruments were adopted from the two research with slight adjustments according to the this research design. The central and inscribed angle are the materials used. All the materials were studied through four phases: 1) prior knowledge activation phase; 2) pre-test phase; 3) learning phase (acquisition phase), and 4) post-test phase. Figure 1 shows the target competency achievement of each phase. The time allocation for each phase is 60 minutes.

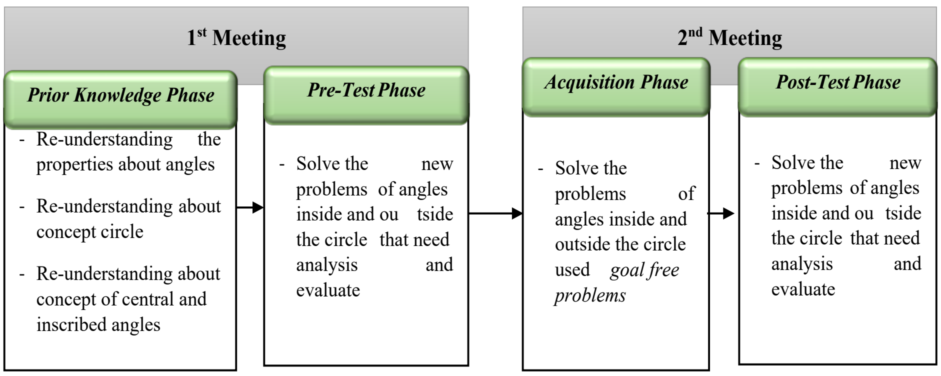

Figure 1. Learning Competences in Each Phase

In the prior knowledge activation phase, there were three basic materials that must be remembered and re-understood by students. Details of the materials

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can be seen in Table 2. In this phase students activity is trying to reunderstood all theorems by solving the problem with conventional instructions (goal specified problems) which seen in Figure 2.

Find the value of a!

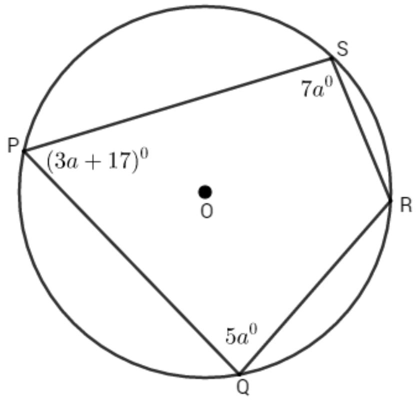

Figure 2. *Goal Specified Problem*

Table 2. Learning Materials

No.	Descripts
Angles Theorems	
1	Supplementary angles add up to 180 °
2	One complete rotation is 360^0
3	Vertically opposite angles are equal
4	The total degrees of the three angles inside the triangle is always 180°
5	Angle opposite to equal sides of an isosceles triangle are equal
6	The measure of each angle of an equilateral triangle is 60^0
7	The total degrees of the four angles inside the quadrilateral is always 360^0
Circle: definition and parts	
The Inscribed and Central Angles Theorems	
1	Inscribed angle is always one-half the measure of either the central angle or the intercepted arc sharing endpoints of the inscribed angle's sides
2	The Inscribed Angles Subtended by the Same Arc Are Equal
3	The angle inscribed by the ends of a diameter is always a right angle
4	The opposite angles in a cyclic quadrilateral are supplementary

For the learning phase (acquisition phase), student activities were learning through goal free problem. Students were faced with eight circle problems presented in the form of a booklet with the instruction to work on "determine the size of the unknown angles in the circle as much as possible", which is the characteristic of goal free problem presentation. Figure 3 is an example of the intended problem presentation. Both in the prior knowledge activation phase and the acquisition phase, students learn in groups of 2-3 people.

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Find the unknown angles as much as possible!

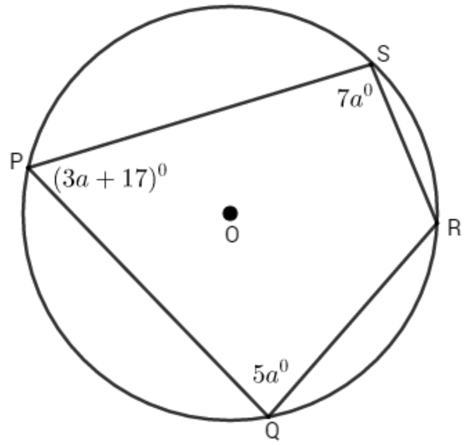
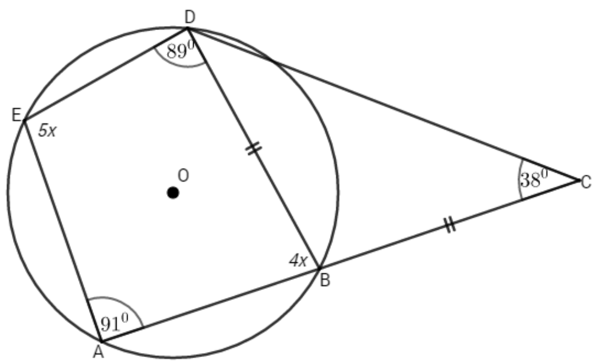


Figure 3. *Goal Free Problem*

For the test phase, there are two phases: the pre-test and post-test phases, where in both phases the students' higher order thinking skills were measured. There are 5 essay questions with Alpha Cronbrach = 0.67 that were tested individually. These questions have different characteristics and a higher level of difficulty compared to the problems studied in the learning phase. These instruments have been validated both from face falidity and logical validity by 2 experts in mathematics education field. Figure 4 is an example of a higher order thinking test item used.



Evaluate the measure of angle A, C and D!
If its not corect, find the right answer.

Figure 4. An example of HOTS test item

In this test phase, students' cognitive load was also measured. Cognitive load can be interpreted as the total amount of mental activity imposed on working memory in one unit of time (Plass et al., 2010; Sweller et al., 2011). The instrument that used to measure cognitive load a 9-point Likert scale with a range of 1 = "very-

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very easy" to 9 = "very-very difficult". This is the standar instrument and commonly uses by the expert of CLT (Sweller et al., 2011). Figure 5 shown the 9-point Likert scale. This instrument was adopted from previous research by the experts of Cognitive Load Theory (Plass et al., 2010; Retnowati et al., 2010; Sweller et al., 2011). According to Sweller et al., (2011) the 9-point Likert scale has been shown to be better and more sensitive in measuring cognitive load. The 9-point Likert scale has also been shown to have quite high reliability by Paas, van Merriënboer & Adam (Plass et al., 2010; Sweller et al., 2011). Recent research conducted by Ouwehand et al., (2021) has also proven that this 9-point Likert scale is valid and reliable for use. This likert scale is listed at the end of each question that students work on

How easy or difficult was 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 5. The 9-poin Likert scale

Data Analysis Technique

This research aims to see whether there are significant changes in the sample group before and after being treated, therefore the researcher used the dependent-means t-test (paired-samples t-test) to analyze the data. The steps for data analysis carried out: 1). Assumption test; 2) Hypothesis test. For the assumption, only the normality test must be met (Field, 2009). For the hypothesis, the research tests the hypothesis: There is a significant difference between the average (mean) of higher order thinking skills and cognitive load of students before learning through the goal free problems compared to the average (mean) of higher order thinking skills and cognitive load students after learning through the goal free problems. This hypothesis will be accepted if the significant value is less than 0.05. Furthermore, to see the magnitude of the effect of the treatment, Field (2009) explains that it can be seen from the effect size value. Effect sizes are in the range of 0-1. A value of 0 means that the treatment has no effect on the dependent variable, while a perfect effect is a picture of a value of 1. The effect size value of the dependent-means t-test is reflected in the correlation coefficient value (r). The classification of the effect size value according to Cohen, (1988, 1992) is r = 0.10 (small effect), r = 0.30 (medium effect) and r = 0.50 (large effect). The calculation formula for r in this research is as follows (Field, 2009):

$$r = \sqrt{\frac{t^2}{t^2 + df}}$$

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RESULT AND DISCUSSION

Based on the research design that has been designed, the results of data analysis are obtained to answer the assumptions. Table 3 shows the result for normality test. By using the *Kolmogorov-Smirnov* test, it was found that the data obtained are normally distributed (p > .05). Table 4 and Table 5 present the information related to the results of the data analysis obtained for each dependent variable. These results are the reference for drawing research conclusions.

Table 3. Sig. Value for Normality Test

Group/Class	*Tests of Normality*			
	p			
	HOTS		*Cognitive Load*	
	Pre-test	*Post-test*	*Pre-test*	*Post-test*
Goal Free (N=31)	0.200	0.200	0.108	0.200
Conclusion	Data is normally distributed			

Table 4. Statistic Results for HOTS

Group/Class	*Dependent-means t-test*						
	HOTS						
	Pre-test		*Post-test*		p	t	r
	$\bar{X}$	SE	$\bar{X}$	SE			
Goal Free (N=33)	45.14	4.12	61.52	4.03	0.00	-4.52	0.64
Conclusion	• There is a significant difference between the average HOTS of students before and after learning through goal free problems. • Goal free problems have a big effect on increasing students' HOTS						

Table 5. Statistic Results for Cognitive Load

Group/Class	*Dependent-means t-test*						
	Cognitive Load						
	Pre-test		*Post-test*		p	t	r
	$\bar{X}$	SE	$\bar{X}$	SE			
Goal Free (N=33)	8.44	0.13	4.65	0.34	0.00	12.25	0.91
Conclusion	• There is a significant difference between the average CL of students before and after learning through goal free problems • Goal free problems have a big effect on reducing students' CL						

Data analysis for Higher Order Thinking Skills

The results confirmed the research hypothesis where there was a significant difference between the average (mean) of students' higher order thinking skills before and after learning through the goal free problems (p = 0.00 <0.05, t (32) = -4.52, r = 0.64). The average of students' higher order thinking skills

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before learning through the goal free problems was 45.14 (SE = 4.12) increasing to 61.52 (SE = 4.03). The value of r = 0.64 means that the goal free problems have a major effect on improving students' higher order thinking skills. So, can be concluded that the average of students' higher order thinking skills has increased significantly after learning using the goal free problem compared to the average of students' higher order thinking skills before learning using the goal free problem.

Data analysis for Students Cognitive Load

The results for this variable also confirmed the research hypothesis where there was a significant difference between the average (mean) cognitive load of students before and after learning through the goal free problems. This statement is supported by the significance value of $p = 0.00 < 0.05$, with $t(32) = 12.25$ which gives a value of $r = 0.91$. The average cognitive load of students before learning through the goal free problems was 8.44 (SE = 0.13) reduced to 4.65 (SE = 0.34). The value of $r = 0.91$ means that the goal free problems have a very large effect on reducing students' cognitive load. So, it can be concluded that the average cognitive load of students decreased significantly after learning using the goal free problems.

Discussion

Different from previous studies related to goal free problems (Ayres, 1993, 1998; Blegur, 2018a; Bobis et al., 1994; Maulida et al., 2022; Purnama & Retnowati, 2020; Sugiman et al., 2019), currently study focuses on students who already have classical learning experience about the central and inscribed angle. The researcher wants to measure the extent to which the goal free problems influence students with the characteristics referred to as the dependent variables of higher order thinking skills and cognitive load.

The results show that goal free problems have a large influence on improving students' higher order thinking skills before and after treatment. This is proven by the significant increase in the average of students' higher order thinking skills before and after learning through the goal free problem. The results are support the first research hypothesis and also in line with the research conducted by Ayres (1993, 1998); Blegur (2018a); Bobis et al., (1994); Maulida et al., (2022); Purnama & Retnowati, (2020); Sugiman et al., (2019)

The significant increase in the average higher order thinking skills of students further strengthens the opinion expressed by Ayres (1993) who stated that goal free problems provide space for limited working memory in building knowledge. The instruction "find as many angles as possible ..." in goal free problems makes students work forward without connecting the final goal with the problem. Students are focused only on the known information and how to answer each problem step by step (Sweller, 2004; Sweller et al., 2011). As the result, students train to think about which properties or theorems that have been previously learned can be applied to solving problems. Students use these properties and then store all this information back in long-term memory, this

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process is called the process of knowledge acquisition and automation (Blegur et al., 2017; Retnowati, 2009). So, it is not surprising that when faced with new problems that require higher order thinking skills such as in the test phase, students can find a series of efficient solutions.

Different situation comes before learning through goal free problems. All students have had previous learning experiences, so the students have had prior knowledge. The researcher only triggered this prior knowledge through activities to remember and re-understand the materials that had been previously studied. All the materials learn through discus problem solving questions with conventional instructions (goal specified problems) like in Figure 3. However, the results showed that the average higher order thinking skills of students in the pre-test phase was low. Students were unable to construct efficient problem-solving methods when faced with more difficult questions. This is an indication that the process of building knowledge in previous learning experiences did not occur optimally (Blegur & Retnowati, 2018). Figure 6 and Figure 7 show the results of student A's work in completing one of the HOTS test item in the pre-test and post-test phases.

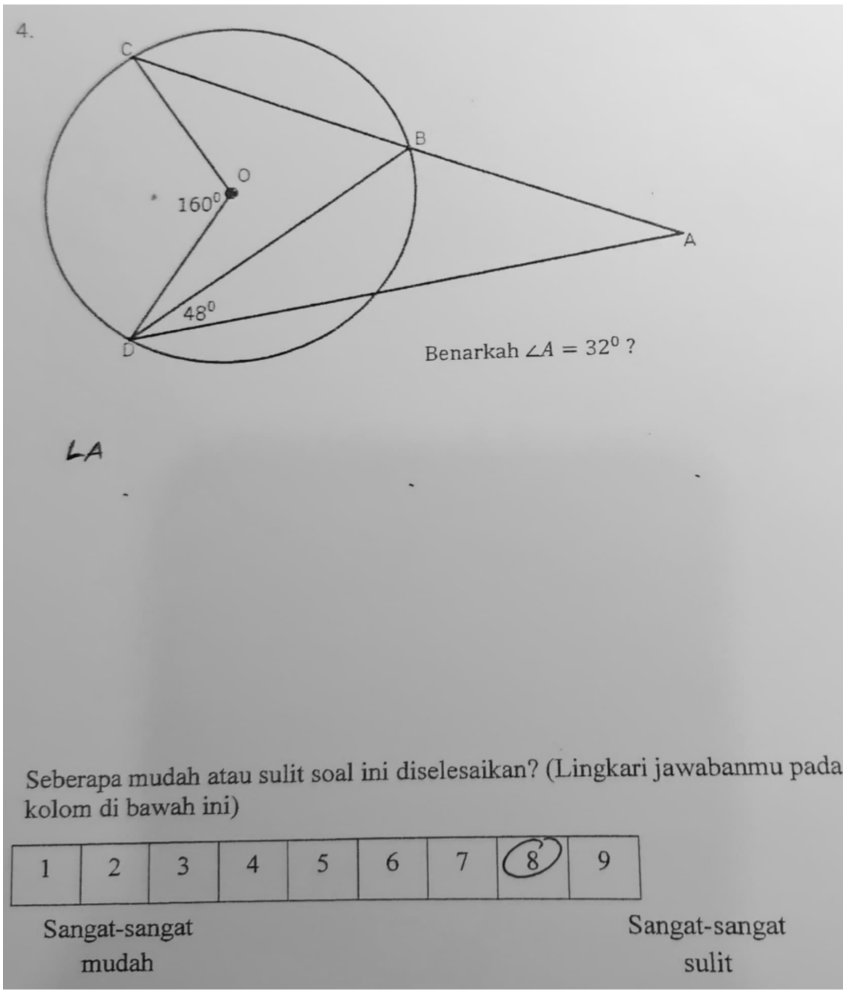

Figure 6. Student A's answer to HOTS test item no. 4 in the pre-test phase (after students learned through problem solving with conventional instructions (goal specified problems))

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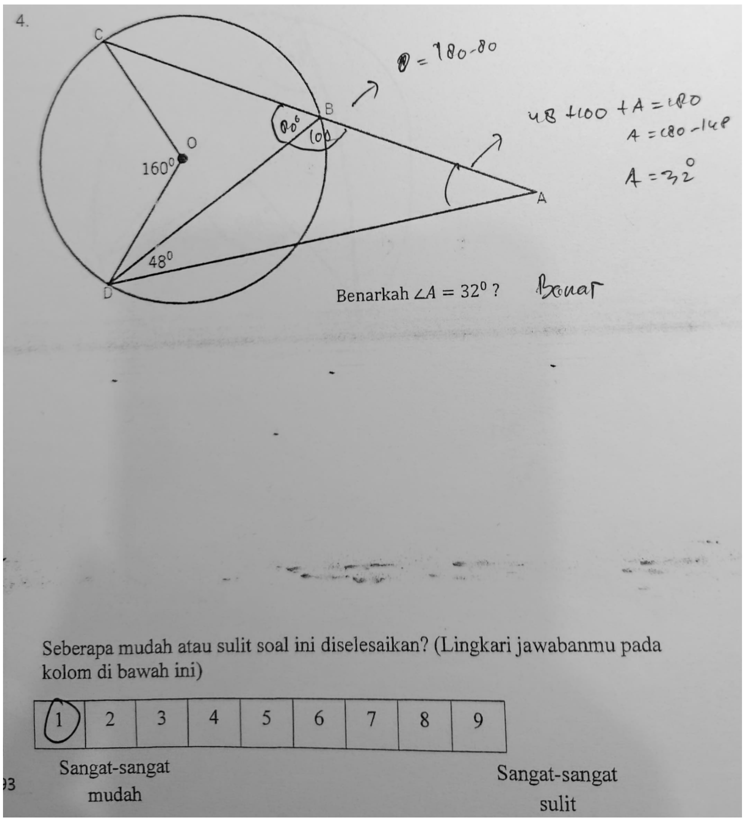

Figure 7. Student A's answer to HOTS test item no. 4 in the post-test phase (after the students learned through goal free problems)

It can be seen in Figure 6, even though students have had previous learning experiences and have been reminded of the materials in Table 2 in the prior knowledge phase, students still have difficulty solving a new problem. Students cannot determine which theorems that use to solve the existing problem. This indicates that the development of knowledge in students' long-term memory does not occur optimally. In fact, this problem can be answered by first determining the value of ∠DBC which is half of 160^0 (see Theorem C.1 in Table 2), then ∠DBA which is 180^0-∠DBC (see Theorem A.1 in Table 2), then determining the value of ∠A which is 180^0- 48^0- ∠DBA (see Theorem A.4 in Table 2) and making a conclusion.

Different situation comes after student A learned through goal free problems as seen in Figure 7. The same student was able to find a series of solutions to solve the problem. The student was able to determine which angle should be solved first using the right theorem, then the next angle to look for, what theorem to use, and so on until providing the correct final answer. This indicates that the process of knowledge acquisition and automation occurred well after learning through goal free problems.

The imperfect knowledge development experienced by student A before learning through goal free problems is thought to be caused by the Conventional instructions (goal specified) used. According to Sweller et al., (2011), goal specified

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problems will automatically guide students to use the means ends analysis strategy. Students create the solution from what is asked, determine sub-subgoals first, and finally answer the specified goal. The means ends strategy does not promote induction rules or the acquisition of certain procedural schemes for learning activities. Students will understand the induction rules if some information is added. So even though the problem can be solved, but the knowledge development process by students itself occurs ineffectively (Kalyuga, 2009)

Imperfect knowledge construction is inversely proportional to cognitive load. Students who are unable to construct knowledge well indicate that the cognitive load of students present in the students' working memory is high, and vice versa (Maulida et al., 2022). This opinion is supported by the results which found that there was a significant decrease in the average of students' cognitive load before and after learning through the goal free problem. Students who studied before using goal free problems experienced a higher cognitive load than after learning through goal free problems. The results are support the second research hypothesis and also in line with the research conducted by Ayres (1993, 1998); Blegur (2018a); Bobis et al., (1994); Maulida et al., (2022); Purnama & Retnowati, (2020); Sugiman et al., (2019)

As explained previously, the use of Conventional instructions (goal specified) is thought to be the causes. The goal specified instruction will guide students to use the means ends analysis strategy. Starting from what is asked then creating sub-subgoals and completing one by one. If subgoal 1 is successful then the work continues to subgoal 2, if not then the work process must be repeated, and so on until the final answer. Sweller (1988) describe how hard working memory works when faced with goal specified problems as shown in Figure 8. Completing existing sub-goals makes someone process information excessively (Kalyuga, 2009; Sweller, 1988, 2004). As a result, the cognitive load will present in higher condition in working memory when students learn the material. Hence, will prevent students from storing knowledge well in long-term memory. Knowledge that is not stored properly results in insufficient knowledge availability when faced with a new and more difficult problem like the final test. Students' intrinsic cognitive load become higher (Ayres, 2006), resulting the score of students higher order thinking skills test low. That’s why student A choose 8 in the 9 likert-scale shown in Figure 6.

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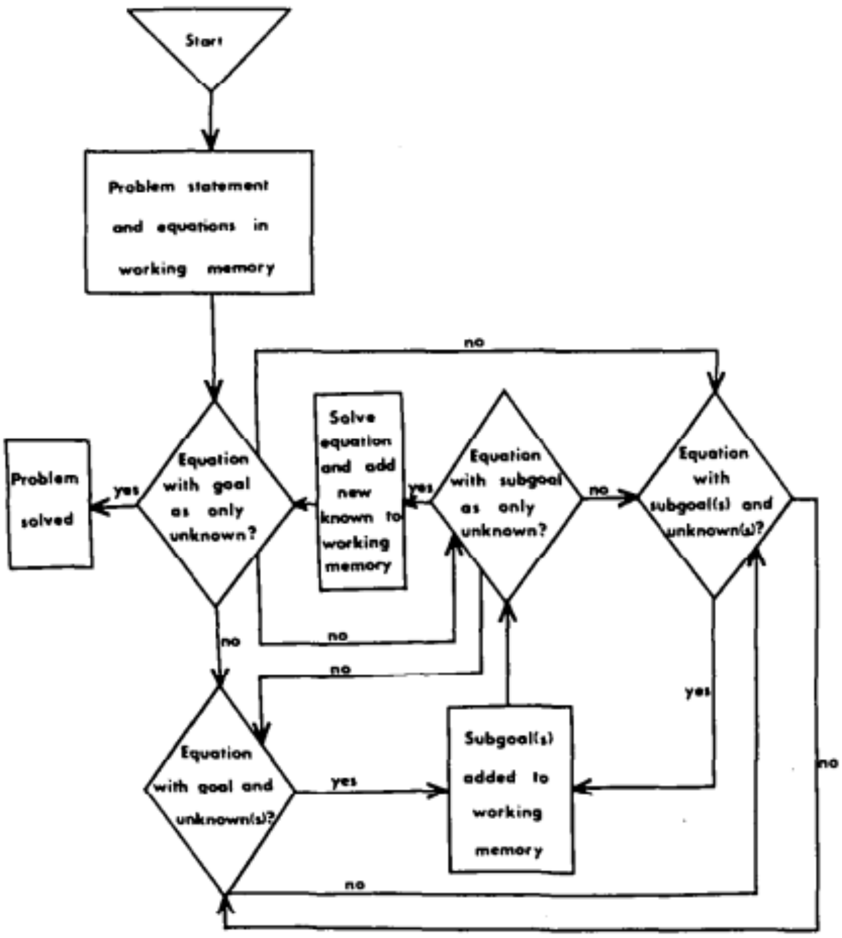

Figure 8. Flow of control under goal specified problems (Students create the solution from what is asked, determine sub-subgoals first, and finally answer the specified goal. Many students make mistakes when determining sub-subgoals makes cognitive load become higher)

On the contrary, as has been said, learning through goal-free problems trains students to work forward without connecting the final goal with the problem. Figure 9 illustrates this principle (Sweller, 1988). Students are focused only on the information they know and how to get to the final problem. This principle reduces cognitive load because the interactivity between elements of the information being processed by students decreases when solving problems (Sweller et al., 2011). Lower cognitive load makes the working memory have enough spaces to build knowledge well. As a result, when faced with more difficult problems, students can recall the knowledge and solve the existing problem. Students do not find difficult to solve the problem as depicted in Figure 7, student A who previously gave a score of 8 changed to 1 in the 9-likert scale after learning through goal-free problems.

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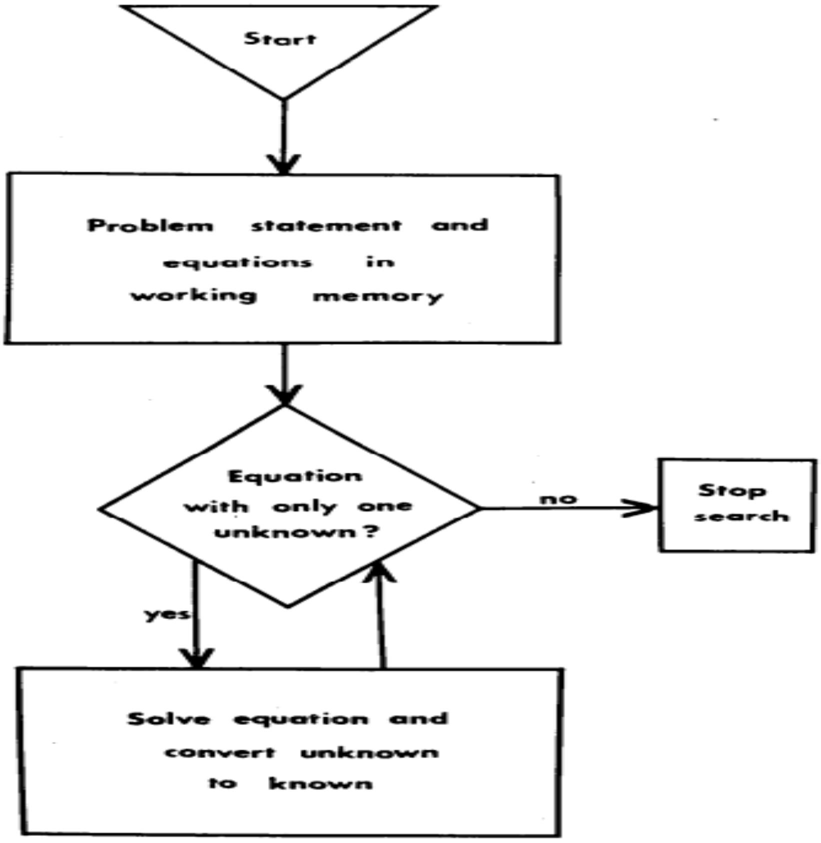

Figure 9. Flow of control under goal free problems (Students work forward without connecting the final goal with the problem. Students are focused only on the known information and how to answer each problem step by step)

This research finally concluded that Goal free problems are still effective in improving higher order thinking skills of students who have had prior learning experience about central and inscribed angles. Likewise in reducing cognitive load. This means that students' previous learning experiences related to materials do not have an effect on the effectiveness of goal free problems. Its effectiveness is the same as in students without experiences. So the researcher recommends that teachers can apply goal free problems to both situation.

Futhermore, this research uses One-Group design, where the control group as a comparison is eliminated. It maybe can be the limitations of the reasearch. Subjects has the potential to be contaminated by bias variables such as prior learning experiences. The use of the same instrument test in the pre-test and post-test also provides its own bias, where it is possible that the final test results of students obtained are due to the recalling previous questions, not learning outcomes due to treatment. However, despite all these limitations, this research is actually only a preliminary study to see how effective goal free problems are for students with learning experiences. The researcher only wants to start a study that has never been done before through a brief study with a simple research design.

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Therefore, the researcher realizes that the results of this study may or may not be followed by other researchers. The results of this study actually also improve the results of previous research by Samo et al., (2024) for the same treatment and independent variables. The only difference is in the research design where this study does not use a control group while the previous study used a control group. So actually the results of this study also provide an overview for other researchers regarding which experimental research design will provide more accurate results. Thats why further empirical research to obtain definite conclusions is still needed.

CONCLUSION

These results suggest that the use of goal free problems in the context central and inscribed angles is still much more effective for improving higher order thinking skills for students with previous learning experience compared to conventional presentation techniques (goal specified problems).This finding leads to further implementation in the classroom where teacher can use goal free problems as an alternative to improve students higher order thinking skills. Moreover, research on goal free problems using different mathematics learning materials needs to be followed up also like in geometry or algebra. Seeing the effectiveness of goal free problems with a combination of group learning strategies such as cooperative or collaborative learning is also can be the suggestion for further research.

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