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Optimization of Worked Example-Problem Solving Pair to Increase Learning Independence and Reduce Cognitive Load

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Abstract

This study aims to show what kinds of problems are able to optimize worked examples to increase student learning independence and reduce cognitive load for VIIB grade junior high school students in algebraic forms material. The data in this study were in the form of learning independence data, cognitive load, and implementation of learning obtained through questionnaires and observation sheets, as well as learning achievement data obtained with test instruments that have been tested to be valid and reliable according to experts and statistical test results. The results showed that the addition of the deep isomorphism problem type with insufficient guidance in the worked example-problem solving pair increased learning independence and reduced cognitive load, accompanied by an increase in student achievement. The increase is indicated by: (1) the average student's learning independence is in the "high" category, (2) the average cognitive load reaches the "low" category, and (3) obtained 75% of students with learning achievements that pass the minimum pass criteria, i.e. 65, and (4) implementation of learning with worked example-problem solving pair 80%. It is really recommended for the next researcher to make student worksheets as attractive as possible to avoid redundancy effect, present varied types of problems, provide guidance as clear as possible but not excessive, and serve the student worksheets to students individually.

Keywords: cognitive load, learning achievement, learning independence, worked example pair

INTRODUCTION

One of the government's efforts to create a good and effective education and learning system is to improve the quality of the curriculum continuously. Currently, Indonesia is implementing the 2013 Curriculum, which puts forward three competencies that develop the affective, cognitive, and psychomotor domains (Guntur, 2015). The three domains must be developed as a whole without being separated from one another. The affective domain is something that needs attention from the teacher. One of the affective domains that can be developed in a learning process by teachers is learning independence (Guntur & Retnawati, 2020).

According to Zumbrunn et al., (2011) learning independence is an aspect that can encourage students to regulate emotions and thoughts so that they can navigate or control their learning. Furthermore, it is also explained that learning independence is important in predicting student motivation and academic achievement. Independent learning of students can help students learn better and strengthen their ability to learn, apply good learning strategies in order to maximize their learning achievement, monitor their performance, evaluate their learning achievement and especially increase their motivation (Guntur, Setyaningrum, Retnawati, & Marsigit, 2020).

Mathematics education can develop the character of students, including independent learning (Guntur & Setyaningrum, 2021). The characteristics of independent learning include students being able to design, choose strategies, and evaluate their learning outcomes (Indarti, 2014). Based on the results of research conducted by Priyanto, (2013, p. 5) that showed students' mathematics learning achievement is influenced by students' mathematics learning independence, this is in line with Danianti's (2013, p. 9) research that showed there is a significant influence between students' mathematics learning outcomes and their learning independence. In a learning process, individuals (students) who are independent in terms of thinking must dare to make decisions in solving problems. According to Zimmerman (2022), learning independence includes aspects of motivation, metacognition, and an active attitude to learning. Students who have independent learning can be measured using a questionnaire that contains indicators of motivation, responsibility, initiative, and self-confidence.

Retnowati (2008) states that in the learning process, of course, the memory system is involved. A learning process certainly cannot be separated from thinking activities. In thinking activities themselves, there must be a cognitive load or often referred to as cognitive load. Cognitive load is the cognitive load caused by learning activities (Sweller et al., 2011). The presence of cognitive load on students does not always indicate that it is a bad thing. On the other hand, the emergence of cognitive load is also a good sign. In this case, it indicates that someone is doing a learning activity in his mind. It's just how a teacher minimizes the cognitive load of students so that the learning process can take place well and allows students to build and store new knowledge in their memory for a long time.

Cognitive load theory is a learning design theory that is used to build a learning procedure based on human cognitive structures (Paas & Sweller, 2012; Endah Retnowati, 2012). Cognitive load theory (Sweller et al., 2011) explains that cognitive load occurs as a result of the limited memory capacity of workers. Cognitive load theory distinguishes cognitive load into 3 types, namely "intrinsic load", "extraneous load", and "germane load" or effective load (Van Gog et al., 2012). Intrinsic load is related to the characteristics of learning material, the extraneous cognitive load is the impact of poor learning design, while the germane load is related to the automation process and the formation of knowledge schemas in students' memory. If the complexity of the material is high and the presentation of the material is not systematic, it will cause a very high cognitive load, thus inhibiting the germane cognitive load in schema formation. If students experience a high cognitive load (especially extraneous load), they will have difficulty accepting learning (Retnowati, 2008). Effective learning according to Sweller (2011) is learning that is able to minimize students' cognitive load, Learning that pays attention to cognitive load will have a very good effect on helping students understand and build the knowledge they learn.

Based on the results of observations and giving questionnaires to class VII B at a junior high school in Yogyakarta, Indonesia phenomena, it was found that: (1) students' learning motivation was still lacking, which was marked by students' passiveness in learning and actually doing activities that were not in line with learning activities; (2) students' responsibilities are still lacking which is marked by students not completing assignments (examples of questions) presented by the teacher in class if they are not monitored; (3) students' initiative is also still lacking, which is marked by students who are just silent or do not try to find out the information themselves when they need to solve problems; and (4) students' self-confidence is still lacking, where students are not so sure when working alone to solve problems, which in general can be said that students' learning independence is still lacking. Based on the learning independence questionnaire, it was found that the learning independence of students categorized as "high" was only 10%, while 23% of students were categorized at the "moderate" level and the remaining 67% were categorized as being at a low to the very low level.

Based on students' cognitive load questionnaire, it was found that during learning, 53% of students experienced high cognitive load and only 17% of students experienced low cognitive load. This finding shows that a lot of students not in good condition and learning activities could be disturbed. If this condition keeps going, student will feel exhausted easily and lose their motivation before they are able to achieve their learning goals. Therefore, a mathematics learning strategy is needed that can increase students' learning independence and reduce students' cognitive load in order to obtain better learning achievement as well.

Ideally, a good and effective learning activity is a learning that combines problem solving with examples. The combination of these two things is then known as a worked example learning strategy (Renkl, et al., 2002). Because, according to Grobe & Renkl (2007), learning through examples is more profitable for students than learning through problem solving because students are given the opportunity to relate each principle through the many problems presented. This opinion is in accordance with Miller (1956), who said that working memory of individuals is limited, so it appears that problem solving learning strategies cause a high cognitive load, especially for novice students, because in practice, problem solving strategies begin with the cognitive acquisition process, and partly because large working memory capacity is used to solve problems as a result in the process of forming schemas for new knowledge, there is only a small amount of working memory, which is not necessarily sufficient (Grobe & Renkl, 2007).

Anderson et al., (2001) states that basically a worked example is a problem solving that is added with an explanation or reason for the use of each step used in the problem-solving process. This opinion is in line with Grobe & Renkl (2007) who say that the difference between problem solving and worked examples is the addition of examples given explicitly before students solve similar problems or often referred to as isomorphic problems. The combination of problem solving and worked examples is called the worked example-problem solving pair.

In general, the types of problems presented in the worked example-problem solving pair consist of two, namely: 1) surface isomorphism, namely examples whose relationship to each other can be easily seen, where the examples used are examples that are in the same context and only replace the numbers in the problem, replace the sentence formulation, and of course, with the same procedure and 2) deep isomorphism, an example with the same procedure but with a different context, not just replacing numbers or sentences in the problem. As for applying isomorphic problems in worked example-problem solving pairs in class, it goes through five steps as follows: (1) apperception, which is in the form of an introduction to the problem without giving examples or solutions; (2) using examples on LKS (worked examples) to solve problems; (3) presenting problem-solving results on worksheets; (4) solving new problems without referring to examples; and (5) drawing conclusions (Pastoriko & Retnowati, 2019; Maharani et al., 2021).

Research conducted by Irwansyah & Retnowati (2019) proves that the worked example pair is effective when viewed from the standpoint of learning independence and students' cognitive load. Furthermore, Rohman & Retnowati (2018) showed that the worked example pair increased student learning independence. Nurhayati, (2017) shows that the worked example pair can reduce cognitive load in students.

Based on the discussion above, it is clear that student worksheets in the form of worked example-problem solving pairs is effective to minimize student’s cognitive load so they can study effectively and achieve their best mathematics learning achievement. Besides that, student worksheets worked example-problem solving pairs is one of the perfect options to train another important skill such as students’ independence learning skill. If this skill is successfully developed, the student could learn effectively by themselves in the future, so they will achieve success in their mathematics learning activity.

The relationship between the worked example-problem solving pair and the learning independence variable is shown in Table 1.

Table 1. The Relationship between Variables

	Worked Example-Problem Pair	Learning Independence
Cognitive load	Worked examples (surface isomorphic problem)	Motivation
		Responsibility
	Problems (surface isomorphic problem)	Initiative
		Confidence

Therefore, this study aims to increase learning independence and reduce students' cognitive load through a worked example pair strategy for class VIIB students of At a junior high school in Yogyakarta, Indonesia in the 2019/2020 school year. The worked example-problem solving pair is said to be successful if (1) it is obtained that a minimum of 75% of students get a mathematics learning achievement score that passes the minimum pass criteria (65); (2) the average student learning independence increases with an average reaching the high category; (3) the average score of students' cognitive load decreases until they reach the low category; and 4) the implementation of learning with worked examples reaches a minimum of 80%.

METHOD

The research method used is classroom action research. This research studies learning strategies carried out in cycles so that learning outcomes can be obtained that can increase learning independence and reduce students' cognitive load. The subjects of this study were 30 students of class VII B at SMP N 2 Yogyakarta in 2019/2020. The research model used is cyclical research from the Kemmis and McTaggart model (Hopkins, 2008), see Figure 1.

This model runs cyclically and stops when it has reached the success indicator. Each cycle has four stages: planning, action, observation, and reflection, so that the given worked example will continue to be carried out with the same syntax until it reaches the target of success in this research (Guntur, 2020). The instruments in this study consisted of learning tools such as lesson plans and student worksheets in the form of a worked example, a learning independence questionnaire in the form of a 5 Likert scale questionnaire totaling 36 items with 23 positive statements and 13 negative statements, a cognitive load questionnaire consisting of 9 Likert scales, and worked example-problem pair learning implementation sheets. All of the instrument used in this study have been tested to be valid and reliable according to experts and statistics.

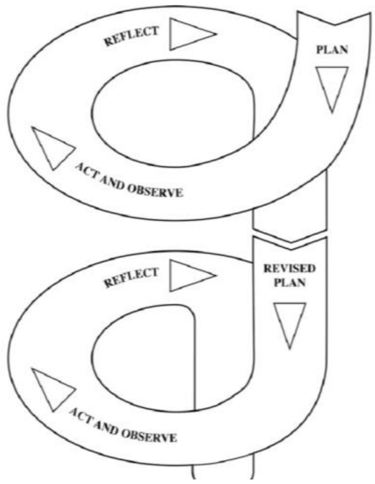

Figure 1. Kemmis & Taggart Spi Spiral Design (Hopkins, 2008)

The data analysis used in this study are:

1. Analysis of learning independence questionnaire data.

Learning independence has four indicators, as follows: motivation, responsibility, initiative, and confidence. The worked example-problem solving pair can be said to be successful in improving students' learning independence when the average of students' learning independence is in the high category. The data analysis technique in the questionnaire was obtained quantitatively by giving a Likert scale score of 1-5 for each answer. Then, the data is converted into qualitative data with a conversion score assessment table using the criteria from Azwar (2016, p. 148) as shows in Table 2.

Table 2. Criteria for Independent Learning Questionnaire

Quantitative Score Interval	Quantitative Score Interval	Category
$x \geq Mi + 1{,}5\ Sd_i$	$x \geq 144$	Very high
$M_i + 0.5\ Sd_i < x < Mi + 1{,}5\ Sd_i$	$120 < x < 144$	High
$M_i - 0.5\ Sd_i < x \leq Mi + 1{,}5\ Sd_i$	$96 < x \leq 120$	Moderate
$M_i - 0.5\ Sd_i < x \leq Mi + 1{,}5\ Sd_i$	$72 < x \leq 96$	Low
$x < Mi - 1{,}5\ Sd_i$	$x \leq 72$	Verry low

Information: $\overline{M}$ = actual average; $\overline{M_i}$ = ideal mean; Sd_i = ideal standard deviation

2. Data analysis of cognitive load questionnaire results

Worked example-problem solving pair can be said to be successful in reducing students' cognitive load when the average of students' cognitive load is in the low category. The data on the cognitive load questionnaire with a Likert scale of 1-9 indicates the higher the students choose the number, the higher the cognitive load of the students. From the 9 selected scales for each question, the average for each student was then averaged for each student to be grouped into 3 cognitive load levels, namely, low, moderate, and high.

Table 3. Cognitive Load Questionnaire Criteria

Interval	Category
$9 \geq x > 5$	High
$x = 5$	Moderate
$1 \leq x < 5$	Low

3. Analysis of learning achievement test results

If 75% of students get learning achievement scores minimum pass criteria = 65, then the worked example-problem solving pair can be said to be successful. The results of the learning achievement test were obtained quantitatively through a learning achievement test on algebraic forms material with sub-test 1: introduction to the concept of algebraic forms and sub-test 2: operations on algebra. The test results are calculated and determined as a percentage of the number of students who pass the minimum pass criteria is 65 with the following formula:

Pass Percentage = (Number of students who passed the minimum pass criteria /Total number of students) × 100%

4. Analysis of observational data

Learning with a worked example-problem solving pair must be carried out at least 80%. The technique of data analysis on the observation sheet is by giving a score of implementation on each aspect that is observed. If these aspects are carried out, a score of 1 is given. Otherwise, a score of 0 is shown.

RESULTS AND DISCUSSION

This research lasted for two cycles, with each cycle consisting of three learning meetings. Cycles I and II were each carried out with a duration of 7 × 40 minutes, with 2 × 40 minutes used for learning achievement tests in cycles I and II. In both cycles, the researcher acted as the executor of the action and the teacher as an observer. In addition, the two cycles were carried out with the syntax for implementing the worked example-problem solving pair strategy. In the implementation, each cycle is carried out with a learning achievement test, a learning independence questionnaire, and a cognitive load at the end of the lesson to determine its achievement.

Cycle I

The planning stage of cycle i begins by making lesson plans for learning algebraic forms materials in accordance with the implementation steps of the worked example-problem solving pair, student worksheets, which contains examples and surface isomorphic problems type, students' mathematics learning achievement test kits, learning independence questionnaires, and students' cognitive load and learning implementation observation sheets. The implementation and observation phase of the first cycle consisted of 2 meetings with a time allocation of 2 × 40 minutes at the first meeting and 3 × 40 minutes at the second meeting. Learning is carried out by the lesson plans that have been prepared, which begin with a greeting, praying, checking student attendance, motivating, preparing students to learn by distributing student worksheets , then apperception and learning objectives are conveyed orally or in writing through student worksheets , providing opportunities for students to learn and work on examples on student worksheets independently, choosing students randomly to present the results of the discussion, which includes question and answer activities, students are asked to work on questions independently without referring the worked example, helping students make conclusions, and closing the lesson.

Based on the questionnaire results, the student's mathematics learning achievement test, and the observation of the implementation of learning in class vii b, information was obtained as shown in Table 4.

At the reflection stage, it was found that, based on the results of the questionnaire, students' learning independence increased to a moderate category from the previous low category. If viewed from each aspect of learning independence, it appears that the responsibility aspect has increased to a high category, but other aspects still need to be improved because it is still in the medium category. The previously high cognitive load can be reduced to a low category. In cycle one, there were 40% of students who did not pass the minimum pass criteria, with the implementation of learning by 80%. Based on the table, it appears that learning independence and learning achievement still do not meet the indicators of success. Here are the things that must be improved from Cycle I:

1. The presentation of student worksheets is still considered unattractive by students,

   "… look at the student worksheets, my head hurts just by looking at that…" (student 14)

   "… i don't really like the color …" (student 6)

2. The examples presented are too many,

   "I think the questions is too long for me, it takes time to read that" (student 9)

   "The number of problems makes me anxious, haha…" (student 16)

3. Because all the examples and questions given are surface isomorphic problems, the context of the questions presented feels monotonous and boring.

   "… to be honest, I feel like the question is kind of boring…" (student 1)

   "I think I have already mastered this kind of problem. Is that it?" (student 22)

Table 4. Measurement Results in Cycle I

Variable	Initial Condition	End of Cycle I
Independent learning	Low = 91.1	Moderat = 105.7
■ Motivation	Low = 25.65	Moderat = 28.35
■ Confidence	Low = 26.35	Moderat = 27.05
■ Responsibility	Low = 20.05	High = 26.95
■ Initiative	Low = 19.05	Moderat = 23.35
Cognitive load	High = 5.7	Low = 4.2
Learning achievement	-	Complete = 18 (60%) Incomplete = 12 (40%) Average = 69.7
Learning implementation	Teacher activities = 86% Student activities = 80%	

4. In some examples, the guidance given in one question seems repetitive and has the potential to cause a cognitive load due to the redundancy effect.

   "… Sir, this is the same information right?" (student 1)

5. Surface isomorphic problems provide contexts and solutions that are almost exactly the same, so that students are less familiar with other contexts and lack confidence when faced with new contexts.

   "… I can not really understand when working on a new problem" (student 28)

6. Surface isomorphic problems with guidance that is too detailed and too indulgent for students cause students to lack the initiative to think independently.

   "I think just learning the worked example is enough. I don't need to work on the problem…" (student 24)

7. There are still missed learning steps due to a lack of time management.

The impact of deficiencies during the first cycle on each aspect of the independence of learning mathematics is presented in Table 5.

Based on several field notes, corrective steps were taken for each stage of the implementation of cycle II. The suggestions for improvement include the following: 1) Improve the design of student worksheets; 2) Improve time management so that no learning steps are missed; 3) Reduce the number of questions presented; 4) Adding another type of problem, namely the deep isomorphic problem so that the problems presented are more varied both in terms of the level of difficulty and the context of the problem. With deep isomorphic problems, students will take the initiative to find as much information as possible from the previous example to solve problems in new contexts; 5) Make guidance that is not excessive to avoid redundancy effects.

Table 5. Reflection on the Application of Surface Isomorphic Problems

Reflection Aspect	Reflection Aspect
Things that need to be fixed	
Motivation	- The student worksheets used was judged by the students to be less attractive. - Too many examples are given, - The use of Surface isomorphic problems causes the variety of problems presented to be monotonous, as well as the same solution and tends to be accompanied by overly repetitive guidance which has the potential to cause a cognitive load for students because of the redundancy effect.
Confidence	Surface isomorphic problems make students lack the vocabulary of the problem context, thus making students hesitant and less confident when dealing with new contexts that are less familiar.
Initiative	The surface isomorphic problem is too detailed, so students don't have a question in their mind because everything has been answered by example, thus making students' initiative in learning less because they seem too pampered.
Things that need to be maintained	
Responsibility	By Giving the worksheet that contain examples and problems to each student makes all students feel responsible to solve the problems given.

Based on the results of reflection, it is necessary to carry out learning in cycle II so that researchers can improve things that become deficiencies during cycle I. Students' cognitive load can be minimized and students' learning independence can be increased, which consists of four aspects, namely motivation, self-confidence, initiative, and responsibility, accompanied by increased student achievement.

Cycle II

The teaching and learning process in Cycle II was carried out exactly the same as in Cycle I, which was accompanied by improvements made according to the reflection results of Cycle I. The results of the final reflection of Cycle II also showed that the learning carried out in Cycle II had proceeded as planned. In cycle II, all achievement indicators have been met, so at this stage, Classroom Action Research is discontinued because the problems have been resolved.

1. Implemented worked example-problem pair using surface and deep isomorphic problems

The implementation of this strategy was measured using an observation sheet carried out during Cycles I and II. It was found that the overall quality of learning from Cycle I to Cycle II, both from teacher activities and student activities increased from 86% and 80% to 100% and 90%, respectively. The percentage of learning implementation in cycles I and II has also met the predetermined indicators (80%). The implementation of learning in cycle I for teacher activities and student activities is in the "high" category. The implementation of learning in cycle II for teacher and student activities is in the very high category.

2. Student Learning Independence

Based on Cycle II result, it is shown that student learn independence is higher than the initial condition and Cycle I. This can be one of the proofs that the worked example-problem solving pair with deep isomorphic addition can optimize student's learning independence. This finding is consistent with the findings of Mufidah (2019), Irwansyah & Retnowati (2019), and Rohman & Retnowati (2018) who found that the worked example pair is effective to increase student learning independence.

The results of the mathematical disposition questionnaire data can be seen in the Figure 2. Based on the diagram, it can be seen that the average score of student learning independence continues to increase, with the average score was 91.1 in the "low" category, 105.7 in the "medium" category, and 122.7 in the "high" category. In Cycle II, out of 30 students, there were 16 (53.3%) students in the "moderate" category, 10 (30%) students in the "high" category, and 4 (16.7%) students in the "very high" category. If it is reviewed in more detail on each aspect of learning independence, looking at all aspects, all aspects of independence are categorized as "high" categories as shown in Table 6.

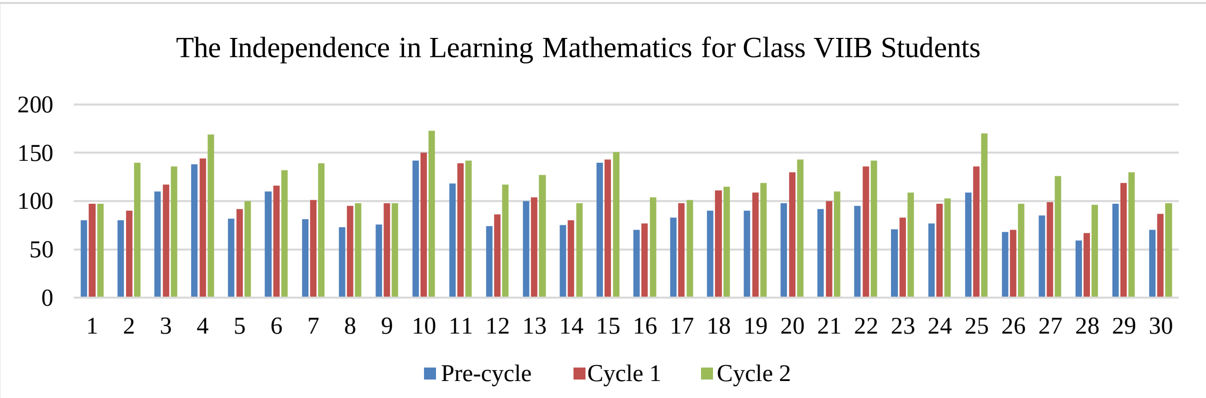

Figure 2. Diagram of Student Learning Independence Questionnaire Results

Table 6. Cycle II Learning Implementation Results

Variable	Initial Condition	End of Cycle I	End of Cycle II
Independent learning	Low = 91.1	Moderat = 105.7	High = 122.7
■ Motivation	Low = 25.65	Moderat = 28.35	High = 34
■ Confidence	Low = 26.35	Moderat = 27.05	High = 33.65
■ Responsibility	Low = 20.05	High = 26.95	High = 28.05
■ Initiative	Low = 19.05	Moderat = 23.35	High = 27
Cognitive load	High = 5.7	Low = 4.2	Low = 3.4
Learning achievement	-	Complete = 18 (60%) Incomplete = 12 (40%) Average = 69.7	Complete = 23 (77%) Incomplete = 7 (23%) Average = 78.5
Learning Implementation	-	Teacher Activities = 86% Student Activities = 80%	Teacher Activity = 100% Student Activity = 90%

It appears that all components of learning independence, consisting of motivation, self-confidence, responsibility, and initiative have all succeeded in increasing to the "high" category. The addition of deep isomorphic problems is one step that plays a major role in increasing student learning independence in Cycle II, because by providing various isomorphic examples in the form of surface and deep isomorphic problems, students can manage their cognitive load and motivation to learn the material through worked example. Sweller et al. (2011) revealed that revealed that giving an example followed by a problem aims to motivate students to learn the worked example because students can know that they will be able to solve a similar problem (isomorphic) immediately after learning the example.

If students have met various examples of various contexts (deep isomorphic problems), it will make students familiar with various solving procedures and make them more confident when dealing with new problems. Because deep isomorphic problems offer problems with multiple contexts, of course, accompanied by various guidance (provided that the guidance provided is not excessive), it will build students' initiative to think independently in obtaining the information needed by studying previous examples to solve new problems that they are familiar with (Irwansyah & Retnowati, 2019).

In addition, according to Mufidah, (2019), giving problems independently fosters a sense of responsibility for students to try to solve problems as much as possible. It is proven that the worked example-problem solving pair, with the addition of a deep isomorphic problem accompanied by guidance that is not excessive, succeeded in increasing student learning independence to the "high" category and fulfilled one of the indicators of research success.

3. Student Cognitive Load

Based on the result of Cycle II, it is shown that student learning independence is higher than in the initial condition and Cycle I. This can be one of the proofs that a worked example-problem solving pair with deep isomorphic addition can minimize students’ cognitive load. This result is in line with the results of researches conducted by Asrafil et al. (2020); Irwansyah & Retnowati (2019); and Nurhayati (2017). It showed that the worked example-problem solving pairs were effective at reducing students’ cognitive load in their learning activity.

The results of the student's cognitive load data can be seen in the Figure 3.

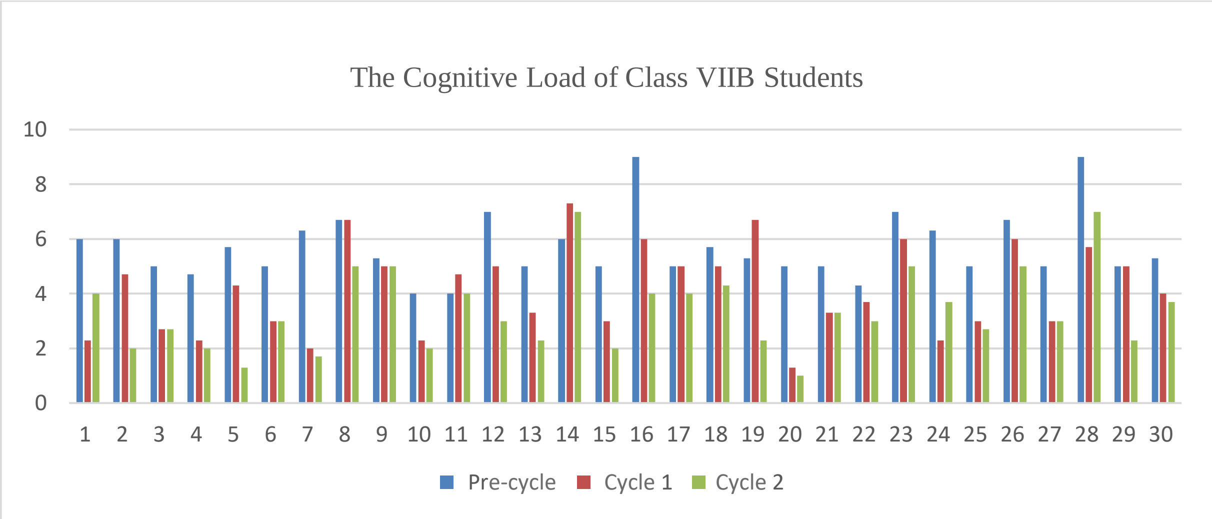

Figure 3. Students' Cognitive Load

The diagram in Figure 3 shows that the cognitive load score continued to decline until the second cycle, with the mean scores respectively are 5.7 which was categorized as "high", 4.2 which was categorized as "low", and 3.4 which was categorized as "low". This shows that the worked example-problem solving pair was able to reduce students' cognitive load to the "low" category since the first cycle and even lower in the second cycle. Out of 30 students, in the first and second cycles, there were respectively 24 (80%) students are in the "low" category, 4 (13%) students are categorized as "medium", and 2 (7%) students are categorized as "high". So, it can be concluded that the worked example-problem solving pair with the addition of a deep isomorphic problem accompanied by guidance that is not excessive, succeeded in reducing students' cognitive load to the "low" category and fulfilled one of the indicators of the success of this study.

4. Student Achievement

Based on Cycle II result, it is shown that student learn independence is higher than Cycle I. This can be one of the proofs that the worked example-problem solving pair with deep isomorphic addition effective to help students achieve better learning achievement. This result is in line with the results of researches conducted by Asrafil (2020).

The results of the student's cognitive load achievements can be seen in the Figure 4.

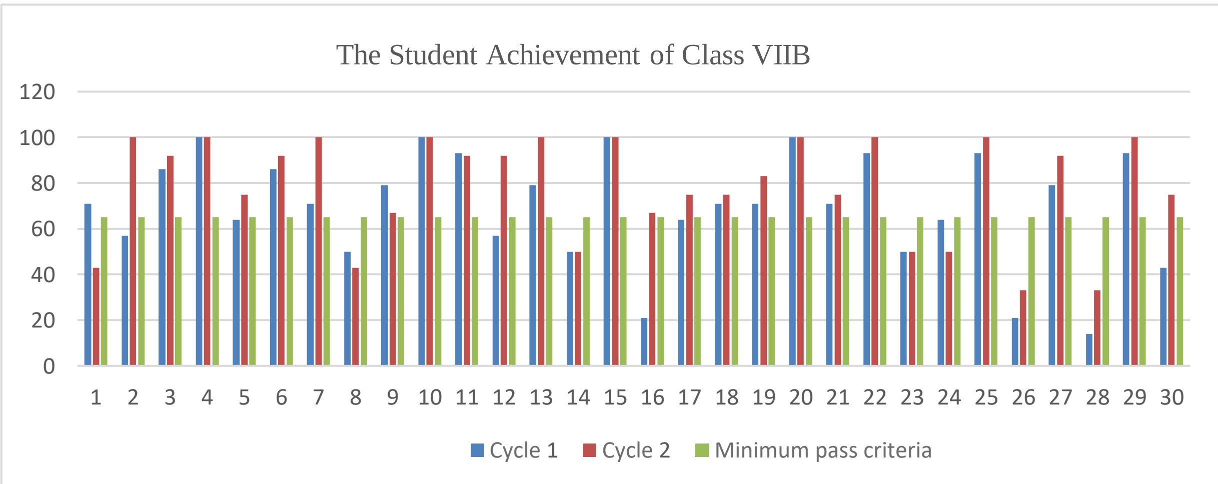

Figure 4. The Diagram of Learning Achievement Results

Based on the diagram above, it is clear that student learning achievement continues to increase up to Cycle II, with the mean scores of 69.7 and 78.5, respectively. So, it can be seen that the worked example-problem solving pair was able to improve student achievement. In the first cycle, out of 30 students, there were 12 students (40%) who did not pass the minimum pass criteria (65), while in the second cycle, there were seven students (23%) who did not pass the minimum pass criteria (65). So, it can be said that the worked example-problem solving pair with the addition of a deep isomorphic problem accompanied by guidance that is not excessive, succeeded in increasing student learning achievement, which was marked by 77% (> 75%) of students passing the minimum pass criteria (65) and fulfills one of the indicators of the success of this research. The Table 6 shows the details of changes to the dependent variable.

Based on Table 6, it appears that all achievement indicators in this study have been fulfilled so that the repetition of the cycle can be stopped, which means that the worked example-problem solving pair can increase students' learning independence and reduce students' cognitive load, which is followed by an increase in student achievement. The rise of students' learning achievement is in line with the high of students' learning independence and the low of students' cognitive load, so we can conclude that students' learning independence and cognitive load are two of the main factors to maximize student learning achievement. This statement is in line with Danianti (2013); Irwansyah & Retnowati (2019) an ; E. Retnowati (2012).

CONCLUSION

The worked example-problem solving pair can increase students' learning independence and reduce students' cognitive load, which is followed by an increase in student achievement in class VII B At a junior high school in Yogyakarta, Indonesia in the 2019-2020 academic year on algebraic forms material with the following considerations. first, student worksheets must be made as attractive as possible. second, avoid the redundancy effect. third, the types of problems presented must be varied. It is not enough to only use the isomorphic surface problem, but also combine it with the deep isomorphic problem. Fourth, the guidance provided must be as clear as possible but not excessive. Fifth, worked example-problem solving pairs are given to students to work on individually.

The improvement is evidenced by: (1) obtaining a minimum of 77% of students getting a score of mathematics learning achievement passing the minimum pass criteria (65), (2) the average student learning independence increased to reach the high category, (3) the average score of students' cognitive load decreased to reach the low category, and (4) the implementation of learning with worked examples pairs is more than 80%. I hope that there will be other research aimed at optimization of worked example-problem solving pair to increase learning independence and reduce cognitive load on other materials or other educational levels.

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