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Research Article

The Use of Chunking Technique Combined with the Writing Is Thinking Technique to Control Students' Cognitive Load When Learning About the Human Reproductive System

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Abstract.

Cognitive load is related to working memory capacity, which affects the cognitive processing system. This study aimed to control the cognitive load of students by using chunking techniques combined with the writing is thinking technique when learning about the human reproductive system. The research was conducted at a senior high school in Tasikmalaya City during the 2020/2021 academic year. 56 research subjects were divided into two groups - the experimental group and the control group. The research method used was quasi-experimental with a post-test-only control group design. Measurement of students' cognitive load included intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL), which was measured using an instrument in the form of a subjective rating scale questionnaire with a scale of 1 – 8. The results showed that learning about the human reproductive system using the chunking technique combined with the writing and thinking technique obtained the average value of a student's ability to receive and process information was 38.4 (low ICL). The average value of mental effort was 32.8 (low ECL), and the average value of the cognitive load related to student learning outcomes was 73.7 (high GCL). Based on the results of statistical tests with the Mann Whitney two-mean difference test, there were significant differences in the ICL, ECL, and GCL components between the experimental group and the control group, so the use of chunking techniques combined with writing is a thinking technique that can control the cognitive load. The chunking technique combined with writing is a thinking technique that is able to optimize working memory capacity by managing pieces of information and helping students construct knowledge by rewriting the information obtained using their own language.

Keywords: chunking techniques, writing is thinking technique, human reproductive system

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1. INTRODUCTION

Learning activities involve interaction between teachers and students in the learning environment. Good learning can occur if students can process some information in working memory. This is because the learning process is related to working memory in receiving and processing information to form cognitive schemas [1]. Everyone has a limited working memory capacity, so that if students receive excess information, it will cause students to be overloaded because working memory cannot provide memory space to understand the learning material. In this condition, students are said to experience cognitive load.

Cognitive load is the demand for carrying out certain tasks that burden the cognitive processing system [2]. There are three components of cognitive load in working memory, namely intrinsic cognitive load (ICL), extraneous cognitive load (ECL) and germane cognitive load (GCL) [3]. Intrinsic cognitive load (ICL) is a cognitive load related to the complexity of the learning materials encountered or related to the received learning materials. Extraneous cognitive load (ECL) is a cognitive load that arises because of the learning design or the organization of teaching materials. Germane cognitive load (GCL) is the load in constructing cognitive schemas [4].

Biology is a scientific discipline that studies living things and their interactions with their environment, one of them is human reproductive system learning. Based on interviews with biology teachers at one of Senior High Schools in Tasikmalaya City, the material for the human reproductive system includes complex material for students. This can be seen based on the results of the average test scores of the previous year, only 46% of the 35 students who scored above the KKM. Based on these data, it shows that there are still many students who get a low average test score, which means that students have difficulty in learning. Some students also expressed the difficulties faced in studying the human reproductive system, including too many concepts that must be memorized such as the parts of the organs and their functions and the mechanism processes that occur such as gametogenesis, fertilization and menstruation. The difficulties experienced by students cause students to not be able to process information properly so that it affects student learning outcomes.

The limitations of students in receiving, processing and remembering information is by arranging the stimulus into a sequence of pieces of information, namely the chunking technique [6]. The chunking technique is a process in which information is divided into smaller pieces to make it easier to remember and understand which aims to enable students to increase their working memory capacity [5]. If students are able to overcome

working memory, students need to construct their knowledge in order to understand learning well, namely by writing and thinking. Writing is thinking when students write about a subject it can require students to think, thinking is what teachers want students to do [7]. So the chunking technique combined with writing is thinking is a learning strategy where information is divided into several meaningful pieces then students rewrite the information using simple language so that it can be easily remembered and understood in cognitive processing.

Based on the explanation, the problem can be formulated as "How is the cognitive load of students in learning the human reproductive system using chunking techniques combined with writing is thinking?". The formulation of the problem which is detailed into research questions, namely how is the intrinsic cognitive load, extraneous cognitive load, and germane cognitive load of students in learning the human reproductive system using chunking techniques combined with writing is thinking?

2. RESEARCH METHOD

The research used is a quasi-experimental with a posttest only control group design. The research subjects in this study involved students of class XI MIPA in the academic year 2020/2021 with a total of 56 students consisting of 28 students in the experimental group and 28 in the control group using purposive sampling technique.

TABLE 1: Research design post-test only control group design.

Group	Treatment	Posttest
Experiment	X_1	O
Control	X_2	O

Source: [8]

Description:

X_1 : learning using chunking technique combined with writing is thinking

X_2 : conventional learning

O : measurement of cognitive load (intrinsic cognitive load, extraneous cognitive load, germane cognitive load)

The learning was carried out during two meetings, the first meeting discussed the structure and function of male reproduction and the second meeting discussed the structure and function of female reproduction. Facilitated learning steps by WhatsApp Group, YouTube and Google Form. Chunking technique learning strategy is carried out by the teacher while the writing is thinking activity is carried out by the students.

The following are the learning steps for the experimental group 1) the teacher provides learning material through learning videos from the material chapter into sub-materials, from sub-materials into material concepts 2) after the teacher delivers the material, students rewrite the information they get using their own words 3) students connect between information with other information obtained. While the control group learning steps 1) the teacher provides the entire learning material through learning videos 2) students work on the Student Worksheet (LKS). After students receive the learning materials, students fill out a subjective rating scale questionnaire to measure cognitive load.

The measurement of cognitive load in this study consists of three components, namely intrinsic cognitive load (ICL) which describes the ability to receive and process information, Extraneous Cognitive Load (ECL) which describes mental effort and Germane Cognitive Load (GCL) which describes students' ability to construct the measured knowledge. Using a subjective rating scale. The subjective rating scale instrument is a questionnaire used to measure cognitive load [9] which has been validated by expert lecturers. The scoring on the subjective rating scale uses a Likert scale from a range of 1 to 8 which is converted into a scale of 100. The scores for each component of cognitive load are categorized according to categorization [8] namely very high (80-100), high (60-79), medium (40-59), low (20-39), very low (0-19).

Data analysis of each component of cognitive load, namely intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL) was carried out facilitated by SPSS software version 23 including normality test using the Shapiro-wilk test and homogeneity test using the Levene-test. Then it was continued with the mean difference test using the Mann Whitney test with a significance level of 5% to determine whether the data for each component of the cognitive load of the experimental group and the control group were significantly different or not.

Students' ICL acquisition is said to be low if the score of ability to analyze information is high, otherwise if the score obtained is low, the ICL is said to be high. The ECL is said to be low if the mental effort score in understanding information is also low. While the amount of GCL is in accordance with the ability of the reasoning score [10].

3. RESULTS AND DISCUSSION

Based on the data obtained regarding the results of the cognitive load measurement, it shows that the experimental group students whose learning process using chunking technique combined with writing is thinking obtained an average value of the ability

to receive and process information of 38.4 (low ICL) which is lower than the control group which is 44,2 (medium ICL), the average value of mental effort is 32.8 (low ECL) lower than the control group, which is 39.7 (medium ECL) and the average value of knowledge construction is 73.7 (high GCL) higher than the control group which is 59.1 (medium GCL). This is shown in Table 2.

Table 2: Results of cognitive load measurement on human reproductive system learning.

	Experiment Group			Control Group		
	ICL	**ECL**	**GCL**	**ICL**	**ECL**	**GCL**
Meeting 1	38.1	32.1	73.5	44.9	41.2	59.0
Meeting 2	38.8	33.5	73.8	43.5	38.2	59.2
Average	38.4	32.8	73.7	44.2	39.7	59.1

After the data was obtained, a two-mean difference test was conducted to determine whether there were differences in the components of cognitive load, namely ICL, ECL, and GCL between the experimental group and the control group. To find out, a prerequisite test is carried out first, namely the normality test which is presented in Table 3.

Table 3: Normality test results for cognitive load components.

Cognitive Load Component	**Group**	**Sig. Value**	**Interpretation**	**Conclusion**
ICL	Experiment	0.038	Sig. < 0.05	not normally distributed
	Control	0.000	Sig. < 0.05	not normally distributed
ECL	Experiment	0.063	Sig. > 0.05	normal distributed
	Control	0.005	Sig. < 0.05	not normally distributed
GCL	Experiment	0.032	Sig. < 0.05	not normally distributed
	Control	0.017	Sig. < 0.05	not normally distributed

After the normality test, it can be concluded that almost all of the data are not normally distributed. Therefore, the Mann Whitney test was used as a follow-up test and the results are presented in Table 4.

The low ICL results in the experimental group showed high ability to receive and process information compared to the control group. This means that learning using chunking techniques combined with writing is thinking helps students receive and process information in studying the human reproductive system. On the other hand, the low ECL scores in the experimental group showed that the students' mental effort

Table 4: Mann whitney test results for cognitive load component.

Cognitive Load Component	Sig. Value (2-tailed)	Interpretati	Conclusion
ICL	0.004	Sig. < 0.05	significant difference
ECL	0.002	Sig. < 0.05	significant difference
GCL	0.000	Sig. < 0.05	significant difference

was lower than the control group. This means that the learning strategy used by the teacher has facilitated students in understanding new information using their cognitive abilities. The high GCL results showed that the experimental group was better than the control group. This means that a low ECL can cause a high GCL because ideally the ECL needs to be reduced so that most of the cognitive load is on the GCL, meaning that the majority of students' energy should be able to construct new knowledge [11]. In other words, learning using chunking techniques combined with writing is thinking helps control students' cognitive load. In fact, based on the Mann Whitney test, it shows that there is a significant difference between the components of the cognitive load of the experimental group and the control group.

The difference in cognitive load is due to the learning strategy used. Learning strategies in the experimental group using chunking techniques help students to optimize working memory capacity in receiving and processing information. While writing is thinking helps students to construct knowledge based on the information they have obtained by writing information that has been processed in the mind into written form using their own language so that students can learn according to their understanding.

This is in line with what was stated the chunking technique helps reduce students' cognitive load by chunked information into simpler and more meaningful ways to make students able to manage cognitive systems [12]. Thinking makes students able to write unorganized understanding into a more coordinated whole, so the use of thinking by writing it into a simpler language can help students in the learning process [13].

The high cognitive load in the control group is thought to be because students still have difficulty in receiving and processing the information provided by the teacher with a wide scope and exceeds the capacity of students' working memory which causes students to be burdened. This causes students to not be able to learn optimally because the working memory they form is very broad while the capacity of working memory is limited. The use of worksheets has not been able to construct student knowledge because students only focus on the questions given and seek answers from the material not from the results of their learning understanding. This is in line, the use of worksheets

in the learning process helps students to understand the material by doing questions [14].

4. CONCLUSION

In this study, results showed that learning using chunking techniques combined with writing is thinking causes low ICL, low ECL and high GCL in learning the human reproductive system. The results of the Mann Whitney test showed that there was a significant difference between the components of cognitive load (ICL, ECL, and GCL) in the experimental group and the control group. The chunking technique combined with writing is thinking is able to optimize working memory capacity by managing pieces of information and helping students construct knowledge by rewriting the information obtained using their own language.

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