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Measurement of Student Cognitive Loads on Course Kapitaselekta Mathematics

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Abstract---*The purpose of this study was to measure intrinsic cognitive load, extraneous cognitive load, and germane cognitive load students in the elementary school teacher education program (PGSD) at the Kapitaselekta lecture and how is the relationship between the three cognitive load components of PGSD students in the Kapitaselekta Mathematics lecture. This study uses a qualitative approach with descriptive research methods that aim to get a picture of the cognitive burden of PGSD students in the Kapitaselekta Mathematics lecture. The research subjects were PGSD students who contracted the Kapitaselekta Mathematics course in the 2018/2019 Academic Year as many as 50 students. Data analysis showed that the three components of the cognitive load filter correlated significantly even though the correlation was weak for several sub-concepts at the Kapitaselekta Mathematics.*

Keywords---*Cognitive Load, Kapitaselekta Mathematics, PGSD Students*

I. INTRODUCTION

Subanji (2015) stated that thinking is part of the student's cognitive ability in the face of every learning activity so that in learning students should be invited to think. Thinking about providing enough information about the cognitive processes of students in the domain needed to make a correction of learning (Abdillah et al, 2016).When students think, it will enter into the student's memory. There are 3 types of memory, namely: 1). short term memory; 2). long term memory; and working memory

Baddeley (2012) mentions working memory responsible for processing information and following up on such information. Miller (Nursit, 2015) mentions working memory can only store about seven items or pieces of information at a time (Cowan, 2001; PAAs et al, 2014). At the time of processing the information (organizing, indicating differences, and comparing), humans can only manage two or three items of information simultaneously, depending on the type of processing required (Kirschner et al, 2006). So that new information stored in working memory if not trained is lost in about 15 to 30 seconds (Driscoll, 2005; Paas, et al.2014).

Van Merrienboer & Sweller (2005) mentions that according to the cognitive load theory (CLT) in working memory can be caused by three sources, namely: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load (Plass, J.L., et al, 2010). Intrinsic cognitive load relies on the level of difficulty of the material, but with good rendering techniques and does not complicate learners ' understanding of it will be managed intrinsic cognitive burden. The extraneous cognitive load relies on the presence of matter. While the germane cognitive load is a relevant or beneficial burden imposed by teaching methods that lead to better learning outcomes. In learning, cognitive overload depends on the degree of difficulty of the material learned according to intrinsic cognitive load. If the material is learned intrinsic

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cognitive load high, then the design of learning should be organized in such a way that the extraneous cognitive load can be suppressed as minimal as possible. This is in line with previous studies stating that CLT's nuance of the learning process is able to solve mathematical problems (Damayanti, 2013; Fitriyah, DKK, 2014; Kristiana, 2015).

Based on the background of the problem described, the purpose of this research is how to intrinsic, extraneous, and germane cognitive load students of PGSD at the academic course of mathematics and how the relationship between the three components Cognitive load of PGSD students at the College of education kapitaselekta Mathematics.

II. RESEARCH METHODS

This study used a qualitative approach with a descriptive research method aimed at obtaining a picture of the student's cognitive burden on the college's kapitaselecta. The research subject is a student of Elementary School Teacher Education Study Program (PGSD) which contracts with the academic year of kapitaselecta of mathematics 2018/2019 as many as 50 students

The three components of cognitive load measured in this study are Intrinsic Cognitive Load (ICL), Extraneous Cognitive Load (ECL) and Germane Cognitive Load (GCL). The high and low cognitive load of students is seen based on the relationship between the three components. The instruments used in this study are described in table 1.

TABLE 1. Student Cognitive Load Measurement Instrument

Cognitive Load	Instruments
Intrinsic Cognitive Load (ICL),	Task worksheet complexity (Brünken et al., 2010), in the form of MFIs developed in accordance with the indicators of Kapitaselekta Mathematics lectures
Extraneous Cognitive Load (ECL)	Questionnaires are in the form of a subjective rating scale based on the Likert scale (Brünken et al., 2010) regarding the influence of learning activities and instructional materials developed.
Germane Cognitive Load (GCL)	The final test was used to measure the mastery of concepts in the Kapitaselekta Mathematics course. The value of the ability level to receive and process information and learning outcomes is categorized according to the categorization of 100 Arikunto (2002) scale values, which are very good (80-100), good (66-79), moderate (56-65), less (4055), very less (0-39).

Cognitive load measurement is based on, ICL students are said to be low if the score of the ability to process information is high (intrinsic load to process information is low). Conversely, if the score obtained is low then ICL is said to be high (intrinsic load to process information is high). For ECL it is said to be low if the score of mental effort in understanding information is also low (external difficulty level in understanding information is low). The amount of GCL is in accordance with the score of the mastery of the concept (Rahmat and Hindriana, 2014), the relationship between the three ICL components, ECL and GCL were measured through the correlation test calculation.

III. RESULT AND DISCUSSION

The measurement of cognitive load in this study was seen through three components of cognitive load, namely information processing ability (ICL), mental effort in lectures (ECL) and learning outcomes (GCL). The ability to process information is measured in each material for the Kapitaselekta Mathematics course. The same thing was done in measuring mental effort and the ability to construct knowledge that was reflected in learning outcomes. Table 2 shows the results of cognitive load measurements.

TABLE 2. Results of Measurement of the Cognitive Load of Fraction Materials in the Kapitaselekta Mathematics Course

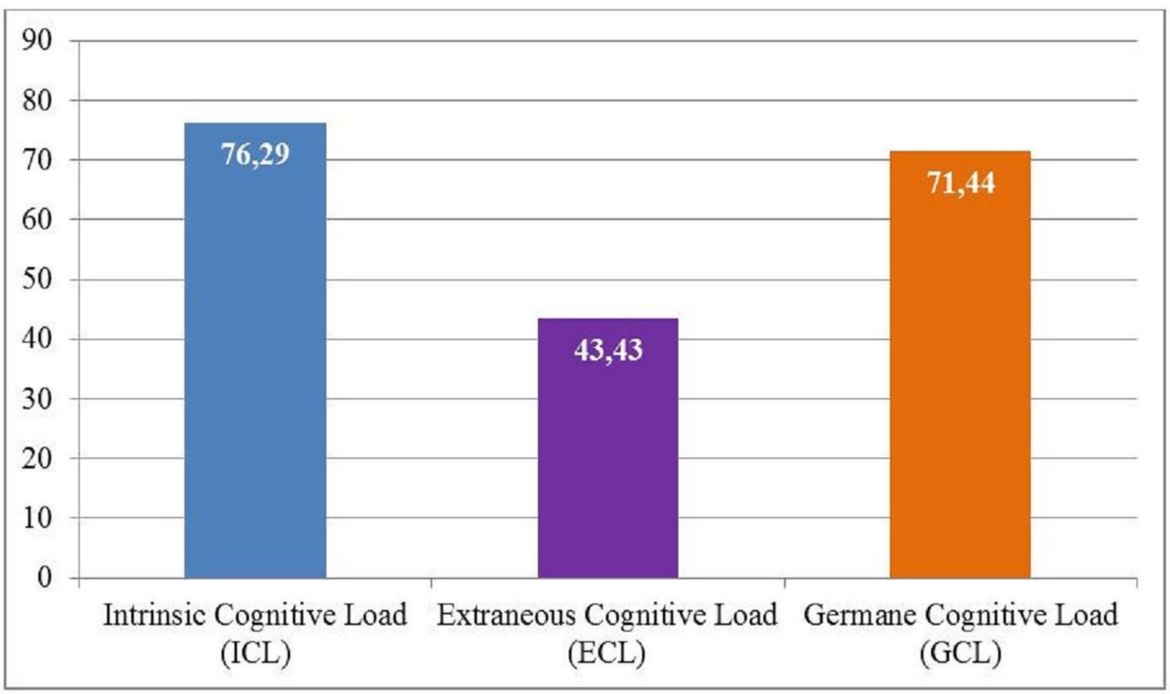
No	Sub Konsep	Processing Information (ICL)	Mental Enterprises (ECL)	Learning Outcomes (GCL)
1	Fraction Concept	76,32	42,30	71,78
2	Sort Fractions	75,38	40,72	70,80
3	Addition and Reduction of Fractions	75,80	44,08	68,78
4	Multiplication and Division of Fractions	77,66	46,60	74,40
	Average	**76,29**	**43,43**	**71,44**

Cognitive load measurement is performed on sub-fraction material concepts, which consist of: fraction concepts, sort fractions, addition and subtraction fractions, and multiplication and fraction division. Each sub-concept is measured by the ability to process information and the mental effort needed by each student. Both of these cognitive burdens were seen from each student and viewed the correlation between the two. If the correlation is inversely proportional (negative value) it can be said that the higher the ability to process information the lower the mental effort needed or vice versa. If the correlation is directly proportional (positive value) it can be said that the mental effort needed is proportional to the ability to process information (Rahmat and Hindriana, 2014).

The results of data analysis on the measurement of cognitive load showed that the learning outcomes for fractions included in the high category were 71.44. These results are strengthened by the ability to process information from students at 76.29. So the tendency of the teaching and learning process carried out is almost in accordance with the characteristics and cognitive burdens of students. The learning results in the sub-concepts of Addition and Fraction Reduction are in the medium category which is equal to 68.78. These results indicate that the learning done causes students to still experience cognitive burdens that must be considered in determining learning success, but the still high mental effort is still smaller than learning outcomes. For the sub-concepts of Addition and Subtraction Fractions, there is a possibility that the strategies used by the teacher are less relevant. This is in line with what was stated by Kalyuga (2011) that cognitive load arises as a result of delivering information or learning strategies that are not in accordance with the material. Because of the basic cognitive load for students is critical and creative thinking (Billing, 2007).

The ability to process information in the subconcept of Multiplication and Fraction Distribution is 77.66, while the achievement of learning outcomes is 74.40. although the information processing capability is in the high category the learning outcomes are below it. Tendency learning outcomes are thought to be caused by other factors beyond cognitive load such as interest and motivation to learn. As (Rashid and Rana, 2019) that motivation is a key element that facilitates students to adopt learning strategies and the process can be influenced by students' motivation and attitudes towards the material being studied (Mayer and Moreno, 2010: 133).

Fig. 1. The Average Cognitive Burden Measurement Result of Fractional Matter in The Academic Course Of Mathematics Kapitaselekta



External factors other than the cognitive load described are described in how the relationship between the three cognitive load components of PGSD students in the Kapitaselekta Mathematics lecture in table 3.

TABLE 3. Relationship Between Components of Cognitive Load of Fraction Material

No	Correlation	Pearson Correlation	Sig. (2-tailed)
Sub Concept of Definition of Fractions			
1	The ability to process information on learning outcomes	0,459	0,001 < 0,05
2	Mental effort towards learning outcomes	-0,277	0,52 > 0,05
3	The ability to process information against mental effort	-0,142	0,326 > 0,05
Sub Concept Sorting Fractions			
1	The ability to process information on learning outcomes	0,307	0,030 < 0,05
2	Mental effort towards learning outcomes	0,0001	0,995 > 0,05
3	The ability to process information against mental effort	-0,056	0,697 > 0,05
Sub Concept of Addition and Subtraction			
1	The ability to process information on learning outcomes	0,309	0,029 < 0,05
2	Mental effort towards learning outcomes	-0,123	0,396 < 0,05
3	The ability to process information against mental effort	-0,127	0,379 < 0,05
Multiplication and Distribution Sub Concepts			
1	The ability to process information on learning outcomes	0,302	0,033 < 0,05
2	Mental effort towards learning outcomes	0,079	0,584 > 0,05
3	The ability to process information against	-0,082	0,569 > 0,05

mental effort

Based on Table 3 it appears that the relationship between the three cognitive loads shows a significant correlation (α > 0.05) and some are not significant, which means that the existing statistical price correlation coefficient can be ignored. In other words, even though the negative correlation value obtained between the ability to process information and mental effort means that the higher the ability to process information, the lower the mental effort needed, but the correlation value is classified as very weak. Table 3 shows that for the sub- concepts of the definition of fractions there is a significant correlation (α < 0.05) between the ability to process information against the mental effort. this shows that although learning outcomes are high but not due to intrinsic load and extraneous load, there are other factors that can be caused by learning strategies not in accordance with the material being taught, even though students will be better at learning if learning resources are used in accordance with the concept self from students (Rockliffe dan Gifford, 2012).

Sub Concept Sorting Fractions there is a significant correlation (α < 0.05) between the ability to process information with learning outcomes. This shows that good management of information processing can increase the german load, but learning outcomes are not highly correlated with the extraneous load.

The subconcept of addition and subtraction shows the relationship between the ability to process information, a mental effort towards learning outcomes. The correlation calculation shows the correlation between the three is significant (α < 0.05). this means that learning outcomes are influenced by low ECL and high information processing processes. In line with an opinion (Jong, 2010; Lin dan Lin, 2013), in intrinsic cognitive load learning applications must be managed as well as possible, extraneous cognitive loads must be kept as low as possible and Germane's cognitive burden must be increased. Because according to (Jong, 2010) that a high extraneous load tendency makes performance in learning worse but on the contrary, with a high cognitive load Germane makes learning performance better. Instructional design that increases the use of working memory resources intended for intrinsic cognitive loads has the effect of increasing Germane's cognitive load

The multiplication and division sub-concepts show a significant correlation between information processing and learning outcomes, this indicates that the germane load correlation is more influenced by intrinsic load compared to extraneous load. The correlation relationship between mental effort and learning outcomes and the ability to process information with mental effort is not significant (α > 0.05) which means that the existing statistical price correlation coefficients can be ignored. Data analysis from Table 3 implies that there is an association between the three components that can determine the cognitive load of students and there is substantial empirical evidence to support the theory of cognitive load (Bokosmaty et al 2015; Leppink et al 2014; Russo & hopkins, 2017). In addition, this theory has clear implications for learning processes. This implies that teachers must develop teaching and learning processes that minimize foreign cognitive load, maximize cognitive load closely and optimize intrinsic cognitive load.

IV. CONCLUSION

The Sub Concept of Multiplication and a discussion of how to measure cognitive load and how it relates to the three components in it can be concluded that the results of data analysis on cognitive load measurements show that the relationship between the three cognitive loads shows a significant correlation (α > 0.05) and some are not significant. In other words, even though the negative correlation value obtained between the ability to process information and mental effort means that the higher the ability to process information, the lower the mental effort needed, but the correlation value is classified as very weak. There are other factors that cause the correlation to be weak because of motivation and learning strategies that are less relevant. So for that, there are several things that are suggestions for further research, including the need to build student interest and motivation as a basis for the teaching and learning process. In addition, there is also a need for further analysis of learning strategies that are more suitable to be applied during the teaching and learning process and division

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