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COGNITIVE LOADS JUNIOR HIGH SCHOOL STUDENTS IN LEARNING EXCRETION SYSTEMS POST PANDEMI COVID-19

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Abstract: This research was conducted to obtain an overview of the cognitive load of junior high school students on excretory system material in limited face-to-face learning after the Covid-19 pandemic. Cognitive load is measured based on three components, namely mental effort to describe extraneous cognitive load, ability to receive and process information that describes intrinsic cognitive load, and reasoning ability as a result of learning to describe germane cognitive load. Mental effort was measured using a subjective rating scale questionnaire using a Likert scale, the ability to receive and process information was measured through excretion system questions based on information processing components, and learning outcomes were measured through reasoning questions based on reasoning dimensions. The relationship between the three components of cognitive load was analyzed through a correlation test. The results of the analysis show that the correlation of mental effort with the ability to receive and process information (UM-MMI) and the correlation of mental effort with learning outcomes (UM-HB) shows a negative value and is not significant. The correlation value between the ability to receive and process information with learning outcomes (MMI-HB) shows a positive value and is not significant. Based on the correlation between the three components, students' cognitive load on the excretory system material is still in the high category because the correlation in each component does not have a significant correlation.

Keywords: Cognitive load, intrinsic cognitive load, extraneous cognitive load, germane cognitive load.

INTRODUCTION

It is undeniable that the emergence of the Covid-19 pandemic that has hit Indonesia has had an impact in various ways (Dede Trie Kurniawan, 2020). Various policies have been issued by the Indonesian government to reduce the rate of spread of the corona virus by imposing social distancing, physical distancing to implementing PSBB (large-scale social restrictions) in several areas. Policies issued to limit the spread of Covid-19 have had an impact on various fields throughout the world, especially education in Indonesia. In order to stop the spread of this pandemic, the government has established a Learning from Home (BDR) policy.

There is a change in the way of teaching and learning from face-to-face to distance learning resulting in changes in the learning process. This poses a challenge to all elements and levels of education to keep classes active even though schools have been closed. Teachers and educators as important elements in teaching are required to make an unprecedented massive migration from traditional face-to-face education to online education or distance education (Bao, 2020; Basilaia & Kvavadze, 2020 in Herliandry *et al*., 2020).

Distance learning is certainly inseparable from loopholes that cause this learning system to be less effective, one thing to fear is that if distance learning lasts for a long time it will have an impact on students' learning loss. The Education and Development Forum in (Sofyan, 2020) defines that learning loss is a situation where students lose knowledge and skills either in general or specifically or there is an academic setback due to certain conditions such as prolonged gaps or the non-sustainability of the educational process. The learning loss that is feared to occur is the limited interaction between educators and students, limited interaction between students and other students, learning time problems, lack of concentration and loss of focus, as well as the lack of student absorption of the learning material provided. Not doing face-to-face learning has an unfavorable effect on learning motivation, when face-to-face learning is usually carried out, they consider it to be directly and clearly observed or supervised, so that the level of desire to learn is relatively more maintained, but with the pandemic conditions, awareness of the desire to learn has decreased .

According to Mayasari (2021) that face-to-face learning is felt to be more effective than online learning because it will be more controlled through positive affirmations given by the teaching staff, even though the enthusiasm for learning is somewhat fluctuating. when face-to-face learning is usually carried out, they perceive that they are being cared for or supervised directly and clearly, so that the level of desire to learn is relatively more maintained, but under the conditions of a pandemic, awareness of the desire to learn has decreased. According to Mayasari (2021) that face-to-face learning is felt to be more effective than online learning because it will be more controlled through positive affirmations given by the teaching staff, even though the enthusiasm for learning is somewhat fluctuating. when face-to-face learning is usually carried out, they perceive that they are being cared for or supervised directly and clearly, so that the level of desire to learn is relatively more maintained, but under the conditions of a pandemic, awareness of the desire to learn has decreased. According to Mayasari (2021) that face-to-face learning is felt to be more effective than online learning because it will be more controlled through positive affirmations given by the teaching staff, even though the enthusiasm for learning is somewhat fluctuating (Rr. Arum Setyorini *et al.*, 2021).

*Learning loss*is the impact of a change that occurs suddenly, usually people affected by learning loss are people who are not ready for change (Ulfah, 2022). This learning loss can be called an effect due to problems that occur in learning activities. UNESCO in (Arifudin, 2022) states that short school interruptions in children can have a long-term negative impact on their learning.

Any changes in this way of learning directly or indirectly will be a psychological burden for students. This change certainly burdens students in processing information. If the learning strategy used is not managed or not prepared properly by the teacher, it is likely that students will have difficulty receiving information when studying. Meanwhile, according to Kalyuga (2011) an effective and efficient learning must be able to build a learning condition, where the information received by students is stored based on their memory capacity, so that students do not experience memory overload. In this case, learning strategies that are in accordance with the characteristics of the material are needed in the learning process so that students are able to analyze the information conveyed by the teacher so that in the end students do not use other strenuous efforts to obtain the information they need. Such a learning strategy can reduce students' cognitive load due to the limited working memory of each individual.

Basically, everyone's working memory or cognitive abilities are different, everyone's memory has a limited capacity to receive information. This limitation is a burden for someone when facing excessive brain work. As explained by Jong (2010) in his article that cognitive capacity in working memory is limited, so if the learning task exceeds capacity, learning will be hampered. Cowan, 2001; Miller, 1956 (in Jong, 2010) suggests that there are two kinds of memory, namely long term memory and short term memory. Long-term memory is a part of memory where a large amount of information is stored (semi-) permanently whereas short-term memory is a memory system where only a small amount of information is stored.

Cognitive load or*cognitive load*is an instructional theory that originates from an idea that our working memory is limited by the response to the amount of information that can be received and the number of operations that can be performed by that information. This means that a learner can support the efficient use of working memory, especially when learning difficult tasks or jobs (Paas *et al*., 2003).

This limited cognitive load needs to be stabilized in the process of working memory in learning, especially learning science. There are three components of cognitive load that occur in working memory during learning, namely (1) Intrinsic Cognitive Load (ICL), (2) Extraneous Cognitive Load (ECL), (3) Germane Cognitive Load (GCL). Intrinsic Cognitive Load (ICL) relates to the inherent characteristics of the content to be learned and also relates to difficulties with subject matter problems (Cooper, 1998; Sweller and Chandler, 1994; de Jong, 2010) Extraneous Cognitive Load (ECL) is a cognitive load evoked by instructional materials and indirectly contribute to learning (Jong, 2010). Meanwhile, Germane Cognitive Load (GCL) closely refers to the load imposed by learning outcomes (Jong, 2010).

Cognitive load possessed by students is very influential on the learning process. The greater the cognitive load (overload), the more hampered the learning process. The cognitive condition of a person (student) should be able to achieve an adequate level of ICL, be able to reduce ECL and be able to increase GCL (Meissner & Bogner, 2013 in Rahmat et al., 2014). In accordance with Jong's statement (2010) that students' ICL is adjusted to the amount of knowledge about the material to be studied. Intrinsic Cognitive Load (ICL) is high if students have little knowledge of the material to be taught and ICL is low when students are able to master the material being studied with the knowledge they have. When the ICL is low, then the student's ECL will be low because the student's effort in understanding the lesson is little and vice versa when the student's ICL is high, the student's ECL will be high because the student must try hard to understand the lesson that the student is studying. GCL will be heavily influenced by ICL and ECL. GCL will be better when students' initial knowledge is sufficient for their memory capacity so that the effort made to understand the material being studied is very small, thus the cognitive load felt by students is small.

Based on the description of the cognitive load theory mentioned above, it is very likely that students will have a cognitive load in the distance learning process. Cognitive load experienced by students is possible because of the relationship with the learning strategies used by teachers to teach. Besides that, the influence of information and communication technology is very large on the level of students' mental effort (ECL). The existence of constraints experienced by students and teachers in the application of information and communication technology in the learning process allows the emergence of cognitive load on students.

Based on the explanation above, the authors consider it necessary to conduct research by measuring the cognitive load experienced by junior high school students in learning natural sciences after the Covid-19 pandemic. The components of cognitive load observed in this study are the ability to process information (intrinsic cognitive load), the mental effort required during the learning process (extraneous cognitive load), as well as the ability of students to form knowledge schemes (germane cognitive load). Based on the relationship between the three components of cognitive load, it can be seen how students' cognitive load is in science learning when studying online during the Covid-19 pandemic.

METHOD

The method used in this research is descriptive method (Sukmadinata, 2011). The subjects in this study were class VIII students of private junior high schools in Bogor Regency, even semester of the 2021/2022 academic year. The research sample consisted of two classes. The sampling technique was carried out by purposive sampling. The data collection techniques used in this study consisted of providing worksheets to measure students' ability to receive and process information (MMI), administering questionnaires to measure students' Mental Effort (UM), and daily tests of the nervous system chapter to measure students' level of reasoning on systems material. nerves (HB). The details of data collection techniques can be seen in Table 1.

Table 1. Data Collection Techniques

No.	**Data**	**Data Collection Time**	**Instrumen t**
1.	Students' ability to receive and process information (MMI)	At the end of each lesson	*Worksheet s*
2.	Mental effort (UM)	At the end of each lesson	Questionn aire
3.	The level of student understanding/learnin g outcomes (HB) of excretion system material	At the end of the excretory system chapter learning	Test Questions

The instruments used in this study are: The worksheet contains questions that measure students' ability to receive and process information (MMI) in excretion system material developed using a task complexity worksheet (Brunken, et al., 2010) based on information processing standards from Marzano (1993), the questionnaire contains statements which are subjective rating scales using a 5-point Likert scale which was developed based on statements that refer to the steps of the learning process (Brunken et al., 2010), and test questions to measure students' level of reasoning (HB) in studying excretory system material.

The data obtained were then processed and analyzed descriptively and quantitatively. ICL data was obtained from answers to MMI questions compiled using a task complexity worksheet. The value of students' ability level in analyzing information refers to the categorization of Arikunto (2012). ECL data was obtained from an analysis of student responses from a questionnaire regarding the learning process. The processing technique used is to use a 5-point Likert scale. This processing is done by calculating the average score of each answer from the respondent. The data used to measure GCL are the results of students' reasoning tests (HB). To analyze student test results, categorization tables are used in Arikunto (2012).

Table 2. Interpretation of Research Data

intervals	Criteria
80-100	Very well
66-79	Good
56-65	Enough
40-55	Not enough
30-39	Fail

Quantitative data processing is carried out through regression correlation statistics to look for relationships between the three categories of cognitive load. Correlation is intended to analyze the extent of the relationship between the three components of cognitive load. If the correlation is positive, then the relationship between the two variables is unidirectional. If the correlation is negative, then the relationship between the two variables is in the opposite direction. The relationship between the two can be determined using the Spearman test because the data to be tested is not normally distributed and is not homogeneous. The size of the relationshipamong the three cognitive load components are interpreted based on the deep category (Sugiyono, 2007).

Table 3. Interpretation of the Correlation Coefficient

0.00 - 0.199	=	very low
0.20 - 0.399	=	low
0.40 - 0.599	=	currently
0.60 - 0.799	=	strong
0.80 - 1.000	=	very strong

RESULT

Measurement of Mental Effort (UM)

ECL measurement is carried out through measuring the mental effort of students needed in learning excretory system material. UM data were obtained based on the opinions of students on a questionnaire designed based on the implementation of learning strategies and learning steps carried out by the teacher in class. Instruments are given at the end of each learning meeting. This data collection is done by looking at students' responses to the learning carried out by the teacher in presenting excretory system material. The recapitulation of the students' average MU values in the excretory system learning shows that the average value of the mental effort component obtained by students in dealing with the excretory system learning is in the very low category. (Table 4).

Table 4. ME Data Summary

Average (%)		Category
Meeting 1	31.39	Very low
Meeting 2	34.07	Very low
Meeting 3	35.50	Very low
UM average	**33.65**	**Very low**

Measurement of Ability to Receive and Process Information (MMI)

MMI ability is used to measure students' ICL in learning excretion system material. Obtaining data on students' MMI abilities, obtained from instruments in the form of description questions. Problem descriptions are given at the end of learning at each meeting. The questions are adapted to the delivery of material provided by the teacher and are designed using the second strategy (Information Processing) in Marzano et al. (1993). Information Processing indicators consist of information processing standards, information identification, interpretation and analysis of information relevance, as well as information application.

The recapitulation of the average value of the ability to receive and process student information shows that the class average score at meeting 1 is higher than the other meetings, namely 78.98 (good category), while the average value at meeting 3 has the lowest average value, namely 65.40 and included in the sufficient category Table 5.

Table 5. Recapitulation of Students' MMI Capabilities

Average		Category
Meeting 1	78.98	Good
Meeting 2	71.94	Good
Meeting 3	65,40	Enough
Average MMI	**72,10**	**Good**

Student Learning Outcome Measurement (HB).

Measurement of students' HB was measured through a reasoning test that was used to measure students' GCL in learning the excretory system. Measurement of HB through reasoning test questions on the excretory system material given at the last meeting on the excretory system material in the form of multiple choice questions, to get an overview of GCL. The average value obtained by students after participating in the excretory system learning is 66.25 and is included in the sufficient category Table 6.

Table 6. HB Data Summary

Indicator	Average per Indicator	Average
comparison (compare)	65,67	**66,25 (Enough)**
classifying (clarifying)	60.00	
Induction (Induction)	80.00	
deduction (Deduction)	86,67	
Error Analysis (Error Analysis)	36,67	
Construction Support	76,67	
Abstracting (Abstraction)	70.00	
Analyzing Perspectives (Perspective Analysis)	53,33	

Average Cognitive Load Components of Students

The average acquisition of the cognitive load component of students in the excretory system material can be seen based on the acquisition of UM, MMI and HB values which can be seen in Figure 1.

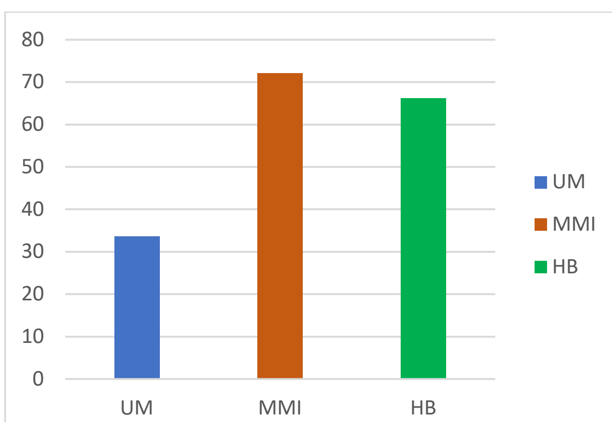

Figure 1. Average Cognitive Load Components of Students

Correlation Test Analysis Between Cognitive Load Components

Correlation of UM to MMI

Based on the calculation results in Table 7, the correlation value between MU and MMI is negative, namely -0.208 with Sig. 0.366 (not significant). This negative correlation illustrates the inverse relationship between UM and MMI, namely a low UM can affect an increase in MMI scores. UM and MMI correlations have a low level of correlation. This shows that the contribution of UM to MMI is not clear but there is still a contribution of mental effort to MMI, so it can be interpreted that students still have cognitive load even on a small scale.

Table 7. Correlation of UM to MMI

	UM-MMI
coefficient r	-0.208
Sig. (2-tailed)	0.366
Category	Negative
	Not significant

Correlation of UM to HB

Based on the calculation results in Table 8, it shows that the correlation of UM to HB is negative with a correlation coefficient of -0.205, which means that the correlation level is low with Sig. 0.374 (not significant). This correlation indicates that the contribution of UM to HB is not clear, so it is possible that students still have a cognitive load to acquire reasoning abilities.

Table 8. Correlation of UM to HB

	UM-HB
coefficient r	-0.205
Sig. (2-tailed)	0.374
Category	Negative
	Not significant

Correlation of MMI to HB

Based on the results of calculating the correlation of MMI to HB in Table 9, the correlation value of MMI to HB is positive, namely 0.343 with Sig. 0.127 (not significant). Obtaining the correlation coefficient illustrates that the correlation between MMI and HB has a low level of correlation. This can be interpreted that MMI does not make a strong contribution to HB, so that students still have the cognitive load to acquire reasoning abilities and the contribution of MMI to HB is not clear.

Table 9. Correlation of MMI to HB

	MMI-HB
coefficient r	0.343
Sig. (2-tailed)	0.127
Category	Positive Not significant

Total Cognitive Load

To determine the level of students' cognitive load, the main correlation component is directly seen based on the correlation between MMI and HB, then the correlation between UM and HB, and the correlation between UM and MMI.

Based on the results of the study, it can be seen that the correlation of MMI ability to students' HB has a positive correlation which describes a unidirectional relationship, and the correlation of the UM component to HB is negative and the correlation of the UM component to MMI ability which has a negative value describes an inverse correlation. However, the value of the correlation coefficient of the three is low and not significant. This shows that there is still a cognitive load on students in learning the excretory system material.

CONCLUSION

*Cognitive load*students obtained from the scores on the components of Mental Effort (UM), Receiving and Processing Information (MMI) and Learning Outcomes (HB). Students' UM scores are in the very low category which indicates that students' ECL is in the low category. The MMI values obtained by students are in the good category, and the HB values obtained by students are in the sufficient category. *Cognitive loads*students on excretory system material as a whole are still in the high category. The level of students' cognitive load is seen based on the correlation of each component. The correlation between mental effort and the results of the ability to receive and process information (UM-MMI) shows a negative value and is not significant which illustrates that there is still a contribution of UM to MMI, any decrease in mental effort contributes to an increase in the ability to receive and process information but is not significant so that it cannot be it is determined how much the contribution is (unclear).

The correlation between mental effort and learning outcomes (UM-HB) has a negative value and is not significant. This indicates that the contribution of UM to HB is unclear, so it is possible that students still have cognitive load.The magnitude of the correlation value between the ability to receive and process information with learning outcomes (MMI-HB) shows a positive value and is not significant, meaning that the ability to receive and process high information contributes to improving learning outcomes in the form of reasoning abilities, but not significant so it cannot be determined how much the size of the contribution (unclear). Therefore, in this study the students' cognitive load was still in the high category because the correlation in each component did not have a strong or significant correlation.

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