



Intrinsic Cognitive Load in Online Learning Model of School Mathematics 1 in Covid-19 Pandemic Period

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Abstrak: Penelitian bertujuan untuk mengetahui munculnya Beban Kognitif *Intrinsic* dalam Pembelajaran Model Daring pada Mata Kuliah Matematika Sekolah 1 ditengah Wabah *Covid-19*. Penelitian ini merupakan penelitian Kualitatif Deskriptif dengan data yang diperoleh merupakan data kualitatif dari lembar observasi, angket belajar, dan hasil wawancara. Pengecekan keabsahan pada penelitian ini menggunakan metode triangulasi dalam penelitian. Subjek penelitian adalah Mahasiswa Universitas PGRI Banyuwangi Semester 2 tahun pembelajaran 2019/2020. Hasil penelitian yang diperoleh bahwa Beban Kognitif *Intrinsic* dalam pembelajaran secara daring pada mata kuliah Matematika Sekolah 1 ditengah wabah *Covid-19* adalah Beban Kognitif yang disebabkan oleh *Element Interactivity* dan *Isolated/ interacting element* yang terkandung dalam proses pembelajaran. *Element Interactivity* berupa istilah-istilah atau konsep dalam pembelajaran matematika. Istilah atau konsep tersebut contohnya adalah arti dari Pengetahuan, pengukuran baku, Pendekatan Matematisasi, Prinsip Jalinan, Konten, Konteks, Kompetensi, Konsep Belajar PISA, Dekonseptualisasi, Pendekatan Sistem, Pendekatan Konseptual, dll. *Isolated/ interacting element* ini terlihat dari mencari contoh implementasi dalam dunia nyata dan aktualisasi kejadian di Indonesia. Contoh implementasi dalam dunia nyata merupakan suatu *element* yang berinteraksi pada contoh keadaan nyata dalam praktik pembelajaran matematika. Penelitian yang dapat direkomendasikan untuk kedepannya adalah perihal Pengelolaan Beban Kognitif *Intrinsic* dalam perkuliahan Daring. Menjadi pertanyaan penelitian kedepan, apakah beban kognitif *Intrinsic* akan dapat berkurang dengan berjalannya waktu saat mahasiswa sudah terbiasa dengan perkuliahan model daring?.

Kata kunci: Beban Kognitif *Intrinsic*; Matematika Sekolah 1; Pembelajaran Daring

Abstract: The study aims at determining the emergence of intrinsic cognitive load in online learning models of School Mathematics 1 in Covid-19 pandemic period. This research is a descriptive qualitative one the data of which are obtained from observation sheets, questionnaires and interview results. Validity checking uses the triangulation method. The research subjects are the second semester students of PGRI University of Banyuwangi at 2019/2020 Academic Year. The results of the study show that the intrinsic cognitive load is caused by the interactivity and isolated/interacting elements contained in the learning process. Elements of interactivity are in the form of terms or concepts in Mathematics learning. These terms or concepts, for examples, are the meaning of Knowledge, Standard Measurement, Mathematical Approach, Intertwined Principles, Content, Context, Competence, PISA Learning Concepts, De-conceptualization, Systems Approach, Conceptual Approach, etc. Isolated/interacting elements are seen from looking for examples of implementation in the real world and actualization of events in Indonesia. An example of implementation in the real world is an element that interacts in real situations in the learning practice of Mathematics. The research recommendation is intrinsic cognitive load management of online learning. The next research question will be whether or not intrinsic cognitive load can be decreased with the passing of time when students get used with online learning model.

Keywords: Intrinsic Cognitive Load; School Mathematics 1; Online Learning

INTRODUCTION

The goal of education is to educate the life of the people. This goal is written in the preamble of the fourth paragraph of 1945 Constitution as one of Indonesian State goals (RI, 2002). Through policies in the National Education Program, the government continuously tries to manifest the goal. Regulation after regulation is designed as well to improve the quality of national education which has an estuary on the quality of life of Indonesian citizens.

Curriculum and learning are important and considered as inseparable components of national education. Curriculum is a set of plans and arrangements regarding the goals, content, and learning materials, as well as the methods used as guidelines for implementing learning activities to achieve certain educational goals (RI, 2003). There is a guideline for implementing learning activities that lead to the achievement of educational goals. Learning can certainly be a very important component in carrying out curriculum programs in order to achieve national education goals.

As an activity that aims to facilitate students to learn (Sukmadinata dan Syaodin, 2012) learning is a process of interaction between students, between students and teachers and learning resources in a learning environment (RI, 2014). Learning must be continuously improved in order to create good and effective learning activities (Voutsina dan Ismail, 2011) which finally increase the quality of learning end result, those are human resources.

Learning activities are currently experiencing problems with Covid-19 pandemic. All activities are done with online model that requires teachers or students to interact via internet. In order for education not being stopped by Covid-19 pandemic, there should be solutions that the learning process can still be conducted. The difficulties experienced both by educators and students should be explored continuously to be able to make improvements in the current online learning model.

Learning improvement must begin with an understanding on how students learn. Learning is a process of change in a person that makes a person obtain new knowledge. It is also an active process in constructing knowledge (Subanji, 2015). Learning will make someone have better understanding and be more able to do something from the results of the learning process. Learning provides a different experience than before.

Learning is a process that occurs in a person's cognitive in a complex way. It requires thinking or mental abilities of someone who is doing learning activities (Cooper, 1998; Slavin, 2009). There happen mental or cognitive activities when people are doing learning activities.

Cognitive functions to process new informations. The cognitive psychological development is in line with a theoretical framework called information processing (Slavin, 2009:216). Information processing theory says that information is processed in the human brain. The human brain is divided into parts which accept and process the information received. The main parts of the human brain that work in information processing are working and long-term memories (Slavin, 2009).

Working memory acts as the processing center of information received. The load that occurs in the working memory is called cognitive load (Plass, Moreno dan Brünken, 2010; Sweller, Ayres dan Kalyuga, 2011). Cognitive load theory divides cognitive load into 3 (three) types; namely intrinsic, extraneous, and germane cognitive loads.

Cognitive load theory is part of learning theory that seeks to improve learning (Kalyuga, 2011). In accordance with the opinion of experts, the intrinsic cognitive load should be managed, the extraneous cognitive load should be kept as low as possible, and the cognitive load of germane should be increased (de Jong, 2010; Lin dan Lin, 2014) so that in learning the most important thing is the role of Germane's cognitive load. Germane

Cognitive Load is a cognitive load caused by students' efforts to understand learning materials.

One of the urgent problems in Covid-19 pandemic period is the transfer of learning model from face-to-face (offline) to online in School Mathematics 1. Online learning model arises a cognitive load both for lecturers and students in current learning activities that there should be proper strategy to improve learning.

From the learning processes that have been taking place there are many difficulties experienced by students when trying to understand the materials. These difficulties are included into intrinsic cognitive load that must be managed so that in the future it is easier for students to understand the material in the School Mathematics 1.

Intrinsic cognitive load which is part of Educational Psychology discusses about students' knowledge building process in learning (Kalyuga, 2011). Therefore, this research, then, aims at describing students' working memory strength in receiving and understanding materials learnt in their cognitive. School Mathematics 1 covers materials related to Mathematics taught at junior high schools. When receiving this subject, students are in transition period since they consider changes. Previously their cognitive load functions as receivers of Mathematics, but now the cognitive load is received as tutor or the ones who teach it in junior high schools.

For the time being, intrinsic cognitive load becomes a research object limited to students and Mathematics. The occurrence of intrinsic cognitive load can be seen through direct (face to face) learning. This research discusses the emergence of intrinsic cognitive load at the time of pandemic *Covid-19*. The pandemic *Covid-19* firstly occurred in 2019 and gave impact to learning in the beginning of 2020. The impact of the pandemic occurrence is the complexity experienced in the learning of School mathematics 1.

The emergence of intrinsic cognitive load is determined by several factors. Students will experience an intrinsic cognitive load in Mathematics learning practice which is caused by element interactivity and separate/interacting elements (isolated/ interacting element) (Artino, 2008). These two factors will provide direction for researches on intrinsic cognitive load since of these two factors indicators of the emergence of intrinsic cognitive load can be compiled as in table 1.

METHOD

This part consists of the research design, settings, objectives, subjects, procedure, instruments, techniques of data analysis, and validity checking of the findings.

THE RESEARCH DESIGN

This study aims to explain and describe the emergence of intrinsic cognitive load in the learning of School Mathematics 1 lectures that the design used is descriptive qualitative research.

SETTINGS

The research setting of place is Universitas PGRI Banyuwangi in the even semester of the 2019/2020 Academic Year to class 2019 with a total of 7 students. It was conducted for 4 times on 3, 17, 24 April 2020 and 8 May 2020 with 150 minutes in duration per meeting.

OBJECTIVES

This research is targeted to describe the emergence of intrinsic cognitive load clearly and can also describe the causes of intrinsic cognitive load. A clear description of intrinsic cognitive load can provide a reference about the management of intrinsic cognitive load in learning. The main target of this research in the future is to provide descriptions of intrinsic

cognitive load which is a very important type of cognitive load because it contains content that must be understood in a course.

SUBJECTS

Subjects of this study were students of class 2019 of Department of Pendidikan Matematika, FMIPA, Universitas PGRI Banyuwangi. They were chosen because in this semester there was School Mathematics 1 which becomes basic course for a prospective teacher to teach in Junior High Schools and they also experienced many difficulties in online learning model.

PROCEDURE

This research was done using a method developed by Creswell (Creswell, 2009:286) which consists of 5 steps, namely: (1) Preparation; (2) Pre-survey; (3) Data Collection; (4) Data Processing; and (5) Report Writing. Preparation is done by completing the research proposal and also compiling supporting instruments. The proceed with the Pre-survey to determine the research schedule and also see the conditions of learning that have been and are currently running. Data collected by observing, interviewing, and distributing learning questionnaires to respondents. Data processing is carried out by following the flow of data analysis techniques. The final stage is report writing of the research undertaken. The step showed in Figure 1 below.

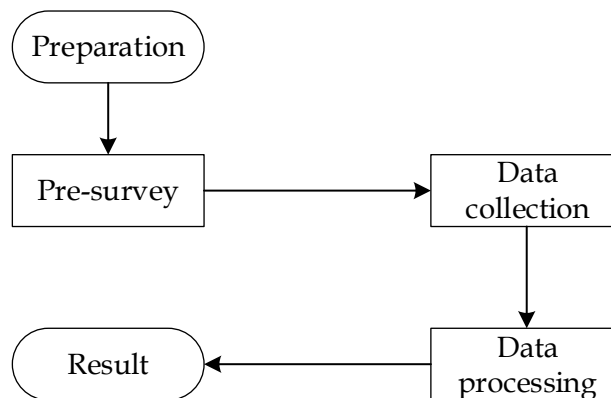


Figure 1. Steps of the Research Procedure

INSTRUMENTS

There are main and supporting instruments in this research. The main instruments are the researchers themselves while the supporting instruments are in the form of observation sheets, interview guidelines, and questionnaires.

The observation sheets Contains about the possible difficulties that come from the Learning materials, difficulties from instructional, and the efforts made by students during learning. This Observation sheet was filled out by the observer during the lesson. The data obtained from the observation sheet were learning materials difficulties experienced by student.

Semi-structured interview guidelines contain questions to students about the difficulties experienced, Larning material that they feel is not understood. The data obtained from this interview were larning material difficulties experienced by student and efforts made to overcome difficulties experienced during learning.

An open questionnaire was filled out by students after learning is complete and the questionnaire contains a description of the student's experiences during learning activities

related to difficulties the learning material. The questionnaire contains a list of possible learning material difficulties experienced by students during learning. Student are welcome to choose the difficulties and fill in other events that are not contained in the learning questionnaire. The data obtained from the study questionnaire were learning material difficulties experienced by students.

TECHNIQUES OF DATA ANALYSIS

Data analysis technique used 8 steps consisting of: (1) Transcribing verbal data; (2) Understanding the data; (3) Reducing the data; (4) Coding the data; (5) Describing the structure of the coding; (6) Analyzing the data; (7) Analyzing points of interest; (8) Drawing conclusion (Creswell, 2009).

VALIDITY CHECKING

The findings were checked for the validity by using Triangulation method. Triangulation method is done by triangulating data obtained from observations, interviews, and open questionnaires.

FINDINGS AND DISCUSSION

The research was conducted on a course entitled School Mathematics 1. This course material consists of 2 (two) standards, namely Content and Process Standards (NCTM, 2000). Content Standards are related to Mathematics material taught in Junior High School which includes Numbers and its operations, Algebra, Geometry, Measurement, and Data Analysis. Process Standards are related to the Mathematics learning process which includes Problem Solving, Reasoning and Evidence, Communication, Connection, and Representation.

School Mathematics 1 discusses 8 materials of 11 lectures. The materials are School Mathematics, Realistic Mathematics Education (RME), Regional Teaching both in elementary and junior high schools, Deconception of Mathematical Knowledge, PISA and its problems, Problem Solving Strategy, Types of Mathematical Errors for Middle School Students, Students' Mathematical Thinking.

The lectures of School Mathematics 1 are conducted online using email and Whatshapp Group. Lectures are not conducted face-to-face to prevent the spread of Covid-19 in the campus environment. Lectures are conducted at each student's home and guided by a lecturer who teaches School Mathematics 1. The lecture begins with the lecturer assigning assignments to students to make papers and power points then the papers are shared in the Whatshapp Group. Students are required to ask via the Whatshapp Group and students who make questions are required to recap each question and answer from their friends.

Intrinsic Cognitive Load can be seen from several indicators of the emergence of Intrinsic cognitive load in School Mathematics 1 learning. These indicators showed in Table 1. Below.

Table 1. Indicators of Students' Cognitive Load

Cognitive Load Type	Emergence Causes of ICL	Indicators of Students' Cognitive Load
<i>Intrinsic</i>	<i>interactivity element</i>	<ul style="list-style-type: none"> - Students are able to see what has been written by the lecturer, being explained by the lecturer, or the lecturer turn on a video in learning process (physiological motion). - Students write down what has been explained by the lecturer. - Students ask questions to the lecturer about the learning material given.

	- Students are unable to answer the lecturer's questions about related materials.
<i>isolated/ interacting element</i>	- Students ask about the examples of a concept in daily life - Students ask about steps of solving Math problem - Students doing errors in solving the problems in School Mathematics 1 learning.

PROCESS STANDARD

Intrinsic Cognitive Load that occurred when the School Mathematics 1 material enters the process standard material is derived from concepts, terms, real examples, and applications. Intrinsic Cognitive Load can be seen from the difficulties felt by students through the questions asked. Every student has different difficulties so that they have different intrinsic cognitive loads.

Intrinsic Cognitive Load can be seen through observation sheets, questionnaires and online interviews. Observations were made by observing the questions asked by students from the given assignment. Questionnaires were given through the google form application which must be filled in by students so that they can be immediately followed up after lectures are finished. The questionnaire result provides data of the cognitive load emergence. The technique of measuring cognitive load by using questionnaire is called *Naïve rating* (Klepsch, Schmitz dan Seufert, 2017). However, in this research there is no mark given for learning situation. Interviews were conducted by asking students via video calls or using zoom application.

The observation sheets show that Intrinsic Cognitive Load can be seen from students' questions during learning. Intrinsic Cognitive Load that appeared is about understanding the definition of the terms in the material being studied. Intrinsic Cognitive Load can be seen from the questions asked by students as seen from the list of questions asked by students as that in the learning process, giving attention to working memory load is urgent Working memory load should be maintained in order to give useful load at class (Gathercole *et al.*, 2016). The load is included as intrinsic cognitive loads since it is cognitive intrinsic in School Mathematics 1 Learning. As for the list of student questions in learning is as follows:

1. What are assimilation and accommodation?
2. What are standard measurement?
3. What are intertwined principles?
4. What are guided reinvention through progressive mathematization?
5. What are visualizing problem?
6. One of mathematical main principles is leveling principle. What is it?
7. What is meant by study concept in PISA related to long life learning? Give example.
8. Three aspects assessed in PISA are content, context and competence. Explain those three aspects.
9. How is the form or concept of knowledge deconceptualization of concept?
10. What is Systems Approach?
11. What is Conceptual Approach?
12. What is meant by the objective of PISA using symbolic language, formal and operation?
13. How is the level of students' mathematical ability according to PISA level?

The results of observations from School Mathematics 1 learning and the questions posed by students indicated the intrinsic cognitive load of students in understanding concepts in School Mathematics 1 learning. The concepts that become difficult for students are those related to studying and learning. It appears that students did not understand the definition of assimilation, accommodation, standard measurement, the principle of intertwined, rediscovery, problem visualization, and so on. These difficulties that student experienced in School Mathematics 1 that they just participated, the following results of interviews with

students. Student Said “*Sir, I find it difficult to memorize definitions. For example definitions of accommodation, assi-milation and others. Sometimes I remember them for a while, but then forgot. Too many words to memorize. Is it true that we should memorize them exactly as they are written in the book or is it enough to remember the essence?*”.

Difficulty in understanding the definition of terms in School Mathematics 1 learning indicates the emergence of intrinsic cognitive load felt by students. Likewise, the questionnaire that had been given also shows difficulties in understanding the definition of terms in the concept of learning mathematics.

Intrinsic Cognitive Load above is caused by many elements of interactivity that must be processed in the students’ cognitive systems. The elements of interactivity put a burden on students while studying. The number of elements of interactivity and the material complexity become an intrinsic cognitive load in learning (Yohanes, Subanji dan Sisworo, 2016). Interactivity elements which are able to connect the *Problem Posing*, being managed by consistent habituation in problem solving to create effective learning (Ngaeni dan Saefudin, 2017).

The next difficulties indicating the emergence of intrinsic cognitive load relate to the example of the implementation of the term learning in Mathematics in daily life. The teacher readiness in learning can be so influential to the end result of learning process. Lesson Study gives *good impacts* in real learning (Rizki, 2014). It is needed attention that *Open-ended learning will be not effective when viewed from the result of cognitive study* (Rahmawati ES dan Harta, 2014). These difficulties can simply be said to be the difficulties in understanding real examples of learning Mathematics. These difficulties can be found in the results of observations and also list of students’ questions in School Mathematics 1 lectures as follows:

1. Give examples of knowledge on concept and procedure.
2. Give examples of Standard Measurement.
3. Give examples of Standard and Non-Standard Measurement.
4. Give examples of the choosing of geometric shapes.
5. What is visualizing problem?
6. How to solve Math problems using horizontal/vertical mathematical approach?
7. What is lifelong learning in PISA? Give example.
8. What is meant by study concept in PISA related to checked aspects in PISA?
9. Three aspects assessed in PISA are content, context and competence. Explain those three aspects.
10. Give example of pedagogical approach. Is it suitable with all levels of education or just with one level?
11. The last sentence of the fourth slide entitled Rendering PISA Results says “...explicitly, PISA does not assess the students’ knowledge about the current curriculum in their state, but assess the number which had been agreed upon. How is the assessment mechanism? Give example the number which had been assessed internationally.
12. What is conceptual approach? Give example.
13. Of the 4 learning media, which one is the most suitable for Elementary Students?
14. Give examples of 4 Math approaches.
15. How to calculate the area of a flat shape from an irregular shape?

The difficulty of determining a concrete example of a term in the School Mathematics 1 becomes a difficulty for students. They felt it very abstract and find it difficult to understand without a concrete or real example. The results of interviews with students that contained about other than difficulties in understanding the definition, other difficulties presented by the students were “*It was difficult for me to understand because I didn't know what the examples were like. There is only a definition, but I don't really understand it, sir. Hehehehehehe*”.

Intrinsic Cognitive Load is very visible from the list of questions asked by students, the observation sheets, and the interviews. These difficulties impose a burden on students' cognitive related to elements in learning.

Those elements refer to the relationship between a learning concept in everyday life or in other words the connection between Mathematics learning and everyday life. The questions that arise are difficulties which can lead to process skill errors in determining concept examples in real life (Kirschner *et al.*, 2018).

The difficulties may happen because of the lack of prerequisite knowledge of students. One of the ways in managing intrinsic cognitive load can be done by giving pre-training as learning strategies (Huang, 2018).

This Intrinsic Cognitive Load is related to the Interactivity Element between a Mathematics Learning concept and its application in real conditions. The Interactivity Element is part of the Intrinsic Cognitive Load that appears in the practice of Learning Mathematics (Yohanes dan Lusbiantoro, 2019).

The next Intrinsic Cognitive Load can be seen from the real situation in education in Indonesia. PISA actualization and the current situation in Indonesia are burdensome for students to understand. This can be seen from the results of observations from student questions, questionnaires, and also interviews. These questions which shows the emergence of intrinsic cognitive load regarding PISA Actualization in Education in Indonesia as follow:

1. How do Indonesian students' opinion about PISA?
2. How is the ability of students management compared with pedagogical competence?
3. How is the application of PISA to education in Indonesia?
4. How is the review of the reflective form of the curriculum in Indonesia?
5. Explain whether PISA results in 2020 show an increase or decrease.
6. How is the development of PISA in Indonesia?

PISA actualization in Indonesia provides interesting discussions from students which makes it difficult for them. The difficulty is felt because of their limited knowledge of the conditions of education in Indonesia. Students also feel strange of the word PISA which is the benchmark for the achievement of school children across countries. Difficulties can be seen from the results of the interview regarding the difficulties experienced when discussing PISA (Programme for International Student Assessment. The student said *"I am confused sir. I just know about PISA. So if I have trouble.... obviously everything is difficult because I don't really understand and maybe in the future I will look for information about PISA. Hehehehe"*.

The results of the interview above clearly show that difficulties experienced by students regarding the actualization of PISA in Indonesia. This difficulty is also caused by the insufficient knowledge possessed by students. Their prior knowledge about PISA Learning considered low. Students' prior ability in learning affect the low level learning (Sari, Purwasih dan Nurjaman, 2017). Intrinsic Cognitive Load is clearly seen from the actualization or the real situation of education in Indonesia.

PISA actualization in Indonesia gives difficulties for students in terms of understanding. Students still do not understand about PISA and also cannot find references about PISA. PISA is an international body that has researched education rankings in several countries and that is a separate difficulty from the material that has been studied. The ranking does not lead to a learning process but is also influenced by the state of learning that has an impact on the final result. This difficulty depends on the level of student ability which influences the ability to think creatively. Creative thinking consists of fluency, novelty, and flexibility aspects that affect the level of initial abilities possessed (Murtafiah, 2017). The ability to think creatively can also be encouraged by providing open-ended problems in learning (Noer, 2013).

Intrinsic Cognitive Load arises from students' difficulties in seeing the situation or getting information about education in Indonesia. The prerequisite knowledge of students

about Education in Indonesia at PISA makes students experience difficulties. This Prerequisite Knowledge is also the cause of the complexity of the material that has been studied, which causes the emergence of Intrinsic Cognitive Burden in Mathematics learning practices (Yohanes, B. Subanji, 2016).

CONCLUSION

Intrinsic Cognitive Load that appears in School Mathematics 1 learning can be seen from the Element Interactivity contained in School Mathematics 1 which takes form of terms or concepts in mathematics learning, for example, are the meaning of Knowledge, standard measurement, Mathematical Approach, Interwoven Principles, Content, Context, Competence, PISA Learning Concepts, Deconceptualization, Systems Approach, Conceptual Approach, etc. The next emergence of Intrinsic Cognitive Load can be seen from isolated/interacting elements (separate or interacting elements). Isolated/interacting element can be seen from looking for examples of implementation in the real world and actualization of events in Indonesia. An example of implementation in the real world is an element that interacts in real situations in the practice of learning Mathematics. Suggestions for further researches are to be able to see the emergence of Intrinsic Cognitive Load in standard content material. In addition to research, the emergence of cognitive load can also be reviewed about instruments measuring cognitive load in a lesson. During the Covid-19 pandemic period and online model learning today, it is very important that we look at the extraneous cognitive load so that it can become the basis for preparing Mathematics learning.

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