Analysis of content components and context components of mathematics literacy on linear algebra

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Abstract. The aims of this research is to describes of the content components and context components of mathematics literacy on linear algebra materials. This research uses descriptive qualitative approach with documentation, observation, and interview methods. The results of the study were reviewed from the content component, the average score of the learning plan semester was 3.83; the average score of learning media is 3.50; average score of learning evaluation tool 3.40; and the average score of material by students is 3.50. Whereas in terms of the context component, the average score of interpretation is 2.00; the average representation score is 1.75; the average calculation score is 2.15; and the average communication score is 2.00. Based on the results of the study, it was concluded that the content components of linear algebra was quite good, with score more than 3, while the context components of the representation aspect obtained the lowest results among other aspects.

1. Introduction
One indicator that shows the quality of education in the country tends to be low is the result of an international assessment of student achievement. The Program for International Student Assessment (PISA) is an international assessment of student achievement. Indonesia followed PISA in 2000, 2003, 2006, 2009, 2012 and 2015 with the results not showing many changes in each participation. In the 2009 PISA assessment, Indonesia ranked 61 out of 65 participants with an average score of 371, while the international average score was 496. Meanwhile in 2012 Indonesia experienced a downgrade, ranking 64th out of 65 participating countries with an average score average 375. In 2015, there was a significant increase in educational attainment in Indonesia, which was 22.1 points with a score of 386, ranked 58th out of 65 participating countries. The most important thing is to follow up so that the achievements will continue to be improved by improving the quality of education in Indonesia.

Mathematics literacy as the ability to know, understand, and apply mathematics to solving everyday life problems. Mathematics literacy as a student's ability to identify and understand the role of mathematics in real life [1]. The same thing, mathematics literacy is the knowledge to know and apply mathematics to everyday life [2-4]. Mathematics literacy is an issue in society that people should be able to access the quality of mathematics education to be able to think mathematically [5]. Literacy strategy is how to applied mathematics into problem solving of daily life [6]. Characteristics
of PISA questions include the contextual substance, demanding reasoning, argumentation and creativity in solving them. This is consistent with the characteristics of mathematics learning in universities. Therefore, it is very relevant if mathematics education in universities is directed in line with PISA.

According to the Organization for Economic Cooperation and Development (OECD), the mathematics problems in the PISA study measure more mathematical literacy, namely the ability to reason, argue and solve problems rather than questions that measure raw technical abilities related to memory and mere calculations [7]. PISA questions examine three aspects of assessing mathematics literacy, namely the components of the process, content, and context. Content or content of mathematics is something that must be used to solve existing problems. Mathematical content divided into 4 (four) parts, namely change and relationship, space and shape (space and shape), quantity (quantity), and uncertainty and data (uncertainty and data) [8]. While the OECD describes the level of mathematical literacy skills in the PISA study, especially in its mathematical abilities. The level of mathematical ability in the PISA study is translated into 7 (seven) levels, namely level 6, level 5, level 4, level 3, level 2, level 1, and under level 1 [9].

The researcher chose linear algebra material because one of the components in PISA content is change and relationship (change and relationship) related to algebraic material. The content component is then described in the semester learning plan, learning media, evaluation tools, as well as material completeness by students. Assessment is the measurement of the knowledge id widely [10]. While the context component, the researcher limits the scientific component because it is specifically related to scientific activities that are more abstract and require understanding and mastery of theory in solving mathematical problems. The scientific component is limited to interpretation, representation, calculation, and communication.

Based on the results of previous studies [11], mathematics literacy skills of mathematics education students in terms of process components in linear algebra viewed from the aspect of communication achieved an average score of 3.29, meaning that students were quite active in launching ideas when discussing. However, based on the results of the mathematics literacy test results obtained that as many as 60 students or 100% were below level 1, with a score of less than 358. At this level, students were not able to perform mathematical operations correctly. However, they were unable to use their mathematical skills to solve the easiest PISA problems. The most prominent ability is communication, which is that students are able to write down what is known in the problem.

This research is a continuation of previous research in 2017. The previous research [11] analyzed mathematics literacy skills in terms of process components. While this study analyzes the ability of mathematics literacy in terms of component content and context components, with more detailed component indicators. The purpose of this study is to obtain a detailed description of the ability of mathematical literacy in terms of the component content and context components in linear algebra courses.

2. Methods
This type of research is descriptive qualitative which aims to describe the ability of mathematics literacy in terms of content components and context components in linear algebra. Departing from the research question, this study uses a qualitative approach. This research that intends to understand the phenomenon of what is experienced by the subject of research, such as behavior, perception, motivation, actions and others, holistically and by means of descriptions in the form of words and language, in a special natural context and by utilizing various natural methods [12].

Data collection techniques are carried out by observation, interviews, and documentation. The study also involved experts as expert validators who validated research instruments in the form of observation sheets, interview guidelines, and mathematics literacy test questions along with key answers and scoring guidelines as one source of documentation.

Data findings in qualitative research are declared valid if there is no difference between what the researcher reports and what actually happened to the object under study [13]. Researchers used
triangulation techniques for data collection techniques. Triangulation techniques to test the credibility of data is done by checking the data to the same source with different techniques. Researchers used interview techniques and then checked the data with direct observation and documentations.

3. Results and Discussion

This research begins with previous studies, while study of mathematics literacy skills in terms of content components, with only one indicator, namely the completeness of the material by students [14]. While [11], reviewing of mathematics literacy is reviewed only from the process components in linear algebra courses. This research is a follow-up study from previous research, which examines the content components and contextual components of mathematical literacy in linear algebra courses. The content component is measured in more detail by using four indicators, namely the semester learning plan, learning media, evaluation tools, and material completeness by students. While the ability of context is detailed in four indicators, namely interpretation, representation, calculation and communication.

This study aims to describe the ability of mathematics literacy in terms of content components and context components on the linear algebra. The results of the study are described as follows.

3.1 Content Components

Based on the results of observations and interviews, mathematics literacy skills in terms of content components obtained results:

a) Semester learning plan obtains an average score of 3.83 from a maximum score of 5. With the achievement of the score of identity of course 5, the identity of the course is described in a very complete and clear manner, including the identity of the study program and faculty, the name of the course, code and weight of courses, clumps of courses and allocation of total lecture time. The learning achievement of the course gets a score of 4 which means that the learning achievement has been clearly explained including the attainment of attitudes, knowledge of general skills and special skills. However, the achievement of learning has not been explained clearly related to cognitive abilities mastered by students. Indicators of achievement of competencies to get a score of 3 means that they are good enough that they have been described in accordance with the learning material, but the learning indicators have not been specifically described. Score for learning material 4 means that the learning material has been explained clearly but not yet complete. Learning method or strategy gets a score of 4 meaning that using creative methods include lectures, discussions, question and answer, discovery learning, as well as individual and group assignments. While the score for learning activities or student experience 3, it means good enough. Students begin to be trained for discussion and learn to find concepts.

b) Learning media obtain an average score of 3.50 from a maximum score of 5, with the achievement of the level of interest in learning media 4. The lecturer presents the material with interesting, direct learning using blackboard and book media. The systematic presentation of lecture material scores 4, meaning that the learning material is presented in a coherent and clear manner in accordance with the learning design. Accommodating students gets a score of 3, meaning that is good enough. Lecturers have tried to accommodate the diverse abilities of students, from those who are slow to fast. In this case the lecturer conducts scaffolding in the implementation of learning. While giving the opportunity to think and argue gets a score of 3, it means that the lecturer is enough to give the opportunity for students to think through the practice of the questions and to argue the results of the discussion.

c) Evaluation tool obtains an average score of 3.40 from the maximum score 5. Achievement of the suitability of the material with the evaluation technique gets a score of 4, meaning that the evaluation tool used is in accordance with the learning material that is using a description test questions in the form of assignments, quizzes, middle exams semester, and semester final exam. Accommodating students to do interpretation gets a score of 3, meaning that the lecturer has enough space to give students the opportunity to collect and explain mathematical information relevant to the problem, for example students write down what is known in the problem.
Accommodating students to do representation gets a score of 3, meaning that students are able to change the information known in the questions and then write them in the form of problem solving strategies. Accommodating students to do a score of 4 means that students are able to do calculations such as adding, subtracting, and manipulating mathematical numbers and symbols. Students are able to calculate the vector extension and subtraction, dot multiplication and crossing in vectors correctly. While accommodating students to communicate gets score 3 means that students are able to communicate the results of work both verbally and non-verbally well.

d) The completeness of the material by the student obtains an average score of 3.50 from a maximum score of 5, with a score of 3 learning reference completeness means that students simply have a reference or learning resource in the form of textbooks, notebooks and the internet. While the completeness of the lecture notes students get a score of 4, meaning that students have complete records, students record each material delivered by the lecturer, record each task and questions given by the lecturer.

The diagram of the analysis of mathematics literacy content components in linear algebra is presented in Figure 1.

**Figure 1. Content Components Diagram**

Based on Figure 1, it can be seen that the average score of semester learning plan is the highest among other indicators is 3.83. This shows that the semester learning plan made is good. The average score of learning media and material completeness by students gets the same score, which is 3.50 meaning that it is good enough, it needs improvement. While the average score of the evaluation tool gets the lowest score among the other indicators, which is 3.40, which means that it is good enough, but it needs improvement, for example by making an evaluation tool that is appropriate to the type of lecture material, paying attention to the time spent on questions, and the ability of students.

### 3.2 Context Components

Based on the results of the written test, mathematics literacy skills in terms of the scientific context components obtained the following results.
a) Interpretation ability reaches an average score of 2.00 from a maximum score of 2.50, meaning that most students are able to collect and write relevant information in the problem. However, there are still some students who still write information that is not relevant in the matter. For example, students have not been able to write the vector component if the starting point and starting point of the vector are known.

b) The ability of representation to achieve an average score of 1.75 from a maximum score of 2.50, meaning that some students are still unable to convert relevant information into mathematical forms. This is because students are still wrong when interpreting. For example, when looking for the parallelogram area, students have not been able to determine and draw the vectors that form the parallelogram.

c) Calculation ability to achieve an average score of 2.15 from a maximum score of 2.50 means that most students are able to perform calculations, addition, multiplication, and manipulation of numbers and mathematical symbols correctly even though the procedure is still wrong. For example, students are able to calculate the area of parallelogram or triangle through the concept of two vector crossing correctly, but there is a missing procedure.

d) Communication skills achieve an average score of 2.00 from a maximum score of 2.50. This is the same as the ability to interpret. Some students are still weak to argue in writing. Students still have difficulties in arranging sentences or procedures. From the results of interviews, students are actually able to understand the concept and do the calculation correctly, but not accompanied by communication or presentation of the results of a clear settlement. Some students feel lazy, forget, to lay out the completion steps so that the work steps presented are only partial or imperfect.

The diagram on the analysis of the context components of mathematics literacy in linear algebra courses is presented in Figure 2.

![Figure 2. Context Components Diagram](image-url)
Based on Figure 2 above, it appears that the calculation ability gets the highest score compared to other abilities, which is 2.15 from a maximum score of 2.50 meaning that the calculation ability is good. Students are able to complete mathematical operations well. Communication skills are similar to the ability to interpret with an average score of 2.00 obtaining the second rank after the ability to calculate, meaning that communication skills have not been maximized. This is different from previous research [11], that the most prominent communication skills among the components of the process of mathematical literacy in linear algebra courses. In this study, students have not been fully capable of doing a good interpretation. Some students still have difficulties in understanding the problem, resulting in representation abilities. The ability of representation to obtain the lowest average score of 1.75 means that it is not good enough. Students have difficulty in making problem-solving strategies, have not been able to make vector images correctly so that it results in mathematical literacy abilities.

4. Conclusion
Based on the results of the research and discussion, it can be concluded as follows.

a) Analysis of mathematics literacy in terms of the linear algebra subject content component, namely the average score for the semester learning plan 3.83; average score of learning media 3.50; average score of evaluation tool 3.40; and the average score of material completeness by students is 3.50 from the maximum score 5. The most prominent indicator is the semester learning plan, meaning that the learning plan is already good.

b) Analysis of mathematics literacy in terms of the components of the linear algebra course context, the average score of interpretation is 2.00; the average score of representation is 1.75; average calculation score of 2.15; and an average communication score of 2.00 from a maximum score of 2.50. The most prominent abilities are calculations, but are still weak in the representation section.

Based on the above research conclusions, the following suggestions can be given as follows. Lectures should provide insight into the problems of mathematics literacy to students and familiarize train students to work on the problems of mathematics literacy. Lecturers should give more a matter of reasoning, argumentation, and problem solving to students, so that students' mathematics literacy skills to reach the maximum level.

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References

[1] Stacey K 2010 Mathematical and Scientific Literacy Around The World Journal of Science and Mathematics Education in Southeast Asia 33 1
[2] Ojose B 2011 Mathematics Literacy: Are We Able To Put The Mathematics We Learn Into Everyday Use? Journal of Mathematics Education 4 89
[3] Draper R J 2002 School Mathematics Reform, Constructivism, and Literacy: A Case for Literacy Instruction in The Reform-Oriented Math Classroom Journal of Adolescent & Adult Literacy 46 6
[4] Wong P 2005 Mathematical Literacy of Hong Kong’s 15 Year Old Students in PISA Education Journal 32 1
[5] Brewley D S 2012 College Mathematics Literacy Workers of The Young People’s Project. Chicago: A Community of Practice Journal of Urban Mathematics Education 5 44
[6] Hill et al 2010 Moving Beyond The Word Wall: How Middle School Mathematics Teachers Use Literacy Strategies NCSM Journal 11 6
[7] OECD 2010 *The Programme for International Student Assessment (PISA)*
http://www.oecd.org/dataoecd/61/15/46241909.pdf (downloaded 5 October 2013)

[8] Lange et al 2006 *Assessing Scientific, Reading, and Mathematical Literacy: A Framework for PISA 2006* Paris: Organization for Economic Co-Operation and Development (OECD)

[9] Haahr et al 2005 *Explaining Student Performance Evidence from The International PISA TIMMS, and PIRLS Surveys* Danish: Danish Technological Institute

[10] Webb N L 1993 *Assessment in The Mathematics Classroom Yearbook*. Virginia: National Council of Teachers of Mathematics, inc America

[11] Rusmining 2017 *Analisis Kemampuan Literasi Matematika Mahasiswa Pendidikan Matematika Ditinjau Dari Komponen Proses* Unnes Journal of Mathematics Education 6 384

[12] Moleong 2010 *Metodologi Penelitian Kualitatif* Bandung: Remaja Rosdakarya

[13] Sugiyono 2010 *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D* Bandung: Alfabeta

[14] Rusmining 2014 *Analysis of Mathematics Literacy, Learning Constructivism and Character Education* International Journal of Education and Research 2 331