Student's Understanding of Graphs based on Interpersonal and Logical Mathematical Intelligence in Class XI MAN 1 Banda Aceh

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Abstract

This study aims to determine the ability of students in understanding of graph based on interpersonal and logical mathematical intelligence. The approach used in this research was mixed methods by using the stepwise mixed model especially sequence explanatory model. The subjects were six students on grade XI of MAN 1 Banda Aceh selected based on students who have interpersonal and logical mathematical intelligence. The results showed that student's graphics ability with high interpersonal intelligence was in fair criteria, the student was able to translate the graph, but not yet able to interpret and extrapolate the graph. A student with medium interpersonal intelligence had good criteria in understanding the graph when viewed from the ability to translate and interpret the graph, but still made mistakes in interpreting the graph. The ability to understand graphics of low interpersonal students was in good criteria that was shown by smoothly translating graphs, being able to interpret graphs, and being able to extrapolate graphics appropriately. Student's understanding of graphs of high mathematical logical intelligence was at excellent criteria that were showed by being able to translate graphs, being able to interpret and extrapolate graphs. The ability of understanding graphics in students with medium mathematical logical intelligence was having good criteria means that students are fluent in translating the graph but still lacking in interpreting and extrapolating the graph. Student understanding of graph with low mathematical logical intelligence had inadequate criteria, meaning that student was only able to translate graphs on some translational indicators.

Keywords: interpersonal intelligence, logical mathematical intelligence, mathematical understanding.

Introduction

Graphics is one of learning that contains many concepts, but requires very little space. This statement is in accordance with the opinion of Weintraub (1967): Graph…have assumed an increasingly important role in our society. They present concepts in a concise manner or descriptions of descriptive writing. They are also a tool used in science and mathematics to display data and to help analyze the relationships among

the variables so that the data presented will be more clear, concise, concise and simple than the delivery of information in the written description (Saminan, 1996; Koentjaraningrat, 1986). The statement explains that it is very important for students to understand the graph, as it can assist students in obtaining information and solving math problems.

Based on observations of researchers at MAN 1 Banda Aceh found that students still have difficulties in understanding math problems. The basic common mistakes were to draw and to read the graph. Those are seen on the MAN 1 Banda Aceh students test sheet. In addition, according to the National Examination data of the last 5 years there were questions about the graphic, including those in 2012, there was one problem about the graph, in 2013 there were 2 questions, in 2014 there were 3 questions, in 2015 there were 3 questions, and in 2016 there were 2 questions. So it is important for students to be able to understand the graph well. The type of difficulties faced by students is the ability of students in translating, interpreting, and extrapolating mathematical concepts in the graph. These facts are also justified by the math teacher.

The understanding of the graph is the accurate understanding to pull out all information available on the graph. According to the theory of Bloom (1971), there are three aspects of students' ability to understanding the concept, namely translation, interpretation, and extrapolation. The translation is defined as the ability of a person to change or translate a communication into another language or another term, or into another form. One of the abilities of the translation expressed by Bloom is the translation of the symbolic form to another form or vice versa. The symbolic forms in question include maps, tables, diagrams, graphs, mathematical equations, and visualizations, so the ability to translate from symbolic forms into verbal forms is part of this category. Interpretation in mathematics is the ability to interpret verbal statements, the ability to interpret images, interpret graphs, diagrams, and mathematical equations, the ability to interpret different types of data, the ability to make appropriate qualifications in interpreting data, the ability to distinguish between or contradictory conclusions from the data arrangement. Extrapolation is the ability to forecast or estimate. The ability of understanding of extrapolation types is based on the ability of translation and interpretation, so the ability of extrapolation demands the mastery of translation and interpretation abilities.

The ability of students in understanding the graph is also influenced by intelligence. According to Gardner (1983) intelligence is the ability to solve problems that occur in human life or problem solving ability; the ability to produce new problems to solve; the ability to create something or the ability to produce products that will give rise to an appreciation of human culture (Champbell et al, 2002).

Based on the theory of multiple intelligences proposed by Gardner above, interpersonal intelligence and mathematical logical intelligence is part of multiple intelligences. Interpersonal intelligence is the ability to understand and interact well with others. This intelligence is expressed in the joy of friendship and pleasure in various social activities and the reluctance of solitude and solitude. People who have this type of intelligence like and enjoy working in groups, learning while interacting and working together are also happy to act as mediators of disputes both at school and at home and in the environment (Jasmine, 2012).

Logical mathematical intelligence is the intelligence of numbers and reasoning. This intelligence is the ability to use inductive and deductive reasoning, to solve abstract problems, and to understand the complex relationships between mathematical analysis and the scientific process. Also, students who stand out in this intelligence

are happy with the learning process designed in the form of problem analysis, questions, experiments, and analysis to find solutions (Harsanto, 2007; Yaumi, 2012).

Based on the above description, the research problem formula is: "How does the student's ability to translate, interpret, and extrapolate graph concepts based on interpersonal intelligence and mathematical intelligence in Class XI MAN 1 Banda Aceh?"

Literature Review

Definition of Graph

In mathematics learning graph method is most often used to display information. Graphs are often referred to as charts. The graph serves to explain to the graphic readers or people who need the data, the graph itself can make it easier for readers to know and read data without using the wordy words because it presents data in the form of numbers in a worksheet in the form of graphical visualization.
Graphs can be defined as the presentation of framed data, an image table that can have highly useful information values, but from graphs depicting the essence of information at a glance will be more effective. Graphs are a more compelling integration of some well-structured tabular data, the purpose of graphics is to look at comparisons, qualitative information quickly and simply.

Understanding of Graphics

The ability of students in understanding the graph is the ability of students in translating, interpreting, and extrapolating mathematical concepts and presented in the graph. According to the theory of Bloom (1971) understanding of the concept means the aspect that refers to the ability to understand and understand a concept and interpret the meaning of material. The ability of students in interpreting from a concept can by reflecting from the expression of students through words, writing, and the response in explaining back through his language. Bloom classifies students' ability to understand concepts into three aspects, namely translation, interpretation, and extrapolation.

Translation

Translation is defined as the ability of a person to change or translate a communication into another language or another term, or into another form. One of the abilities of the translation expressed by Bloom is the translation of the symbolic form to another form or vice versa. The symbolic forms are liked maps, tables, diagrams, graphs, mathematical equations, and visualizations, so the ability to translate from symbolic forms into verbal forms is part of this category. With a broader explanation, the abilities included in the symbolic translation category according to Bloom (1971, 151) include: (1) the ability to transform or translate geometric concepts verbally given into pictures or terminology of space and vice versa; (2) ability to graph the symptom, or from the observed or recorded data, (3) the ability to read numbers which in physics are expressed in terms of quantities, units and constants, and (4) the ability to read pictures or read the diagram.

Interpretation

Interpretation is interpreted by interpretation or interpretation; broadly interpretation is the ability to interpret from a form of representation. Interpretation relates to the communication representation of an idea configuration, which may require a repetition of the idea into a new configuration of interpreter thinking. In interpreting a representation, a person first translates any parts of the representation that are still general to facilitate the interpretation of representations, or by converting one form of representation to another.

When interpreting a graph, the kind of interpretation students need depends heavily on what the graph indicates. The most commonly used graphs in the study are those that represent abstract functional situations or relationships (usually expressed by equations, and sometimes represented by tables of ordered pairs), or considered as entities. The meaning derived from the interpretation can be within the symbolic space of the graph, or it can move to a different space (the space of the situation or the algebraic space). Interpretation requires moving from one form of representation to another (Janvier, 987d and Kaput, 1987c).

Extrapolation
Extrapolation is the ability to forecast or estimate. Extrapolation demands a higher intellectual ability because one is required to see something written in a click. Make predictions about consequences or expand perceptions regarding time, dimension, case, or problem.

The extrapolation activity on a graph refers to the alleged action of a particular graphics section of how the graph should be placed or how other parts of the graph should be visible. One example of the case is a prediction task involving pattern detection, either in contextual science situations (Karplus, 1979) or in abstract situations (Stein & Leinhardt, 1989).

Multiple Intelligence
Multiple intelligence or multiple intelligence was first introduced in 1983 by Howard Gardner at Harvard School of Education and Harvard Project Zero. This theory refutes tests such as the Stanford Binet Test example which is said to be a traditional count that does not accurately assess intelligence. According to Gardner, intelligence exceeds than just IQ (Intelligence Quotient) because high IQ without any productivity is not good intelligence. Children should be judged on what they can do not what they cannot do. Intelligence is defined as the ability to solve problems and have more value in community culture. Intelligence is a bio psychological potential for processing information so that it can solve problems, create new results that add value to local culture. This new outlook is very different from the old view that always relies on two verbal and computational judgments.

According to Howard Gardner theory in every human being there are 9 kinds of intelligence, namely: (1) Linguistic intelligence, (2) Logical mathematical intelligence, (3) Musical Intelligence, (4) Musical Intelligence, (5) Visual-spatial intelligence, (6)) Interpersonal intelligence, (7) Intrapersonal intelligence, and (8) Naturalist intelligence, (9) Spiritual Intelligence. But in this research will be discussed only two intelligence, namely interpersonal intelligence, and logic mathematical intelligence.

Interpersonal Intelligence
Interpersonal is the intelligence associated with social understanding. This intelligence is the ability to connect with others by reading various moods, temperaments, motivations, and goals of others. Learning activities include: applying the jigsaw model, doing board games, teaching peers, creating teamwork, collaborative skills, simulations, interviews (Jasmine, 2012).

The characteristics of Interpersonal intelligence as described by Gardner in Hoerr (2010) are enjoys cooperative games, demonstrates empathy toward others, has lots of friends, is admired by peers, displays leadership skills, prefers group problem solving, can mediate conflicts, understand and recognizes stereotypes and prejudices.

Logic Mathematical Intelligence
Mathematical Logical Intelligence is intelligence concerning numbers and reasoning. Characteristic of this variety of intelligence is the ability to use inductive and deductive

reasoning, solve abstract problems, and understand causal relationships. According to Yaumi (2012), learning activities include scientific thinking, conducting experiments, critical thinking, making sequences, comparing, making patterns, solving problems.

Logical or mathematical intelligence is known as intelligent numbers including scientific abilities which are often referred to as critical thinking. People who have this intelligence tend to do something with data to see patterns and relationships. In addition, they also love figures and can interpret data and analyze abstract patterns easily. People who are strong in this intelligence are very happy to count, ask, and experiment.

The characteristics of logical mathematical intelligence in Hoerr (2010) are notices and uses numbers, shapes and patterns, precise, use the information to solve a problem, loves collections, enjoys computer games and puzzles. Then, takes notes in an orderly fashion, thinks conceptually, can estimate, explores patterns and relationships, constantly questions, likes to experiment in a logical way, organizes thoughts, employs a systematic approach during problem-solving are also the characteristic mentioned.

Research Methods

This study aimed to analyze students 'understanding of the graph regarding students' interracial and logical mathematical intelligence so that this research approach uses a combination approach (mixed methods). In this research, the researcher uses a strategy of mixed step method (Sequential mixed method). The strategy of this gradual mixed method was divided into several parts, which was explained as a sequential explanatory strategy. In this model, the researcher collects the data with the quantitative method at the first stage and then the qualitative method at the second stage. Qualitative data was used to support the quantitative data that has been obtained.

In this study, researchers collected preliminary data with quantitative data in the form of intelligence questionnaires to group students based on intelligence and then the researchers gave a grasp understanding test to determine the level of understanding of the graphs held by students. After the quantitative data was obtained, the researcher analyzed the quantitative data and described it. In the next stage, researchers collect qualitative data with interviews. This interview was useful to support the quantitative data that has been obtained. The main weight of this research was qualitative data obtained and described.

The problem used in this study was a matter that has been validated by experts and has been tested. The test instrument used was a test of students' ability to understand the graph. Understanding student graphs here was viewed from 3 aspects, namely translation, interpretation, and extrapolation. The indicators used in this test based on three aspects of the above understanding is as follows.

Table 1. Indicators of Understanding Aspect

No	Aspects of Understanding	Indicators
1.	Translation	Read Numbers Read pictures / graphics Translate Information Make charts
2.	Interpretation	Interpret verbal statements Interpret data/numbers

		Interpret and analyze charts or diagrams
		Distinguish contradictory conclusions from data
3.	Extrapolation	Estimate the graph formed

Criteria of understanding of Permendikbud No. 104 at 2014:

Table 2. Criteria of Understanding of Permendikbud No 104 at 2014

Scale	Predicate
86-100	Excellent (A)
70-85	Good (B)
56-69	Fair (C)
≤ 55	Inadequate (D)

The results of the test would have reviewed three things, namely the ability of students in translation, interpretation, and extrapolation of the graph viewed of interpersonal intelligence and logical mathematical intelligence.

Results and Discussion

Student's Understanding of Graph with Interpersonal Intelligence

Based on the results of the study, there were three interpersonal intelligence students: high, medium, and low levels. This intelligence analysis was obtained by giving a talent questionnaire and interview.

Table 3. Understanding of Graph based on Interpersonal Intelligence Level

Student based on the level of Interpersonal Intelligence	Interpersonal Intelligence Score	A score of Test about Graph	Predicate/ Criteria
A student with high interpersonal intelligence	48	58	Fair
A student with medium interpersonal intelligence	33	73	Good
A student with low interpersonal intelligence	26	80	Good

Based on table 3, the score of interpersonal intelligence was got from talent questionnaire that has a score of 50 as the highest score of interpersonal intelligence. The test score about the graph was got from analyzing the indicators of understanding aspects including translation, interpretation, and extrapolation.

The student who had a high level of interpersonal intelligence in understanding of graph was on fair criteria. Understanding the graph with fair criteria meant that the student was only fluent on the part of translating the graph, especially on reading indicators of numbers, making graphs with available data, and translating information. When a student comes to the problem of analyzing/interpreting, the student confused because he/she was unable to associate the information available on the graph so that in answer the problem makes many mistakes. The result of the extrapolation of the student graph was not the exact result of the wrong analysis result. Understanding of graphics that student who had medium interpersonal intelligence was on good criteria. Understanding the graph with good criteria here meant that the student was fluent in translating the graph, especially on indicators reading numbers, reading pictures/graphs, and translating information. This student could also analyze the graph but was not careful in answering the problem so often make mistakes.

For students with low interpersonal intelligence the ability to understand the graph was in good criteria. Understanding the graph on the good criteria here meant the student was able to read the numbers, graphics, and verbal revelations smoothly. It was also capable of translating data into graphs and graphs into equations. In addition, the ability of interpretation was also very good, meant that able to analyze the given graph by linking any information available on the graph. When viewed from the extrapolation aspect, the student was able to estimate the graph correctly. It was occurred because of the correct graphics analysis capability so that extrapolation was correct.

By looking at the results of the above analysis, the researchers found that the lower the interpersonal intelligence, the better the graphing understanding, the researchers found that students with high and interpersonal intelligence were high and did not like something as complicated as numbers and did not like individual learning systems. They assume that everything was a solution and the solution can be solved by exchanging thoughts so that when faced with the problem to be done, each of them experiencing confusion because they cannot exchange ideas with other students.

Student's Understanding of Graph with Logical Mathematical Intelligence

Based on the results of the research, researchers found students who had logical intelligence mathematically with high, medium and low levels. This intelligence analyzed was obtained by giving a talent questionnaire and interview.

Table 4. Understanding of Graph based on Logical Mathematical Intelligence Level

Student based on the level of Logical Mathematical Intelligence	**Logical Mathematical Intelligence Score**	**A score of Test about Graph**	**Predicate/ Criteria**
A student with high logical mathematical intelligence	45	87	Excellent
A student with medium logical mathematical intelligence	35	72	Good
A student with low logical mathematical intelligence	16	52	Inadequate

Based on table 4 showed the predicate/criteria student in the understanding of the graph. A score of logical mathematical intelligence researcher got from intelligence questionnaire was 50 for the highest score of logical mathematical intelligence. A score of test about the graph was got from analyzing the indicators of understanding aspects that is translation, interpretation, and extrapolation.

Student understanding of graph when based on from the logical intelligence mathematically was in accordance with the level of intelligence possessed. It could be seen from the analysis of each aspect of understanding and interview results. Students who had a high level of logical mathematical intelligence, the ability of this student to understand the graph was at excellent criteria. An understanding student on excellent criteria meant that when viewed from the aspect of the student's translation, he was able to read numbers, graphics, translate information, and graphics smoothly. This student was able to transform the data into the graph and graph into equations. In analyzing, the student was able to link the information contained in the graph so that the extrapolation result was made in the right. In addition, the results of the questionnaire test in accordance with the test results about the understanding of the graphics of this student got the highest score among his friends.

Students with mathematical logical intelligence at the medium level when reviewed their ability to understand the graph has good criteria. Understanding the graph on

good criteria here meant that the student was able to translate the graph but less able to interpret the graph. The student was only able to turn data into graphics only. When they were given a matter of graph and asked to analyze, this student was experiencing confusion. The student was unable to link the information of the wrong analysis.

A student with low mathematical logical intelligence in the understanding of graph had inadequate criteria. Understanding the graph in inadequate criteria when reviewed from the aspect of translate the graphics of this student had not been able to read graphics correctly. He did not yet understand where the point 0 was on the Cartesian coordinate. At the time of analyzing the graph, he was only able to analyze or wrote down the points contained in the graph only. It was unable to associate these coordinate points and could not apply what concepts could be used for analyzing. The extrapolation results were also less because of wrong analysis results. Looking at the patterns formed above that the higher the mathematical logical intelligence than the better understanding of the graphics of students showed that the mathematical thinking process of students in accordance with the level of intelligence it has. A student with high logical mathematical intelligence tended to think systematically and was very fond of solving challenging problems so that the mathematical achievement gained is better.

Conclusions

Based on the results of research and data analysis, it can be concluded that students who have high interpersonal intelligence was in fair criteria. The students were able to translate the graph, but not yet able to interpret and extrapolate the graph. Students with medium interpersonal intelligence had good criteria in understanding the graph when viewed from the ability to translate and interpret the graph, but still made mistakes in interpreting the graph. The ability to understand graphics in low interpersonal students was in good criteria that was students smoothly translate graphs, be able to interpret graphs, and be able to extrapolate graphics appropriately.

Student's understanding of graphs with high mathematical logical intelligence was at excellent criteria that student was able to translate graphs, able to interpret and extrapolate graphs. The ability of understanding graphics in students with medium mathematical logical intelligence was having good criteria means that student was fluent in translating the graph but still lacking in interpreting and extrapolating the graph. Student understanding of graph with low mathematical logical intelligence has inadequate criteria, meaning that student is only able to translate graphs on some translational indicators.

References

Abdurrahman, M. (2003). *Pendidikan bagi anak berkesulitan belajar*. Jakarta: Rineka Cipta.

Armstrong, T. (2009). *Multiple intelligences in the classroom*. Virginia: ASCD.

Ambelu, T., & Gebregziabher. (2011). The effects of student-centered approach in improving students' graphical interpretation skills and conceptual understanding of kinematical motion.*Lat. Am. J. Phys*, *5(*2).

A. Van Heuvelen and X. Zou. (2001). Multiple representations of work energy processes. *Am. J. Phys, 69(*2), 184-193.

Bloom, B. S. (1971*). Handbook on formative and summative evaluation of student learning.* London: Looman Group Ltd.

Bloom, B. S. (1974). *Taxonomy of education objective*. Hard book of cognitive domain. London: Looman Group Ltd.

Creswell, Jhon W. (2010). *Research design pendekatan kualitatif, kuantitatif, dan mixed*. Yokyakarta: Pustaka Pelajar.

Gardner, H. (1983).*Frames of mind: The theory of multiple intelligences*. NewYork: Basic Books.

Harsanto, R. (2007).*Pengelolaan kelas yang dinamis*. Yogyakarta: Kanisius.

Hoerr, T. R. (2002). *Becoming a multiple intellegence school*: Buku kerja multiple intellegence. Penerjemah: Ary Nilandari. Bandung: Kaifa.

Hoerr, T. R. (2010*). Celebrating every learner*. San Fransisco: Jossey-Bass.

Irvaniyah, I., & Akbar, R. O. (2014). Analisis kecerdasan logis matematis dan kecerdasan linguistik siswa berdasarkan jenis kelamin. *Studi Kasus.* Cirebon: IAIN Syekh NurjatiCirebon, *3(*1), 2086 – 3918.

Jasmine,J. (2012). *Metode mengajar multiple intelligences*. Bandung: Nuansa Cendekia.

Koentjaraningrat. (1986). *Manajemen penelitian*. Jakarta: Aksara Baru.

Kozma, R.B., & Russell, J. (1997). Multimedia and understanding: Expert and novice responses to different representations of chemical phenomena. *Journal of Research in Science Teaching, 34*, 949-968.

McKenzie, W. (1999).*Multiple intelligence survey*.

Mustain, I. (2015). Kemampuan membaca dan interpretasi grafik dan data: Studi kasus pada siswa kelas VIII SMPN. *Scientiae educatia.* IAIN Syekh Nurjati Cirebon: Pass Sunyaragi, *5(*2).

NCTM. (1989).Curriculum and evaluation standards for school mathematics. Reston, VA: *NCTM*.

Roth, W. M., & Michelle, K. M. (1996). Graphing: cognitive ability or practice? *Issues and trend, 5A(*1) doi: 0036-8326/97/010091-16.

Saminan, dkk. (1996). Kemampuan mahasiswa pendidikan fisika FKIP Unsyiah dalam memahami konsep fisika melalui grafik. *Laporan hasil penelitian.* Banda Aceh: Universitas Syiah Kuala.

Sugiyono. (2013). *Metode penelitian kombinasi: Mixed methods*. Bandung: Alfabeta.

Sukino. (2013). Matematika Kelas X SMA/MA Kelompok Peminatan Matematika dan Ilmu Alam Kurikulum 2013. Jakarta: Erlangga.

Sternberg, R. J. (2008). *Psikologi kognitif*. Yokyakarta: Pustaka Pelajar.

Winarto, P. (2010). Maximing your talent. Online: www.PAULUSWINARTO.com

Yaumi, M. (2012*). Pembelajaran berbasis multiple intelligences*. Jakarta: PT. Dian Rakyat.