

DEVELOPING STUDENTS' MATHEMATICAL COMMUNICATION ABILITY THROUGH PERFORMANCE ASSESSMENT ON DERRIVATIVE TOPIC

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Abstract, This present study purposes to find out the Performance Assessment conducted toward performance, behavior or interaction of students. This study is a descriptive of quantitative research. Methodology chosen in this study is research and development combined with experimental method and the one group pre test post test design in the fourth step of research and development. "Constructed response is a task designed to make students construct answer with new and prior knowledge. It possibly requires students to make differently varying answers. This task could be a product or performance, such us essay, ordering decimal Passover number, mind mapping or concept map, making a prediction, drawing conclusion, journal response, homework reflection, the self-assessment, pair evaluation, evaluating others' work, figural representation, resources' problem, measuring an object, and conference. In addition, task in product form requires students to construct a product that can describe command students' understanding of concept and certain skills or their ability to apply, analyze, synthesize or predict the concept. Pease performance assessment related to real world problem is essential to be implemented to assess and · develop students' ability in mathematical communication. Therefore, performance assessment is a good solution to increase students' achievement in mathematics and form their behavior through value of mathematics education. The findings illustrate screened students' mathematical communication ability on the topics of the derivate at Senior High School in Banda Aceh feel good.

Keywords: *Performance Assessment and Mathematical Communication*

I. INTRODUCTION

Curriculum 2013 requires changes educations in Indonesia, one only change in mathematics. This change aimed to make learning more creative and the students can be actively involved in it. Learning that is expected in this curriculum is the teaching which means that learning should be directed to the real events. Learning this way in line with the idea that called by Prof. Hans Freudenthal and other figures in the Netherlands since the 1970s, namely mathematics teaching realistic approach (This Mathematics Education) (Suwarsono, 2013:1), where mathematics is associated with the real life.

In mathematics teaching, associate matter to in real life is very important. This encourages students to care about the importance and the ties of mathematics with the daily life, as well as give student motivation to learn mathematics. Besides, as learning is also able to stimulate the pattern of thought and analysis of the students to be more creative in solving mathematics problems. This is in accordance with the purpose of the curriculum 2013 namely creativity development (ability creative thinking) in mathematics teaching. According to Suwarsono (2013:4-

5), creative for students means critical thinking in solving mathematics problems and for teachers, creative in designing the questions open-ended and the questions non-routine can be considered the process and the results of the work of the students.

In addition, the curriculum 2013 also requires the students to be able to communicate mathematically. This is listed in the module of implementation curriculum 2013, which stated that the process of learning with the curriculum 2013 developed on the principle of student active learning through observation (see, read, hear, catching), ensnared (orally, paper), analysis (connect, determine relevance, build the story/concept), communicate (verbal, paper, pictures, graphs, tables chart, and others) (the Ministry of Education and Culture, 2013:85). All this time mathematics only considered as a calculations lesson, always associated with numbers. Whereas mathematics is the language that consists of the symbols is artificial given the meaning that can be understood (Sulthani, 2016:2). Therefore, mathematical communication is needed in order to convey the settlement Mathematics problem clearly.

However, mathematical communication that is very important is still apprehensive. This can be seen from the ability of students in completing the questions still low, even students less interested

with questions about the story that tend to require mathematical communication capabilities supported by Kemdikbud (in Suwarsono, 2013:6), based on the analysis of the results of the TIMSS (*Trends in International Mathematics and Science Study*) 2003, students we less enthusiastic, even left the questions that the information is long, and tend to be interested only in the routine questions that directly related to the formula and weak in the question of applications that contain a story, although refuses simple. Low mathematical ability students expressed by Siswono (2013:12) due to the applied mathematics teaching strategies tend to be oriented to the development of analytical mind with The problems that routinely, so that the creativity of the students including mathematical communication did not develop. used to working on the questions regularly and never given the enrichment of the questions non-routinely makes the students become lazy and less motivated working questions about mathematics that need analysis that is quite high and complex mathematical communication.

To solve the problem above, curriculum 2013 apply assessment of *performance assessment*, namely the assessment that combines three aspects: knowledge, skill and attitudes. Conceptually, authentic assessment significantly more meaningful if compared to test the multiple selection (The Ministry of Education and Culture, 2013:229), for this assessment to assess the ability of students to the comprehensive starting from the beginning of the process and until the end of the students work on tasks. This assessment in addition to able to create more meaningful learning can also show the ability of communication mathematics students. This statement supported by the Ministry of Education and Culture (2013:229) that this assessment emphasizes the complex tasks that allows students show their competence.

One of assessment authentic is performance assessment or *performance assessment*. Not only can assess the ability of students, this assessment can also develop mathematical communication skills students. Besides, assessment is actually very simple and very flexible to be used because it can be adjusted with the needs of the students and teachers. But in real world reality, many teachers sometimes still rarely implement performance assessment. This is assumed because it is difficult to devise a good performance assessment and the allocations of time to learn that is not sufficient to apply. So that the teachers are not motivated use this assessment and prefer to use traditional assessment is more practical but not effectively assess the ability of students comprehensively.

Based on the background that has been in describe above, become problems in this research is: *How to develop communication skills Mathematics high school students through learning and implementation of Performance assesment on Materi derivative?*

To menjawab these problems, we need to first understand what is meant by the communication. The communication is to convey an idea or ideas to others both orally and in writing in order to be understood. Dimiyati and Mudjiono (2010:143) proposed that communication is conveyed and obtain the fact, the concept and the principle of science in the form of audio visual or audio visual. Similarly in mathematics, communication has a very crucial role. This is strengthened by Umar (2012:2) who say that mathematics as a language and not just the appliance think, find the pattern, resolve the problem or take decisions, but mathematics is a tool that is very valuable to communicate various ideas by clearly and concisely. In addition, mathematics is also a social activity which can be interpreted as a tool of communication between the students and the students and the students and teachers. On the basis of the communication is very important in mathematics to convey mathematical ideas in the form of symbols, numbers, letters, pictures, graphs, etc. which is used to describe or complete a mathematics problems with the purpose to make those ideas can be understood by others.

According to Prayitno, Suwarsono and Siswono (2013:384), mathematical communication is ability students in understanding, representing and interpret the idea of mathematics in both orally and in writing. In addition, mathematical communication also contain the ability to use the language approach and representation of mathematics such as advanced by the NCTM (2000:60), mathematical communication is a way of expressing the idea of mathematics both orally and in writing using pictures, diagram, objects, presents in the form of algebra, or using the symbols of mathematics. So in mathematics teaching needed logic and communication for the process of thinking someone will be known to others when communicated. Now the achievement indicator logic capabilities and communication according to Wardhani (2010:21) including:

- 1) Presents the statement of mathematics with oral written, table, pictures, (for diagram communication)
- 2) Ask the alleged,
- 3) Do the manipulation of mathematics,
- 4) Draw conclusions, arrange evidence, provides the reason or evidence against truth answer,
- 5) Draw conclusions from the statement,
- 6) Recheck the validity of an argument,

- 7) Find the pattern or nature of the mathematical symptoms to make generalizations.

Meanwhile, Prayitno, Suwarsono and Siswono (2013:385) concluded communication indicator of mathematics based on the NCTM (2000) and Greenes and Schulman (1996) covers the ability:

1. Understanding mathematical ideas that are presented in the writing or oral.
2. reveal the mathematical ideas in writing or oral
3. Using mathematics language approach (notation, term and symbol) to represent mathematical information
4. Using representations mathematics (the formula, diagram, tables, graphs, model) to represent mathematical information
5. Change and interpret mathematical information in the representation of the mate of a different turn discoverable

To evaluate mathematics communication capabilities can be used *Performance Assessment*. *Performance Assessment* is assessments where the teacher asked comprehensively to assess the start of inputs (*input*), process and exodus (*output*). This assessment to assess the readiness of the students with process and results study (Ministry of Education and Culture, 2013:10). *Performance assessment* or performance assessment is one of the evaluation forms that are easy to apply authentic. According To the Ministry of Education and Culture (2013:16), *performance assessment* is a form of assessment of the results of the study that oriented on the process. The aim of this assessment so that the teacher can see how the students planning troubleshooting, see and observe how the students demonstrate the knowledge and skills. Apply *performance assessment* formally have some advantages, according to the Ministry of Education and Culture, namely:

1. Show how the students using the knowledge to perform activities and produce something;
2. The assessment instrument can be used several times;
3. Instrument the assessment can be used for diagnostic purposes;
4. With the same instrument, teachers can create a graph of the development of students from time to time;
5. Allows students to compete with himself;
6. Not the end, but part of the learning process; and
7. Make lessons in schools to become relevant to the real world.

Based on the benefits of performance assessment that background are by the Ministry of Education and Culture above, it is clear that the assessment is very important to be examined more information as material inputs for teachers. So, there are some things that need to be addressed prior to implementing performance assessment or *performance assessment*. First, teachers need to design the *performance assessment* model that will be provided as a task for the students. Second, teachers must prepare the guidelines penskoran (the rubric) based on the tasks that are given to the students. as suggested by Suskie (2009:25) that performance assessment has two components: the tasks that are given to the students and the guidelines of scoring used as a tool to evaluate students.

Performance assessment Model can various in accordance with the needs of the students and the availability of time. *Performance assessment* tasks can be a long-term or short-term. For example, long-term tasks given can be a paper as the final task or portfolios while the short-term tasks such as questions about the explanation or presentation. The *performance assessment* model can also direncanakan sesuai to level the ability of students. For teachers who want to think mengembangkankemampuan high level, teachers can design model *performance assessment* with a high level of difficulty. Therefore the assessment is highly recommended for teachers because it can evaluate students in various level, especially level high level (Wren, 2009:3).

According to the event in Viaduct Park (2010:34-35), *performance assessment* was done on the performance of the behavior or the interaction of students. In mathematics teaching, this rating can be the presentation of the project or investigation, observation, interview and see the results of the work (*product*). In other references, Mueller (2012) mentions the model of this assessment in three different, namely making the response, the work (*product*) and performance (*performance*). Assessment model in the form of making the response that can be designed in mathematics teaching is to make the map concept, concluded, describes the answers to respond to the article, self-assessment, assess the work of friends, measure an object, analyze graphs, and so on. The assessment model in the form of the results of the work or product that is the project, writing reports or papers, analysis of a problem, prove the formula, experiments are modeling the problem, construct build geometry designing planning, Create graphs data, survey, data analysis

statistics, and others. The form of the task of performance that can be made among others presentation, discussion, explain orally, working groups and so on.

2. RESEARCH METHOD

This study is a descriptive-quantitative research because it purposes to investigate and describe students' mathematical communication ability in explaining idea or concept in solving mathematical problem related to real world problem. According to Bugin Bungin (2009, p.48-49), descriptive-quantitative research attempts to describe and explain various conditions based on nature of the event.

Methodology chosen in this study is research and development combined with experimental method and the one group pre test post test design (Suharsimi, 2006, p.86) Research and development method is chosen because it has complex process in each steps that can acomodate various purposes in this research (Borg & Gall, 1989, p.785). Assessment model developed is teaching product related to instructional technology that needs justification in the process. Consequently, the writer needs much time to read many references and theories, visit and do focus group discussion to relevant subjects, and teach in the classroom in order to observe and find out various facts and conditions of mathematics learning at senior high school in Banda Aceh. Research and development method needs continuous process and high desire, dilligent, critic observation, and patient to produce various creative ideas.

Then, doing action research method in the fifth step of research and development is a justification to observe how far this assessment works properly, effectively and significantly for senior high school students.

Table 1. Steps of Research and Development

Main Step of Borg and Gall	10 Steps of Borg & Gall
Research & Information Collecting	Research & Information Collecting
Planning	Planning
Develop Preliminary form of Product.	Develop Preliminary form of Product
Field testing & Product Revision	Preliminary Research
	Product Revision
	Main Research
	Operasional Product Revision

	Final Research
Final Product Revision	Final Product Revision
Dissemination & Implementation	Dissemination & Implementation

Data needed in this study are obtained by giving performance assessment task and questionnaire for students. It is conducted to answer the first research question namely how students' mathematical communication ability by implementing performance assessment. The task given in this study consists of three types as follows.

- **Paper:** Students are required to write a paper about derivative application in daily life with real world problems. This task takes a week. It purposes to investigate students' mathematical communication ability in written form including students' ability in stating relationship of mathematics to daily life, sharing ideas or concepts by picture and algebra as well as modeling mathematical problems. This task is assessed by paper rubric.
- **Presentation:** This task is given after students write the paper. Students are asked to present what they write in the front of class. This task purposes to investigate students' mathematical communication ability in oral form including students' ability in stating relationship of mathematics to daily life, sharing ideas or concepts by picture, interpreting ideas as well as ability in discussion and presentation. This task is assessed by presentation rubric.
- **Witten Test:** Written test is conducted at the last meeting. The test consists of four questions in essay form. It is allocated for two lesson hours, 2x40 minute(80 minutes). This test purposes to investigate students' mathematical communication ability in written form including stating ideas or concepts by picture and algebra, interpreting ideas and modeling mathematical problem. This task is assessed by test rubric.

Afterwards, questionnaire is given after learning process at the last meeting. It purposes to answer the second research question about students' respond toward their mathematical communication ability through performance assessmentimplementation.

To analysis data from performance assessment tasks, the writer utilizes criteria of the score based on standard grading of curriculum 2013. The score obtained based on rubric will be converted and determined predicate based on the following table.

Table 2. Score Conversion and Predicate of Students' Achievement

Interval	Conversion	Predicate	Category
96 – 100	4.00	A	Very good
91 – 95	3.66	A-	
85 – 90	3.33	B+	Good
80 – 84	3.00	B	
75 – 79	2.66	B-	
70 – 74	2.33	C+	Enough
65 – 69	2.00	C	
60 – 64	1.66	C-	Not Good
55 – 59	1.33	D+	
≤ 54	1.00	D	

3. RESULT AND DISCUSSIONS

Based on the data analysis, students' achievement in mathematical communication ability either in written and oral form through performance assessment implementation obtains good category in average. Students' mathematical communication ability through tasks given—i.e., paper, presentation and test—achieve good score.

To assess students' mathematical communication ability, there are eight criteria used in the rubric for paper task and test. However, both have two different criteria and six similar criteria. Analyzing on the similar criteria, it is found that students' ability in algebra process and calculating through paper and test achieves the highest score in average, good category on paper task and good category on test. Conversely, drawing conclusion obtains the lowest score namely enough category on test and good category on paper. Ability in determining steps of problem solution is not significantly different between both paper task and test. Yet, the category obtained is different, good category on paper and enough category on test. Students' ability in mathematical modeling, interpretation on questions, and using algebra/symbol shows satisfied result, very good category on paper and good category on test.

Analyzing on the different criteria, in paper task, ability in stating derivative application achieves good category while ability in stating ideas/situation by picture includes in enough category. The two criteria not in paper task are algebra derivative and optimization concept. Students' achievement on the two criteria obtains good category.

Based on the result above, good achievement in algebra and calculation are caused by learning process at school that usually focuses on calculation. Mahmudi (2009, p.1) states that generally mathematics learning more focuses on computation so that normally students are good at calculation. It is supported by Hamidah's study

(2013, p.51) that shows 80,8% of students do correctly on calculation. This case is based on students' respond that indicates they are good enough in algebra process and calculation as much as 50%. The low achievement in drawing conclusion on test happened because students are not used to draw conclusion after solving a problem. Rasiman (2013, p.190) finds the same case on his study, students are not able draw correct conclusion yet. Students admit their ability in drawing conclusion is less than calculation.

Regarding to steps of problem solving, students achieve enough category in average on test because they do many errors in the fourth question. Most of them write incompletely for steps of problem solving. It is assumed students frequently use shortcut in solving a problem especially questions in multiple choices that are generally used in national or final examination. Rasiman (2013, p.190) also finds in his study, students do not write completely in the steps of problem solving yet. Moreover, difficulty factor in the fourth question also affects on students' score. Similar to Sulastris' study (2013, p.56), she reports, students' mathematical communication ability does not achieve good score because of the high difficulty of the questions. Students are frequently given routine problem based on the textbook (Tandilling, 2012, p.25) so that they face difficulty on non-routine problem.

Problem interpretation and mathematical modelling obtains good achievement because students drill exercises either through discussion or paper task. They solve many problems on worksheets and find many of which to write in their papers. The real world problems given in the tasks help students to engage their meaningful learning. Mandernach (2003) believes performance assessment tasks are able to develop meaningful learning for students. Consequently, they are easier to comprehend the problems and able to make mathematical model based on the problems given. In the study of Rasiman (2013, p.190), students are able to state what they have been known from the questions and find out the solution. Study of Nugroho (2012, p.89) also reports students' ability in converting a problem into mathematical model achieves good score after drilling on discussion first though. After discussion, Rofiah (2010, p.97) also finds almost half of students number increases in mathematical modelling ability. It is supported by students' respond that states their ability in mathematical modelling is higher than determining steps of problem solving.

Based on the paper written by students, only a group who is good in stating picture about derivative application while the rest's score is still in enough category so that the average obtained in this criterion is counted in enough category. This result is different from Hamidah's study (2013,

p.51) that reports 87.8% of students are able to state picture or graph through performance assessment implementation.

Moreover, students' ability in algebraic function derivative is good enough because they also use derivative concept for other subject, physics. So, they are good in determining derivative for simply algebraic function. But, in the fourth questions, most students are not able to determine algebraic function derivative in fraction form because they only get the material in the first meeting and do not do more exercises yet on that material. However, based on students' respond, they are more capable in determining derivative than mathematical modeling.

Furthermore, students' mathematical communication ability in oral form is counted in very good category for a criterion, answering questions. Whereas, it is achieved in good category for some criteria: sharing information, understanding paper material and cooperation. Students are able to explain correctly good answer. They also can build their cooperation with the others by working in team. This task allows them to drill and practice their skill and knowledge in demonstrating what they have learned. Rudner & Boston as well as Wiggins (Houghton Mifflin University, 1997) and Mueller (2012) stated that performance assessment gives students opportunity to demonstrate their knowledge and strategy they have learned. Accordingly, presentation task is beneficial to observe students' knowledge and skill (Mustamin, 2010, p.39) besides assess and develop oral mathematical communication ability of students. Moreover, this assessment can build relationship and cooperation among students.

Based on questionnaire analysis, it is found that students give positive respond for the learning process through performance assessment. They are interested in the tasks given: paper, presentation, and test. It is assumed students rarely did some discussion in mathematics class. So that, the students feels enthusiast to what the writer implemented in the classroom. Moreover, implementing various tasks also makes students not getting bored. Arends (2004, p.246) said that performance assessment task allows students to be assessed by varying tasks. The, similar respond is also attained from Hamidah's study (2013, p.64) that applies performance assessment in the classroom found students are interested in learning process.

To sum up, the highest average through paper task with very good category is achieved in ability of mathematical modeling, algebra process and calculating, interpreting on the questions. However, the lowest with enough category is got in stating ideas or concepts by picture.

In presentation task, the highest score (very good category) is answering questions and

the lowest (good category) is cooperation. Last, in written tests, the highest is algebra and calculating process (good category) and the lowest is drawing conclusion (enough category). Students respond positively toward the performance assessment implementation.

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