Development of Mathematical Skill Assessment Instruments In Secondary School Based On Bloom’s Taxonomy

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Abstract. What are the process and the result in developing mathematical skill assessment instrument in secondary school during numbers course? This study addresses the problem. The assessment follows bloom’s taxonomy. The research is a developmental research by using 4D model limited into defining, designing, as well as developing. The data analysed by using the descriptive rule. The product result of this study is an assessment instrument formed in rubric assessment involved performance aspect assessed and performance qualities in the range of 0-4. The product validated and responded based on material, construction, language, objectivity, systematic, and practicability aspects. The result shows that the developed instrument got a great response in the range of 84,27%. Researcher hope the study result contributes to increase the quality of assessment beside the teachers and practicians develop in that based on bloom taxonomy.

1. Introduction
Assessment has an important role in determining achievement of learning aim. It is because the assessment is used to monitor learning progress, learning results, and detect needs of remedy of students learning results sustainably. Besides that assessment also aims to know level of competence mastery, set completeness competence mastery, establish improvement program or enrichment based on level of competence mastery and improve the learning process.

Assessment instrument is one of parts of evaluation instrument used by teachers in performing evaluation activities of the learning process and students’ learning results [1]. The teacher has responsible for choosing and preparing tasks that involve students actively to build understanding, mathematical thinking and confidence [2]. Besides teachers are also in charge as evaluator in doing assessment on thorough to student’s learning results, both from understanding to material or subjects given start from aspect of attitude, knowledge aspects and skill aspects. However based on the results of observations conducted by researchers on mathematics, at school, the teachers only do assessment on knowledge aspect; the teachers have not done assessment on aspects of attitude as well as skills.

Assessments of aspect of skills still not yet done well, to rate skills of students; teachers only emphasize only activeness of students in follow learning. This can be caused because in compiling the assessment instrument especially in aspect of skills, teachers often experience difficulty. Different with aspect of knowledge assessment can be done by using test only; skill aspects need foresight and accuracy of teachers in observing students. Based on interview of researcher with some teachers in Islamic Junior High School of Diponegoro of Surakarta, most teachers do not do assessment of skills and only guessing the skill value of students. It causes less valid value of students skills so cannot illustrate skills of students indeed. It is strengthened by research results Adi Wahyu Kuncara that explains that teachers assess skills of students on to communication activities by looking at quiz
results given to the students [3]. However, teachers do not set up assessment instrument of skill aspects so indicator assessed is not clear. In line with Arum Dwi Rahmawati in her research also explain that teachers have not fully developed assessment instrument because in preparation of lesson plan still only copy the lesson plan other schools [4].

Objective of curriculum 2013 not only create students’ intelligent, but also students critical and can apply knowledge in everyday life. Therefore, assessment of skills becomes very important. This is strengthened by research conducted by Roslinda Rosli who revealed that use rubric on performance assessment as an appropriate tool in checking the student's ability to solve mathematical problems [5]. Agree with the research results, Christian Meyer in his research explains that students believe that they can memorize knowledge better with authentic assessment using assessment components of peers, and students remember knowledge better if using a project-based assessment model [6].

Bloom taxonomy is drafting guidelines frequently used instrument. Bloom taxonomy apart can measure students' abilities in the cognitive domain; can also be used to measure the psychomotor and affective domains. Bloom Taxonomy can help teachers develop assessment instruments in detail in order to measure student progress in achieving the goals of learning [7].

Assessment skills on mathematics lesson indeed is not easy to be done. Different with sport lesson which its characteristics is physical skills, assessment skills on mathematics requires the teacher measure ability students in apply their knowledge in complete problem every day. Material on mathematics lesson is composed by numbers, algebra, geometry and statistics. Four materials the maybe only on geometry material is quite easy to do assessment of skills, e.g. with draw angle, calculating comprehensive, decisive distance, but on other materials are not as easy as on geometry material. Material of numbers is a vital material because it is a basic for other materials. By because that on numbers material must do assessment skills as well as possible so that the potential skills students honed well. The preparation of the skills assessment instrument should be based on bloom taxonomy to make student achievement more easily identifiable. If students have competence skills well on numbers material, then students the will easy to master competence skills on other materials. Based on description then need to conduct development assessment instrument of skills junior high school mathematics lesson at numbers materials based on bloom’s taxonomy.

2. Methods

Corresponding with aim research that is to develop assessment instrument of skills of junior high school mathematics lesson at numbers materials based on bloom taxonomy, then type of this research is R & D. Early step in development research is first created assessment instrument then perform instrument product test so obtain effective and efficient product.

The first stage in the development of this instrument is the defining stage, which is done by observation and interview to analyze the need, then also necessary analysis of basic competency in the number materials and analysis of appropriate bloom taxonomy. The next stage is the stage of development of a model consisting of the designing stage, the design validation stage and design revision stage. Preparation of the model development stage conducts skills assessment instrument based on the results of the preliminary stage in order to obtain a draft 1. Validation stage is validation from the development stage results based on material, language and construction aspects. Validation is done by three mathematics teachers use instrument of check list form. Check list composed from validation sheet to instruments, columns of feasibility and information. Quantitative data obtained from validation sheet using scale of Guttman with value 1 or 0 only, while the qualitative data is obtained from column of feasibility and information required by expert or validator. Stage of design revisions be revised on the skills assessment tool based on the results of the design validation stage in order to obtain a draft II. The next stage is the initial testing stage. Products are tested in Islamic Junior High School of Diponegoro of Surakarta with subjects as many as 10 students in 7th grade of school year 2017/2018. Based on the results of this initial test, it is obtained user feedback on product quality. Input from this stage is used as evaluation and product improvement to obtain draft III. After the third draft is obtained it will be field test. Field test is conducted in Islamic Junior High School of Diponegoro of Surakarta with the subjects of all 7th grade students of the academic year 2017/2018.
At this stage there is also a product assessment of the user that is the teacher. The assessment of product contains rubric scoring and statements assessment sheet containing value on assessment instrument of products. Rubric gives limits on giving score to objects assessed. Product assessment products developed is scaled in 1-5. This assessment intends to assess products based on material, construction, language, objectivity, systematic and practical aspects. The results of the product assessment are interpreted as follows [1].

| No | Score interval | Category     |
|----|----------------|--------------|
| 1  | 81-100%        | Very good    |
| 2  | 61-80%         | Good         |
| 3  | 41-60%         | Enough       |
| 4  | 21-40%         | Bad          |
| 5  | 0-20%          | Very bad     |

In general, research steps can be seen as the following figure 1.

*Figure 1. Research step*

3. Results and discussion
The preliminary study stage to conduct a needs analysis conducted through interviews obtained results include 1) the difficulty teachers to compile instruments of skills assessment due to the lack of reference to the book BSE curriculum in 2013 both in students’ handbook as well as teacher hand out, 2) difficulty in adjusting basic competence with skills assessment 3) lack of time for skill assessment,
4) the difficulty of providing tools and materials for skill assessment. The 2013 curriculum students’ handbook contains only project tasks to assess students’ skills without any scoring rubric of the project and the assessment rubric of the project. Besides the task of the project in the book is often not related to basic competence should be assessed. The task of projects usually require longer periods of time, whereas the allocation of time mathematics in a meeting is 2x40’. Each project task is done; the teacher must also prepare the tools needed. If the tool is difficult to obtain or made, it will be difficult for teachers. These are the things that is difficult for teachers to make skill assessments. Stage analysis of basic competences in the materials of numbers there are two basic competencies that can be developed for the assessment of the skills of basic competences 4.1) solve problem related with order some integers and fraction numbers (ordinary, mix, decimal, percent) and basic competences 4.2) solve problem related with counting operation on integers and fraction numbers. Basic competencies must be developed into indicators of competency achievement and then compiled its syntax. Bloom taxonomic analysis is performed by analyzing verb psychomotor domains ranging from P-1 imitating, P-2 manipulate, P-3 precision, P-4 articulation and P-5 naturalization. Based on the preliminary results of the study, it is necessary to develop a skill assessment instrument in accordance with basic competencies, time saving, easily accessible tools, and in accordance with the bloom taxonomy.

The Developing Stage or draft 1 begins by arranging grating as table 2.

| Basic Competences                                         | Indicator                                                                 | Syntax                                                                                              | Criteria Bloom         |
|-----------------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------|
| 4.1 Complete issues related with order some integers and  | Sorted the number from the smallest                                       | Reduce the area of the two dimensional figure                                                       | P-1 Imitating          |
| fraction numbers (ordinary, mix, decimal, percent).       |                                                                           | Placing the two dimensional figure two dimensional figure in sequence                               |                        |
|                                                           |                                                                           | Show the smallest dimensional figure into the biggest                                              | P-2 Manipulate         |
| 4.2 Complete issues related with count operation number   | Determine the result of the operation of the sum of the two dimensional    | Combine the available two dimensional figure                                                        | P-3 Precision          |
| integers and fractions.                                   | section                                                                   | Designing a new two dimensional figure using the available two dimensional figure                  |                        |
|                                                           |                                                                           |                                                                                                     |                        |

The grid is tested in the form of project assessment. After a grid is developed, it is necessary to arrange student tasks or commands that students must perform in carrying out a skill assessment. The task is more clearly seen in Table 3.

| No | Syntax                                                                 |
|----|------------------------------------------------------------------------|
| 1  | Students are divided into groups of 2 students                        |
| 2  | Each group is given 3 two dimensional figure (square, rectangle, parallelogram) |
| 3  | Each group is asked to calculate the area of the three two dimensional figures using the plotted paper in print. Do the three two dimensional figures have the same area? |
| 4  | Each group is asked to divide the square into 4 sections, rectangles into 5 sections, and parallelograms into 2 sections. |
| 5  | Each group is asked to compare area $\frac{1}{4}$ section of the square $\frac{2}{5}$, rectangular sections, and $\frac{1}{2}$ parallelogram parts (use plotted paper). Then paste it from the smallest width on the provided paper. |
No  | Syntax
---|---
6   | Attach the remaining part of the three two dimensional figures correspond to your creativity into a two dimensional figure (you may cut the shape). Calculate the area!

Further to an assessment, rubric assessment development is necessary to projects like table 4 below.

**Table 4. Rubric of Project Assessment**

| Aspect | Score |
|--------|-------|
| 1. Ability to plan | 0 1 2 3 |
| 2. The ability to divide up two dimensional figure according to its part | |
| 3. The ability to sort the two dimensional figure portion the smallest area | |
| 4. Ability to explain the intent of the combined two dimensional figure | |
| 5. Product | |

Maximum Score 14

After developing the project scoring rubric there should also be developed the scoring rubric of the project as the table 5 below.

**Table 5. Project Scoring Table**

| Indicator | Rubric |
|-----------|--------|
| 1. Ability to plan | 2: Full Planning (ruler, scissors, glue) 1: Less complete plan 0: No planning |
| 2. The ability to divide up two dimensional figure according to its part | 3: Many parts of the two dimensional figure fit and equal 2: Many parts of the two dimensional figure suit but not equal 1: Many parts of the two dimensional figure are not suitable but equal 0: Many parts of the two dimensional figure are not suitable and not equal |
| 3. The ability to sort the two dimensional figures portion of the smallest area | 3: The order and area are correct 2: The order is correct but the area is incorrect 1: The order is wrong but the area is incorrect 0: Incorrect order and area is incorrect |
| 4. Ability to explain the intent of the combined two dimensional figures | 3: Reason for making two dimensional figure is unique and smooth explanation 2: The reason for making a two dimensional figure is unique but the description is smooth 1: Reason for making the two dimensional figures is usual but explanation is smooth 0: Reason for making the two dimensional figure and unusual explanation |
5. **Product**

| Score | Description |
|-------|-------------|
| 3     | Creative two dimensional figure shape and correct area |
| 2     | Creative two dimensional figure shape but incorrect area |
| 1     | The two dimensional figure form is not creative but the area is correct |
| 0     | The two dimensional figure form is not creative and the area is incorrect |

Draft 1 that has been prepared is validated based on the aspect of material, construction, and language by 3 validators. Validators 1 namely quantitative data obtained validity score 83%, the validator 2 with a score of 92% and validator 3 with a score of 92% so that the validity of the total score is 89%. Qualitative data obtained from the validator input that is on the 2nd point of the student project, should be given the same two dimensional figure so that when comparing the two dimensional figure has been divided really like comparing two fractions. In addition to the two dimensional figure provided different colored so clearly visible difference fraction numbers, in addition to the two dimensional figure formed on point 6 can be viewed more interesting. Based on this feedback it needs conducting revision based on these inputs in order to get the draft 2. After that the initial test is conducted on 10 students to get input from the user as a teacher. At this stage the obtained input on the assessment of students calculate the area of two dimensional figure by utilizing the knowledge of the multiplication of fractions and calculate the area of students who use the plotted paper. Students who count area of the figure using their knowledge of fractional multiplication should get a higher value because they are proven to master the competence of integer operations. This input is used to revise the product to obtain draft 3. This draft is used for field test and tested to all seventh grade students of Islamic Junior High School of Diponegoro of Surakarta accompanied by 3 observers as assessor of product feasibility based on material aspect, construction, language, systematic, objectivity and practicability. Observer 1 gives the product feasibility score of 85.6%, observer 2 gives the product feasibility score of 84.8% and observer 3 gives the product feasibility score of 82.4% so that the average score obtained 84.27 with very good category. Some students found the work students are able to make up the two dimensional figure to two dimensional figure very creative new two dimensional figure as in Figure 2. This means that the project assessment able to hone students' creativity in thinking.

![Figure 2. Samples of Student Work](image)

Assessment of skills with project techniques with the help of these rubrics is very necessary to be developed and done. This is because the use of rubric is the key to authentic assessment [8]. Besides the skill assessment is very important developed by educators because helpful for students in the learning process for introduce students on meaningful learning where related directly with daily life, so students can understand and able looking for completion [9]. By gaining experience directly, the teacher can educate students to think critically and systematically according to the purpose of learning mathematics.
4. Conclusions
Based on the result and the discussion, it is concluded that 1) a mathematical skills assessment instrument based on the bloom taxonomy has been produced using 4D model as project assessment consisting of student project, grid of assessment, assessment rubric and rubric of project scoring, 2) Instrument of skills assessment of mathematics based on taxonomy of bloom get a user response percentage of 84.27 with very good category (based on table 1).

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