Developing of Higher Order Thinking Skill (HOTS) Mathematical Problems With Cartesian Coordinate Material

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ABSTRACT

This study aims to produce mathematical problems of the Higher Order Thinking Skill (HOTS) type on the Cartesian Coordinate material which are valid and practical. This study used design research of development studies type which consists of preliminary stage, self-evaluation, expert review, one to one, small group, and field test. The research subject is eight graders of SMP 17 Palembang, Indonesia. Data collected by tests, interviews, and questionnaires. The results of this study are that the questions developed are valid and practical, the validity seen from the questions is appropriate based on content, construct, and language, while practicality is seen from the questions that can be used by students and the questions can bring up students' higher order thinking skills.

Keywords: HOTS, Mathematical Problems, Cartesian Coordinate, Research Development.

1. INTRODUCTION

Skills that are highly needed in the 21st century is Higher Order Thinking Skills (HOTS) which includes problem solving skills, critical thinking skills, creative thinking skills, the ability to argue, and the ability to make decisions [1]. It is also stated in Permendikbud [2] that one of the competency standards for primary and secondary education graduates that are expected in the skill dimension is that students have higher order thinking skills. By having higher order thinking skills, students can more understand concepts and broader student's knowledge [3]. This shows that higher order thinking skills are important for students. However, Gustiningsi [4] states that students' critical thinking skills are still low. Prasetyani [5] states that only 26.67% of students have higher order thinking skills in a good category and only 16.67% of students have higher order thinking skills in a very good category.

The low level of high order thinking skills of students is related to the types of questions given to students so far. Teachers need to make questions of an open and adequate type to train students' higher order thinking skills [6]. Meanwhile, Herawati [7] revealed that the assessments carried out by schools had not yet developed higher order thinking skills. This means

that questions of higher order thinking skills are needed. Therefore, this study develops a *higher order thinking skill* mathematical problems.

In previous research, Lewy et al. [8] developed a higher order thinking problem of sequence and series material, Budiman & Jailani [9] developed higher order thinking skills assessment instrument for mathematics in junior high school in eight graders, Ahyan et al [10] developed mathematics problems based on PISA level of change and relationships content, Yansen et al [11] developed PISA-like mathematics problems on uncertainty and data using Asian Games football context, Sumiratana et al [12] used realistic mathematics education and the DAPIC problem-solving process to enhance secondary school students' mathematical literacy, Vijayaratnam [13] developed higher order thinking skills and team commitment via group problem solving, Maharani [14] developed mathematics problems with aquatic in asian games context, Dasaprawira [15] developed mathematics questions of PISA type using Bangka context, Kamaliyah [16] developed the sixth level of PISA-Like mathematics problems for secondary school students, Efriani [17] developed PISA-like with sailing context, Rawani [18] developed PISA-like mathematics problems using taekwondo context. In this study develops higher order thinking skill

mathematical problems in cartesian coordinate material with the aim to produce mathematical problems which valid and practical.

2. METHOD

The method in this research is design research with development studies type. The stages taken are the preliminary stage and the prototyping stage [19], [20]. The following are the stages of the formative evaluation carried out in this study.
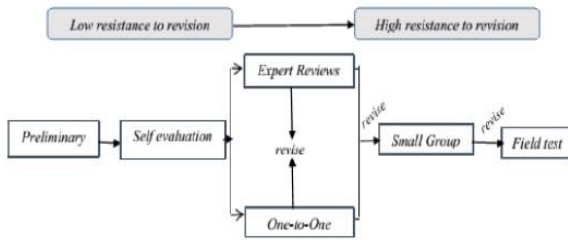

Figure 1. Formative Evaluation Diagram

The research subjects were eight graders of SMPN 17 Palembang. Data were collected using the walkthrough, tests, questionnaires, and interviews. Walkthroughs are used at the expert review stage, while tests, questionnaires, and interviews are used at the one to one, small group, and field test stages. The data obtained from the walkthrough, tests, questionnaires, and interviews were analyzed and described by the researcher. The validity of the questions is seen from the comments and suggestions at the expert review stage in terms of content, construct, and language. Meanwhile, practicality is seen from the comments and suggestions at the one to one stage and small groups. This paper only discusses up to the small group stage.

3. RESULT AND DISCUSSION

The results of the research are as follows:

Preliminary stage, At this stage the researcher analyzes the cartesian coordinate material and analyzes the indicators of the higher order thinking skill question, Self-Evaluation Stage, At this stage the researcher drafted a higher order thinking skill type of mathematical problem with cartesian coordinate material. This problem is called prototype I to be tested at the expert review stage and one to one . Here is prototype I.
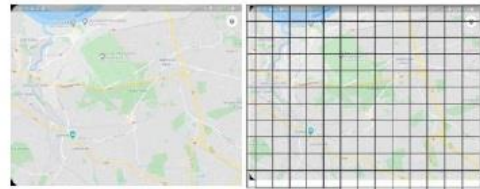

Gambar 1. Denah sekolah SMAN 1 Jember
(Sumber: http://web.sman1jember.sch.id/denah-sekolah.html)

Berdasarkan denah SMAN 1 Jember tersebut Ani, Budi, dan Carli berjalan dari hall menuju musholla dengan kecepatan berjalan yang sama. Rute yang ditempuh Ani ditunjukkan oleh garis berwarna merah, rute yang ditempuh Budi ditunjukkan oleh garis berwarna biru, dan rute yang ditempuh Carli ditunjukkan oleh garis berwarna ungu.
Apakah Ani adalah orang yang pertama kali sampai?Uraikan alasanmu.

Based on the map of SMAN 1 Jember, Ani, Budi, and Carli walked from the hall to the mosque at the same walking speed. Ani's route is shown by a red line, Budi's route is shown by a blue line, and Carli's route is shown by a purple line. Was Ani arrive first? Explain your reasons.

Figure 2. Task 1

Gambar 2. Peta Kota Greenwich
Sumber : Google Maps, Greenwich, London, Britania Raya

Kota Greenwich adalah kota yang dikenal dengan sebutan Meridian utama (*Prime Meridian*) yakni garis bujur yang letaknya di 0^0. Garis Meridian utama terletak pada Royal Observatory Greenwich seperti pada peta di atas. Dalam rangka wisata edukasi David akan mengunjungi Royal Observatory Greenwich dan Old Royal Naval College. Berapa jarak terdekat yang dapat ditempuh oleh David berdasarkan peta di atas. Tentukan lintasannya.

Greenwich City is a city known as the Prime Meridian (Prime Meridian), which is a line of longitude located at 00. The main meridian is located at the Royal Observatory of Greenwich as in the map above. As part of his educational tour, David will visit the Royal Observatory of Greenwich and the Old Royal Naval College. What is the closest distance to David based on the map above. Please determine the trajectory.

Figure 3. Task 2

Expert Review Stage, At this stage, the researcher gives the problem or *prototype* I to the validator to be validated. The validator (*expert*) in this study was 1 lecturer of the Sriwijaya University Mathematics Education Study Program, namely Dr. Yusuf Hartono and 1 math teacher at SMPN 1 Tanjung Raja Ogan Ilir, Mr. Marion, M.Pd. The comments from the validators are shown in Table 1.

One to One Stage, This one to one stage was carried out in conjunction with the expert review stage which was tested at this stage was prototype I. At this stage, the researcher tried out prototype I with one colleague namely Ms. Ratih Ayu Apsari, M.Sc., M.Pd who is a lecturer at the Mathematics Education Study Program at the University of Mataram and one eight grade student. Comments and suggestions for prototype I at the one to one stage can be seen in Table 2.

Table 1. Comments and suggestions from validators

Task number	Validator	Comment
1	Dr. Yusuf Hartono	We recommend that you do not use the brand and do not depend on the image
	Marion, M.Pd.	Okay
2	Dr. Yusuf Hartono	No comment
	Marion, M.Pd.	• Map image is less clear • To be more contextual, add scale to the map • In the question of "how much distance" should be changed to the nearest distance estimate • We recommend that for the question of determining the trajectory it is better to just remove it. Because it makes the concept of coordinate points blurry

Table 2. Comments and Suggestions at One to One Stage

Task Number	Validator	Comment
1	Ratih Ayu Apsari, M.Sc., M.Pd.	No comment
	Student 1	Student can understand the meaning of the questions and can answer questions, but not exactly.
2	Ratih Ayu Apsari, M.Sc., M.Pd.	The O (0,0) coordinate can be clarified by giving a circle on the map, as well as affirming the location of the Royal Observatory Greenwihc (ROG) and Old Royal Naval Collage (ORNC)
	Student 1	Student cannot answer questions because the map image is not clear

Comments and suggestions by the validator at the expert review and one to one stage were used as material for revising prototype I. The revision results can be seen in table 3.

Table 3. Revision decision

Task Number	Revision Decision
1	Eliminating the brand or school name that was originally mentioned in the problem.
2	The map image is converted into a clearer map, the scale is added to the map, the coordinates O (0,0) are added to the map, the questions are changed to determine the approximate closest distance.

Based on comments and suggestions from *expert reviews* and *one to one* , the questions were revised to be as follows.

Gambar 1. Denah sekolah
(Sumber: http://web.smantimahet.sch.id/denah-sekolah.html)
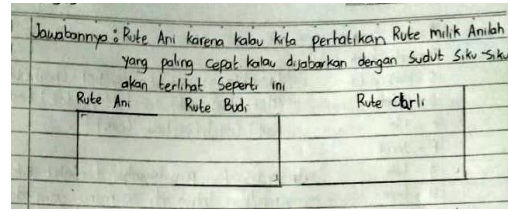
Berdasarkan denah sekolah tersebut Ani, Budi, dan Carli berjalan dari Hall menuju Mushella dengan kecepatan berjalan yang sama. Rute yang ditempuh Ani ditunjukkan oleh garis berwarna merah, rute yang ditempuh Budi ditunjukkan oleh garis berwarna biru, dan rute yang ditempuh Carli ditunjukkan oleh garis berwarna ungu.

Apakah Ani adalah orang yang pertama kali sampai? Uraikan alasanmu.

Figure 4. Task 1 which has been revised

It can be seen from Figure 4 that the name of the school on the school map has been removed according to the validator's suggestion.
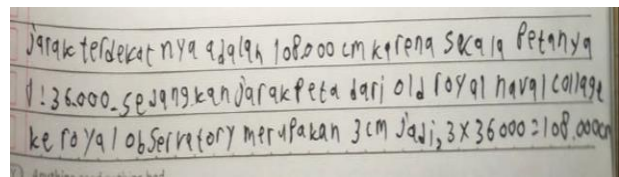
Ani route, because the ani route is the fastest, if we describe it in the form of a rectangular line, the picture looks like this.

Figure 6. Student answer 1

It can be seen from Figure 6 that the students already understood what was being asked in the questions even though the students' answers were not correct.

The closest distance is 108.000 km because the map scale is 1: 36.000, while the distance on the map from old noval royal college to royal observatory is 3 cm, so 3x 36.000 = 108.000.

Figure 7. Student Answer 2

Seen from Figure 7, students can already answer correctly even though the students did not write down how to estimate the distance. But when being interviewed, students know how to estimate it. The following are students' comments when given questionnaires and interviews.

Figure 5. Task 2 which has been revised

The revised problem is called prototype II. Then prototype II was tried out at the small group stage. Small Group Stage, At the small group stage, prototype II was tested on five student of eight grade of SMPN 17 Palembang.

Table 4. Student comments in questionnaires and interviews

Task Number	Students	Comment	Revision Decision
1	Student A	Questionnaires: The pictures is clear, the sentences is clear, the tables is clear. Interview: *Ani came first because he was seen from the route. But Ani and Budi's route is almost the same, they both take 2 turns.*	The problem is still used without revision
	Student B	Questionnaire: The pictures is clear, the sentences is clear, the tables is clear. Interview: *Ani and Budi arrive together because Ani and Budi's route is the same length.*	
	Student C	Questionnaire: The pictures is clear, the sentences is clear, the tables is clear.	
2	Student A	The questions can be answered, the pictures is clear, the sentences is clear, the tables is clear.	The Problem is used without revision
	Student B	The questions can be answered, the pictures is clear,	

Task Number	Students	Comment	Revision Decision
		the sentences is clear, the tables is clear.	
	Student C	The questions can be answered, the pictures is clear, the sentences is clear, the tables is clear.	

Judging from students' answers to tests, questionnaires, and interviews, it can be seen that students understand the meaning of the questions. According to Akker [21] which state "practically refers to the extent that user (or other experts) consider the intervention as appealing and usable in normal conditions*,"* then the problems which developed are included in the criteria that are practical.

4. CONCLUSION

The conclusion of this study is that a higher order thinking skill mathematical problem is produced which is valid and practical, validity is seen from the validator's comments in terms of content, construct, and language, while practicality is seen from the applicability of the problems, students understand and interest with the problem, and the problem is to train students to think at high levels.

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