

**DEVELOPING MATHEMATICS INSTRUCTIONAL MATERIALS
ORIENTED TO CHARACTER AND HIGHER ORDER THINKING SKILL
(HOTS)**

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Abstract

This research aimed to produce mathematics instructional materials for junior high school grade 8th semester 1 that is valid and practical for improving the student's character and higher order thinking skill (HOTS). This research was a developmental research consisting of three phases: preliminary phase, designing phase, and developing phase. In the preliminary phase, contexts and problems analysis, literature review, and formulation of learning objectives were conducted. The designing phase consisted of developing the test instrument, determining the instructional strategies, media, and materials, and designing of the initial products. At the developing phase, three cycles of formative evaluation were conducted, consisting of product testing, evaluation, and product revision in each. The instructional materials produced consisted of lesson plans and student worksheets. The results showed that the instructional materials produced are valid and practical.

Key words: development, instructional materials, lesson plan, student worksheet, character, higher order thinking skill (HOTS)

INTRODUCTION

One of the success indicators of mathematics instruction is the achievement of learning objectives, which are closely related to national education goals. Indonesia's national education goals were mentioned in the law No. 20 of 2003, which is to develop students' potential to be faith and fear of God Almighty, noble, healthy, knowledgeable, skilled, creative, independent, and responsible citizens. More specifically, Ministerial Regulation No. 22 of 2006 concerning the content standards (Depdiknas, 2006, p.346) stated that the mathematics subjects aims to make students have the ability in: (1) understanding math concepts, (2) reasoning, (3) problem solving, (4) mathematics communication, and (5) appreciating the use of mathematics. It is also added that mathematics subject is needed to make students have ability to think logically, analytically, systematically, critically, creatively, and to cooperate.

Based on the description above, it is clear that besides of the cognitive and psychomotor, affective aspect is also very prominent. Thus, the main problems related to the achievement of the learning objectives of mathematics can be categorized into two main aspects. First, cognitive and psychomotor aspects related to the knowledge and skills competence, and second, affective aspects related to the attitude and character competence. The problems can be indicated by the existed phenomena in the field.

Firstly, related to the students' knowledge and skill competence, these phenomena can be seen from the results of international researchs in students mathematics achievement, including Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA). In recent years, Indonesian students achievement based on both of those research have not shown encouraging results. Whereas, many studies state that what measured on TIMSS and PISA is strongly relevant to the matematics content

standards in Indonesia, viewed from both content and process domain. Based on the analysis of the material tested in TIMSS 2011 and PISA 2012, found that both 95.5% TIMSS and 88.5% PISA questions are relevant to the mathematics basic competence of junior high school in the content standards. Thus, the questions characteristics of TIMSS and PISA is proved in line with the mathematics subjects objectives in the standard content. Both of them emphasize on the mathematical reasoning and the use of mathematical concepts aspect to solve problems. Those aspects related to mathematical thinking skills that involve the analyzing, evaluating, and applying mathematical concepts process to solve problems with the right strategy. Those skills were described by Brookhart (2010, p.3) as higher order thinking skills (HOTS).

HOTS is often described as a high-level thinking skills in a variety of thinking skills framework. In this case, the term HOTS is usually contrasted with LOTS (lower order thinking skills). Liu (2010, p.54) and Fisher (2010, p.375) classified cognitive processes of analysis, synthesis, and evaluation in bloom taxonomy (Bloom, et al., 1956, p .18) as HOTS, meanwhile knowledge, comprehension, and application as LOTS. Likewise, in the thinking level of Krulik & Rudnick (1999, pp.138-139), critical and creative thinking are categorized as HOTS, while the recall and basic were categorized as LOTS. Although the definition of HOTS is still debated, generally HOTS can be defined as a critical and creative thinking process involving information processing to face a situation or resolve specific problems. In this case, the problem solving can be positioned as the main base of HOTS constructed of critical and creative thinking skills.

In the mathematics content standards of junior high school, 47% of standard competence (8 of 17) and 27% of basic competence (16 of 59) were identified have HOTS charge. In fact, on a practical level, there are many teachers do not emphasize the need of mathematical thinking skills in instruction. Such condition were identified in a limited survey involving twenty junior high school math teachers in the district of Jepara. Based on the results of the survey, 75% of respondents began their mathematics learning with the introduction of definitions and formulas without connecting with problem solving in a variety of contexts. Meanwhile, 90% of respondents had never planned or implemented instruction that emphasize the thinking skills. Consequently, students' thinking skills is not directed at the level of HOTS

Secondly, related to the attitude and character competence, Lickona (1991, p.53) explained that the character is formed of three components; moral knowing, moral feeling, and moral action. These three components are supporting each other in forming a human character. Meanwhile, there are many phenomena that show a lack of students' character. For example, many students are still cheating during exam. They do not do the assignment which is given by the teachers. They are also lack of confidence in participating mathematics learning.

Actually, the solutions of those problems have been launched by the government through education character. Kemdiknas (2011, p.26) stated that the implementation of education character in junior high school can be integrated through three ways : learning activity, school management, and student maintenance activities. Nevertheless, teachers are still difficult to implement the mathematics learning that integrated with the character. Based on the results of limited survey of mathematics teachers in the regency of Jepara, Central Java, the causes are varied, they have lack of knowledge and ability to plan, implement, and evaluate the education character in mathematics learning. They were also difficult to choose learning method and appropriate instructional materials with the development of character, added with the difficulty to assess character in the mathematics learning.

Based on the description of two main problems above, innovation to develop the instruction oriented to character and HOTS is needed. One of the important components of instruction is instructional materials. Instructional materials can be selected, modified, or developed in order to fit with the needs and learning objectives. Meanwhile, the Instructional materials oriented to character and HOTS is hard to find. Thus, the development of the Instructional materials oriented to character and HOTS is very important to do. Development of the Instructional materials can be done through the developmental research so can be produced a valid, practical and effective product.

RESEARCH METHOD

This research was the developmental research. The developed products were instructional materials. Development model used was adapted from several instructional development models, including models of Dick, Carey, and Carey (2001, p.2), Thiagarajan, Semmel, & Semmel (1974, p.5), Smaldino, et al. (2010, p.48), and Nieveen, McKenney & van den Akker (in Plomp, 2010, Q25). The development model consisted of three phases: preliminary phase, designing phase, and developing phase.

In the preliminary phase, researchers analyzed the context and problems, conducted a literature review, and formulated learning objectives. The designing phase consisted of developing the test instrument, determining strategy, media, and instructional materials, and designing the initial product. Furthermore, at the developing phase, it was conducted three cycles of formative evaluation to improve the quality of the product. The quality of development product can be seen from three aspects: validity, practicality and effectiveness (Nieveen, 1997, p.61).

Each cycle of formative evaluation consisted of product testing, evaluation, and product revision. In the first cycle, the products were assessed by two mathematics education experts and one character expert. Assessment results were used to evaluate the validity of instructional materials as a basis for the first revision. In the second cycle, the products that have been revised were retried out to a limited group involving one teacher and six students. Evaluation conducted in this cycle was readability and practicality of instructional materials. The evaluation results were used to perform a second revision. In the third cycle, the revised product was retried out in field trials involving one teacher and 23 students. Evaluation is about practicality and effectiveness. In this article is only served validity and practicality.

Data and Analysis

The generated data in this study included data on the validity and practicality of instructional materials. The used instrument to measure the validity of instructional materials was a validation sheet which contains items with five rating scale assessments, they are not good (score 1), less good (score 2), pretty good (score 3), good (score 4), and very good (score 5). The total score then was converted into five criterion levels of validity: very valid, valid, quite valid, less valid, and invalid.

The instruments for measuring the practicality consisted of readability test sheets, practicality questionnaires for teachers and students, and learning observation sheets. The practicality analysis made of the results of the practicality questionnaire filling that is fulfilled by teachers and students and learning observations on limited and field trial tests. The score of the questionnaire filling results was converted into five practicality criteria: very practical, practical, reasonably practical, less practical and impractical.

RESULT AND DISCUSSION

The development results of this research are mathematics instructional materials for junior high school, consist of lesson plans and mathematics student worksheets oriented character and HOTS. The learning strategy developed in the lesson plans is problem based learning (PBL). In PBL, as in cooperative learning, students work in small groups and share the responsibility for learning together. This process can develop critical thinking skills and problem solving and ability to collaborate and organize tasks (Arends & Kilcher, 2010, p.326). By looking at the characteristics of the PBL, it is clear that PBL is very relevant to be applied in the instruction oriented to character and HOTS. It was reinforced by Arends (2012, 397) who states that PBL also potent to develop social skills through collaboration that occurs among students in solving the problems.

Furthermore, the media type selected was print media in the form of student worksheet. The student worksheets contain steps arranged coherently to guide the students do activities in problem solving that relate to the subject being studied. Through the use of student worksheets, students can be taught to think critically and creatively to solve problems. In addition, the student worksheets also enable students to work together with one another in constructing ideas and problem solutions so that have great potential to improve the students character. This is according to the opinion of Dimermen (2009, p.70), who suggested that the best way to grow values on a persons' character is through direct experience.

In general, the character orientation is shown by providing activities that support the effort of improving the characters such as group discussion, working together, class presentation, and reflection. The orientation of HOTS is indicated by activities that encourage students to engage actively in resolving a problem or a situation critically and creatively. Among them are identifying and linking relevant information activities, investigating the truth of a statement, making hypothesis, and constructing ideas to solve the problem.

The Validity of Instructional Materials

The validity of instructional materials was measured from the assessment results of three experts. Two mathematics education experts as the assessor 1 and 2, while the character expert as the assessor 3. The results can be seen in Table 1 below.

Table 1. The Experts' Assessment Results

Assessor	Criteria	
	Lesson Plans	Student Worksheets
Assessor 1	Very valid	Very valid
Assessor 2	Very valid	Very valid
Assessor 3	Valid	Valid
Conclusion	Very valid	Very valid

Based on the table 1, both lesson plans and student worksheets can be concluded as very valid criteria. One of the reasons is because the preparation of the instructional materials has been carried out based on the study of the theory and context analysis. Furthermore, The validity analysis of each indicator shows that seven out of nine assessed indicators of the lesson plan are expressed very valid. The other two are declared valid at the oriented of HOTS and character indicator. Although both indicators are declared valid, they need special attention because they are key indicator that characterizes the instructional materials that are developing. It is also seen in the student worksheets at which the aspect of HOTS and character orientation in the student worksheets were also included in the valid criteria.

Some notes which can be summarized in these findings are (1) Grammar needs to be revised, (2) need to notice the coherent of material and activities in worksheets, including the introduction of new terms and the formulation of conclusions, (3) the orientation of HOTS in the both lesson plan and student needs to be sharpened, such activities that can encourage students to think creatively in solving problems so that the steps that too lead can be reduced, and (4) the orientation of the characters in the lesson plan and student worksheets still appear as patches that need additional of narrative in the student worksheets that reinforce the idea of urgency character that is developed for students.

Based on the explanation above, it can be concluded that generally the instructional materials have accomplished criteria of very valid and feasible to use. Some existing findings are evaluation materials for further development process.

The Practicality of Instructional Materials

The measurement of the practicality of instructional materials was carried out through two phases; the limited trial test and field trial test. The limited trial test involved one teacher

and six students consisting of three students with low ability, two students with average ability, and one student with high ability. It was conducted in two sessions: the readability trial test of student worksheets, and simulation of instruction.

At the readability trial test, students were required to observe and answer the worksheets given. Furthermore, students completed a questionnaire to assess whether every worksheet has an attractive appearance, readable writing, and understandable sentences. Besides, the students were also invited to discuss the parts of the worksheets that are difficult either in the terms or the sentence structure. The readability test results showed that 100% of students expressed that the appearance of each worksheet is attractive and has readable writing. Furthermore, in terms of sentence structure, student responses were very diverse. Some students complained about the difficulty to understand the sentence in several worksheets. From the twelve worksheets, six of them are expressed easily understood by 100% of students, while in six other, the number of students who express that the sentences in student worksheets are clear and easily understood range between 50% -100%. The factors that cause it are, (1) the students encounter new or less familiar terms, (2) the lack of a clear command in the steps to answer questions or solve problems. With the findings above, the researchers as developers need to reexamine every activity and command in the student worksheets and add explanation of the terms that may be relative new for some students.

In the instructional simulation session, the partner teacher practiced one of the student worksheets and lesson plans. Simulations were performed with some adjustments, for example in the grouping, six students are divided into three groups in pairs. After the simulation completed, students and teachers complete a questionnaire to determine the practicality of instructional materials. The results of the questionnaire show that both the lesson plans and student worksheets are in practical criteria. However, these criteria can be improved. Based on the analysis result one student (17%) stated that student worksheets are very practical, four students (66%) stated that the student worksheets are practical, and one student (17%) stated that the student worksheets are quite practical. Judged from the indicators, the students' responses are almost similar to the results of the test readability. Lowest scores are achieved on indicators of sentences clarity. This becomes an important note for the improvement of student worksheets at next phase. Meanwhile, other indicators have a similar score with dominance of 4 (practical). The observation results on learning simulation showed that the enforceability of the learning activities reaches 81.25% so that qualifies as very practical criteria.

Based on the results of the limited trial testing, the developed instructional materials have accomplished the practical criteria either for lesson plans or student worksheets. However, the practicality of the product can still be improved. Therefore, based on some notes that were recorded, then the instructional materials are revised and tested back on the field trial test phase to improve the practicality of instructional materials.

Field trial test involved one teacher and 23 students. The teacher assesses the practicality of student worksheets and lesson plans and the students only assess the practicality of the student worksheets. The analysis shows that both teacher and students provide an assessment of the lesson plan and student worksheets into very practical criteria. When it is compared with the results of limited testing, the score that is given by students and teacher increase. Even the score that is given by the teacher is close to perfect.

The results of teachers' assessment towards the practicality of lesson plan show that among the six assessment indicators, the teacher provide a perfect score (5: very good) on five indicators, (1) the ease to be applied, (2) the ease to obtain learning resources and supported media, (3) the clarity of every learning stage, (4) the flexibility in the application of the lesson plan, and (5) the potential of lesson plan to be used by other teachers in the learning process. Whereas, the one other gets scores (4: good). It is on the indicator of the suitability of the activities to time allocation. This means that in applying the lesson plan is needed the precision of the teachers to organize the learning time. The timing organization is also related to the diverse students' ability to complete the assignment that is given by their teacher.

Furthermore, teachers' assessment of the student worksheets shows the almost same results. Among the six indicators of student worksheet assessment, the teacher give a perfect score on the five indicators, (1) the ease of student worksheets usage to support the learning, (2) the ease to duplicate student worksheet, (3) the clarity of each activity and questions in the student worksheet, (4) the flexibility in the application of the student worksheet, and (5) the potential of student worksheet to be used by other teachers in the learning process. One other indicator scored 4 (good). It is on the indicator of the affordability of the cost that is required to use student worksheets. The reason of the scoring 4 can be predicted in advance, because it is not cheap to duplicate the student worksheets at every meeting, especially when the school does not have enough budgets for it. The solution is using the student worksheets for one group or one student worksheets in pairs. For the schools which usually use student worksheets from outsiders, the student worksheet of this development result can be used as an alternative so that the cost of the duplicating can be charged to the students.

Turning to the results of practical assessment of the student worksheets by students, the average score that is given by the 23 students is 25.5 from the maximum score 30 that participate to include student worksheets into very practical criteria. When it is shown from the percentage, 61% of students state that the student worksheet is very practical, 30% of students stated that the student worksheet is practical, and 9% of students stated that the student worksheet is quite practical. The percentage increase when it is compared with the results in previous trial test.

Another evidence of the practicality of the instructional materials can be seen from the feasibility of the learning activities. The teacher has been successfully applied the lesson plans at each meeting with the percentage of enforceability between 87.5% and 100%. The achievement is increased when it is compared with the percentage of adherence to the limited trial tests which only reach 81.25%. The observations results show that the instructional material can be categorize into the very practical criteria. This also reinforces previous evidence that is the results of the practicality questionnaire by the teacher and students who show the similar results. Thus, the developed instructional materials have fulfilled the very practical criteria.

CONCLUSION AND SUGGESTION

Conclusions

Based on the research and discussion result, the conclusions that can be taken are: (1) the mathematics instructional material of junior high school grade 8 semester 1 in the form of lesson plans and student worksheets are included in the very valid criteria, (2) the mathematics instructional material of junior high school grade 8 semester 1 in the form of lesson plans and student worksheets are included in the very practical criteria to improve the character and higher order thinking skills (HOTS).

Suggestions

Based on the research results and conclusions above, there are some suggestions that can be considered to improve the quality of mathematics learning; (1) in learning, teachers need to give emphasis to the conclusion of the class discussion, (2) in order to reach the effective problem-solving process, teachers need to know the students' first knowledge about the required prerequisites materials, (3) to improve the HOTS of students, the teacher's role as facilitator should be noticed, (4) teachers can use the instructional materials of the development results as a reference to develop the mathematics instructional materials in other standard competency, and (5) to other researchers, it needs further research on this instructional materials of the development results to determine the effectiveness of instructional materials that have been developed in the broader context.

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