



## The Development of HOTS-Oriented Science Supplement Book to Improve Problem Solving Ability of Vocational School Students

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### Abstract

The 21st century is an era where information and knowledge technology developed rapidly. They are really affecting all aspect of life especially on education sector. HOTS is one of the skills needed to face the challenges of the 21st century that requires students to think critically, creatively, and analyze an information which can be used as a way to solve the problem. This study aims to develop HOTS-oriented supplement books and find out the effectiveness of supplement books to improve students' problem-solving abilities. The supplement book that developed has HOTS characteristics which able to provoke students to improve their ability of reason, analyze, think creatively and solve the problems. This study uses a modified Research and Development (R&D) method. The results of this study 1) HOTS-oriented supplement book on polymer material in content / material and language in valid criteria according the experts with average of 3.78. Whereas in the graphic component, the language eligibility and the physical component of the supplement book is very valid criteria according to media experts 3,78. 2) The supplement book has oriented on HOTS polymer material developed which improves students' problem-solving abilities effectively. It is proven by an increasing of post-test scores, with medium N-Gain criteria and achieve 100% classical completeness.

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## INTRODUCTION

The 21st century learning is student-centered learning, not teacher-centered anymore. The source of student learning is not only the teacher but all information around them. There is no limit of information which is obtained, students are expected to have 21st century skills. These skills will hone students' thinking skills so the information obtained can be used as a source of learning optimally. The 21st century skills that must be owned by students include creativity and innovation, critical thinking and problem solving, communication and collaboration (Trilling and Fadel, 2009). The 21st century skills will develop students' higher-order thinking skills. In (Permendikbud No. 23 of 2006) explains that the importance of mastering of higher order thinking skills which contained on several points of the Competency Standards for High School Graduates. The expected points are students can build and apply information logically, critically, creatively, and innovatively; demonstrate the ability to think logically, critically, creatively, and innovatively in making decision; and demonstrate the ability to analyze and solve complex problems. Higher Order Thinking Skills (HOTS) are skills that require students to think critically, creatively, and analyze an information which can be used as a way to solve the problem

Higher Order Thinking Skills (HOTS) are thinking skills that occur when a person takes new information and it is already stored in his memory, then connects the information and delivers it to achieve the goal or answer needed (Lewis & Smith, 1993). HOTS in students can be empowered by giving problems that exist in their daily life, so the application of this ability is when students able to explain, decide, show, and produce problem solving in the context of knowledge and experience successfully (Baharin et al., 2018). The more complicated problems that students has faced, they will need higher thinking skills. But in fact students often find the difficulties to solve problems in learning. Problem solving ability is the ability of students to decide what to do by using the knowledge that they have (Gok & Silay, 2010). Students tend to give up easily and then look for answers on search engines. As a result, students' problem solving

abilities do not develop, also students will get more difficult if they are given more difficult problems. Almost all students need to improve higher-order thinking skills, especially in synthesis and evaluation skills to improve students' problem solving abilities (Saido et al., 2018).

Based on the observations did at school, it was found that the books used in the learning process still lacked HOTS content. It can be seen in the lack of activities that stimulate students' problem-solving abilities, also the evaluation questions presented are still in C1 to C3 domains. Especially in polymer material, the book which used just presented the conceptual material without any examples of problems in daily life. Polymer material is taught in class X majoring in tourism. In addition, during the learning process, the teacher just explains polymer material using lecture and discussion method. The teaching materials used by teachers and students are textbooks provided by the school.

The purpose of this study (1) to describe the characteristics of HOTS-oriented supplement book (2) to analyze the validity of HOTS-oriented supplement book on polymer material developed according to material, media and user experts (3) to analyze the effectiveness of HOTS-oriented supplement book of polymer material on students' problem solving abilities and (4) to analyze the problem-solving abilities of students.

## METHODS

This research was conducted at SMK Negeri 1 Kudus. This study uses a research and development method refers to research model which has been modified Borg & Gall (1983). The modified Borg & Gall (1983) model contains of steps research and development research of scientific which include: 1) Research and Information Collecting; 2) Planning; 3) Develop preliminary form of product; 4) Preliminary field testing; 5) Main product revision; 6) Main field testing; 7) Operational product revision; 8) Operational field testing; 9) Final Product Revision; 10) Dissemination and implementation. By the limited time and costs of this study, the research procedure was simplified into seven steps. This study developed a HOTS-

oriented supplement book on polymer material. The supplement book which developed is validated by experts consist of material experts, media experts, and Science teachers. The assessment instrument for HOTS-oriented supplement books refers to the BSNP teaching material assessment standards. The aspects assessed include the correctness of content, presentation, language, and graphics also the level of readability of teaching materials.

## RESULTS AND DISCUSSION

The supplement book developed is a HOTS-oriented supplement book and contains student worksheets that improve problem-solving abilities with and follow the development of teaching materials provisions from BSNP. The supplement book which developed consists of student worksheets that require students to develop their HOTS. Based on the provisions of the BSNP, the composition of the supplement book developed consists of the composition of supplement books generally consists of a front cover, a foreword, a table of contents, a concept map, a description of the material and a HOTS-based student worksheet. The front cover contains of material titles, teacher and class levels, also completed with illustrations or pictures that match with the material. The addition of material should use simple sentences so the students can more understand the contents of the supplement

**Table01.** Supplement Book Validation Results Data by Validators

Validator	Mean Score	Percentage	Criteria
Material Expert	3.78	94%	Very Valid
Media Expert	3.78	94%	Very Valid
Teacher	3.75	93%	Very Valid

The data in Table 1 describes that the scores be obtained from the validation results of each expert. The average percentage score given by material experts is 3.78 with very valid category. The average percentage score given by media experts is 3.78 with very valid category. The average percentage score given by the teacher is 3.75 with very valid category. Based on the assessment given by validators, it can be concluded that the average validation score of

book easily. In addition, the writing of terms should comply with applicable rules. Muslich (2010) stated that book writing must be appropriated with the language that understood by students easily and also appropriate with Enhanced Spelling (EYD).

HOTS-oriented supplement books should have HOTS characteristics, it means that teaching materials which developed must able to provoke students in improving their ability to reason, analyze, think creatively and solve the problems (Anisah, 2018). Therefore, the students can hone their thinking skills. It is appropriate with Musfiqi & Jailani's research (2014) which shows that HOTS-oriented worksheets are effective in improving students' character and HOTS. Moreover, the worksheets given which contain pictures / illustrations can increase students' curiosity. Interesting teaching materials can create a fun learning atmosphere so it helps students to understand the concepts and learning materials (Sulassri et al., 2014).

Supplement book validation is needed to determine the appropriateness of supplement books which can be used in the learning process and specified by BSNP. Validation is done by material experts, media experts and Science teachers. The results of the HOTS-oriented supplement book validation can be seen in the Table 1.

HOTS-oriented supplement books on polymer material is 3.77 with percentage of 86% in the validation category.

The students' problem solving abilities were obtained from the pre-test and post-test scores which analyzed using the N-Gain test and then calculated by classical completeness of all samples are 36 students. Students' problem solving abilities can be seen in Table 2.

**Table2.** Results of students' problem solving abilities

Variable	Mean Score	Criteria
pretest	60	Not finished yet
posttest	80	Completed
N-Gain score	0.50	Moderate

Table 2 shows that the average value at pretest is stated not finished yet. If it's calculated classically, there are only 17 students who stated completed in pretest, while 19 students are stated incomplete. After learning the polymer material using the supplement book, the post-test students' average scores were stated complete. After it calculated classically, there are 29 students who have complete scores while 7 students not finished yet. The N-gain which obtained from the difference between the pre-test and post-test scores has moderate criteria. Therefore there is an

increase in learning outcomes after using supplement books.

The increase of problem-solving abilities was obtained from pre-test scores before the students did the learning process and post-test scores after the students did the learning process using supplement books. The tasks have been adjusted to the problem solving ability indicators according to Polya (1957) which consisted of 20 multiple choice questions. The calculation result of the increase in students' problem solving abilities can be seen in Table 3

**Table3.** Improved Problem Solving Ability

Problem solving ability indicator	Pretest Score	Posttest Score	N-gain
Understand the problem	65.74	76.23	0.30
Planning for problem solving	50.00	69.44	0.38
Carry out the plan	54.50	98.15	0.60
Review the process and results	45.00	70.37	0.46

The increase of problem-solving abilities can be seen on the increase scores at the pretest and posttest with the N-gain in moderate category. Students' problem solving abilities indicators were analyzed based on the evaluation questions given. Based on Table 3, the indicators of understanding the problem get the smallest value. It is because students are still not familiar with learning using problem-solving procedures. In addition, indicator of understanding the problem is the first procedure of problem solving, so the teacher needs to explain it in more detail so that students can step the next stages easily (Fadillah, 2009; Atkinson et al., 2000; Frey & Fisher, 2011). Problem-solving abilities can be trained by giving complex problems so that it requires higher abilities to find solutions of the problems (Rosmawati, 2012; Retnawati et al., 2018; Yayuk & As'ari, 2020).

## CONCLUSION

The HOTS-oriented supplement book developed has HOTS characteristics, its provoking activities for students to improve their ability of reason, analyze, think creatively and solve the problems. The validation of HOTS-oriented supplement books has appropriate criteria according to material experts and media experts. The HOTS-oriented polymer material supplement book which developed has effectiveness in improving students' problem-solving abilities.

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