PBL-team teaching on developing vocational mathematics textbook

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Abstract. The textbook that is used today in some Vocational School in Cirebon region is a textbook of Mathematics for Vocational School from certain Publishers. Although the government once published textbooks for Vocational School, but almost no more teachers use it. Teachers generally complain about the available textbooks in terms of their practicality and effectiveness. According to them, the existing book has too broad a material coverage. In addition, there is no specific book available for use by vocational students to make vocational high school students are not motivated to learn math. This paper explores the development of mathematics textbook which can be used as one of learning resource for vocational students of competence of light vehicle engineering skill and business and motorcycle technique. The research method used is R & D. The research product was in the form of a mathematics vocational school textbook of Geometry & Measurement material designed according to the PBL model and presented through the team teaching method. The results showed that the book had a very valid level of validity. Through the use of this textbook, student can apply mathematical theory to vocational practice.

1. Introduction

Road Map Revitalization Vocational Curriculum 2017\cite{1} illustrates that the characteristics of Vocational School graduates are expected to have dual capabilities, 4C (critical thinking, creativity, collaboration, communication), literacy, elasticity, and global citizen. This is in line with the exposure of the World Economic Forum\cite{2} that 21st century skills that vocational school students must possess are Character (adaptability to dynamic environment), Literacy (Competence), and Competency (complex problem solving skills). In accordance with the Road Map of Vocational School, that the challenge faced by the current Vocational School is the suitability between the implementation of the curriculum of learning in schools with the development of technology and industry needs. But especially for Mathematics subjects, curriculum implementation is currently more academic than vocational. Therefore, it is necessary to harmonize and align the curriculum implementation in accordance with the needs of industry and the standards of Content, Graduate Competence Standard, Process Standards and Appraisal Standards. Mathematics learning materials should be based on adoption, collaboration and adaptation between Core Mathematics Competencies and Vocational Competencies.
Law of the national education system No. 20/2013 argues that vocational education is a secondary education that prepares learners primarily to work in a particular field. To meet that goal, vocational school curriculum aspects are developed based on integrative, student-based, constructive, flexible & tailor-made needs, focusing on optimal student development, sustainable learning and skills accumulation. Implementation of learning programs in Vocational School aims to develop all the potential students to have work insight and able to perform self-transformation of changes in the demands of the world of work. Implementation of learning can be more efficient if done by replicating the work environment as closely as possible with what happens in the actual workplace. In addition, the implementation of learning can also be more effective if students get a lot of stimulus in order to develop their thinking skills.

One medium that can be used in order to help develop students' thinking skills is through the provision of appropriate textbooks. Textbook in addition to supporting the learning process in the classroom, as well as supporting in improving students' cognitive, affective and psychomotor skills. Mathematics textbook serves as a source of information for students in learning mathematics material. The survey results show that the textbook that is used today in some Vocational School in Cirebon region is a textbook of Mathematics for Vocational School from certain Publishers. Although the government once published textbooks for Vocational School, but the survey results show that almost no more teachers use it. Teachers generally complain about the available textbooks in terms of their practicality and effectiveness. According to them, the existing book has too broad a material coverage. In addition, there is no specific book available for use by vocational students to make vocational high school students are not motivated to learn math. vocational high school students in general do not have a good interest in reading so that it has an impact on the quality of understanding and improvement of thinking ability.

Based on these conditions, it is necessary to research the development of textbook in accordance with the character and objectives of learning in Vocational School. The learning that is considered appropriate to improve students' learning outcomes of SMK is problem-based learning (PBL)[3]–[8]. Through many problem, students are stimulated by their curiosity that raises many questions in solving problems. Mathematics subjects are often ignored by vocational students because they generally prefer vocational subjects. Whereas math is very important to support vocational skills, especially for students of SMK technology & engineering. Growing motivation to learn math for vocational students was not easy[3], [9]. Therefore, it is necessary to use learning strategy that is able to accommodate knowledge needs for vocational students. PBL presentation is packed more specifically for vocational students that is by using team teaching method.

1.1. PBL-Team Teaching
Various researches on the implementation of PBL in education have shown that PBL is effective to improve learning outcomes and the ability of vocational students[10], [11]. Through PBL students are able to demonstrate a positive attitude in achieving conceptual and procedural knowledge[12]. PBL is implemented with reference to the stages of problem orientation, organizing students, guiding the investigation, developing and presenting the results, analyzing and evaluating[13].

Lessons learned should depend on the idea that students learn comprehensively and integrally[14]. PBL-team teaching is a learning model that refers to PBL learning steps with team teaching method involving more than 1 expert as a teacher. PBL-team teaching on SMK mathematics learning involves 1 mathematics teacher and at least 1 vocational teacher as a learning resource. PBL-team teaching will greatly enable the occurrence of science collegialization from the interdisciplinary aspect. Type of team teaching that can be selected i.e. semi team teaching and full teaching team[15]. The developed textbook is well suited to the full team teaching method.
1.2. Textbooks
Judging from its form, teaching materials are grouped into printed materials and electronic materials. The textbook is one of the teaching materials in the form of printed materials containing the study that must be mastered by the learners[16].

Textbooks of mathematical materials of geometry and measurements developed, assessed by expert validators based on the following aspects:
1. General Characteristics
   a. Have a concept map
   b. Contains knowledge transformation
   c. Material presentation in general
   d. Discusses the application of mathematics in the field of vocational
   e. Having interdisciplinary linkages
   f. Cognitive emphasis on creative thinking ability
   g. Presentation of tasks
   h. Developed according to PBL syntax
2. Special Characteristics
   a. Relevance
      1) Relevant to competence
      2) Relevant to the problem presented
      3) In accordance with the truth of science
      4) In accordance with daily life
   b. Completeness dish
      1) Contains competency components and learning objectives that are appropriate to the curriculum
      2) Presents a bibliography
      3) Presents the table of contents
      4) Present the introduction
      5) Presents a material summary
   c. Servicatics follows the flow of thought from local to global
   d. Compliance with the principle of student learning center
      1) Encourage the interaction with the students
      2) Encourage students to learn in groups
   e. Compliance with the use of good language rules
      1) The accuracy of spelling use
      2) The accuracy of the use of sentence structure
   f. Legibility
      1) Presentation of sentences that are easy to understand students
      2) Structure of sentences that fit with students' understanding
      3) Using language that can be understood by students

2. Methods
The method used in this research is research and development method (R & D). Textbooks developed that have special characteristics for students of vocational school competence in the expertise of Light Vehicle Engineering and Motorcycle Engineering. The material developed is limited to Geometry and Measurement materials.

Developing steps that are carried out in accordance with the development step according to Sugiyono [17] that has been modified namely, (1) potentials and problems, (2) data collection, (3) product design, (4) design validation, and (5) revision design. The textbook that has been developed, validated by 5 validators namely 3 lecturers of mathematics from the University of Swadaya Gunung Jati, 1 mathematics teacher from SMKN 1 Jamblang, and 1 math teacher from SMK Samudra Nusantara. Data analysis technique in this research is by using qualitative data analysis and quantitative data analysis.
Qualitative data obtained through criticism and suggestions from the validator while the quantitative data obtained through a validation questionnaire.

Akbar[18] revealed that the presentation of textbook achievement level can be calculated using the following formula.

\[
V - ah = \frac{Tse}{TSh} \times 100\%
\]  

3. Result and Discussion

3.1. The description of textbook

Development of textbook of vocational school is done by using development steps according to Sugiyono [17]. The development steps consisting of ten development steps are modified into five developmental steps: potential and problems, data collection, product design, design validation, and design revisions. The textbooks which are developed are students and teacher’s book.

Vocational High School textbook that has been developed is a Geometry & Measurement Mathematics textbook that is designed in accordance with the characteristics of PBL and presented with the teaching team of vocational teacher. The content of teaching materials includes distance from point to line and from point to field in building space. Textbook contain problems and activities that are specifically in accordance with the needs of vocational high school students, especially the group of technology & industry, Vehicle Engineering and Motorcycle Engineering Program. As a support, textbooks are equipped with student activity books and student activity sheets.

![Figure 1](image1.png)

*Figure 1. Light Vehicle Competency Student Book Cover.

![Figure 2](image2.png)

*Figure 2. Technical & Motorcycle Competency Student Book Cover.*
3.2. The properness of textbook

Based on validation by four validators, result validation data that is, expert validator I with validation criterion 90.73%, validator expert II with validation criterion 83.87%, validator expert III with validation criterion 91.13%, validator expert IV with validation criterion 96.37%, and expert V validator with 96.37% validation criteria. The combined validation is obtained through the average calculation of the results of the four validators with the validation criterion of 90.53%, the validity level is very valid. Based on the combined validation data, the textbook of vocational school mathematics on Geometry & Measurement materials can be used in the learning process with not much revision. In addition, the validation of the four validators on the textbook vocational school mathematics declared very valid which means that textbook mathematics vocational school already meet the aspects that have been determined in the validation of teaching materials.

4. Conclusion

Based on the results of research, it can be concluded that the development of textbooks vocational school mathematics on materials Geometry & Measurement done in accordance with the steps of development according Sugiyono [17]. The development steps are modified from ten development steps into five development steps, namely potential and problems, data collection, product design, design validation, and design revision. Potentials and problems are the first step in research to identify problems and establish the concepts that will be developed in vocational school teaching textbooks. The data collection stage is done to obtain information in designing the textbook of vocational school mathematics so that it can solve the problem. Textbook of mathematics vocational school that has been prepared, then done validation of teaching materials by expert validators. Based on the validation results of the five expert validators, the validation of combined textbooks is obtained with validation criterion 90.53% then obtained the validity level is very valid so that the textbook of mathematics vocational school on Geometry & Measurement materials can be used in the learning process.
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