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Developing Textbook Based on Higher Order Thinking Skills for Computer Aided Design Course

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ABSTRACT
This type of research is Research and Development (R & D), the aim of which is to produce a HOTS-based Textbook on CAD courses that are valid and practical. The development model used is the ADDIE development model, namely an acronym for Analyze, Design, Develop, Implement, and Evaluate. This product validation was carried out by 2 experts, namely material experts and media experts. The product trial subjects were students of Mechanical Engineering Education batch 2018. This trial was conducted in one to one and small group trials. The results of the development of the material expert validation show that the HOST-based book development assessment gets an assessment score in the very good category and the media expert's assessment is also in a good category so that HOTS-based book products are said to be valid. Evaluation of a one to one trial in the "Good" category, Small Group Trial in the "Very Good" category. So it can be concluded that HOTS-based CAD textbooks are said to be valid and practical.

***Keywords**: Textbook, HOTS, CAD course, Research and development.*

1. INTRODUCTION

Vocational education is designed to prepare students or graduates who are ready to enter the world of work and are able to develop professional attitudes in their respective vocational fields [1]. Vocational education is education that is designed to develop the skills, abilities, understanding, attitudes, work habits, and appreciation needed by workers to enter and make progress in work in a useful and productive manner [2].

Vocational education in 21st century learning requires students to be competitive in the world of work. Vocational education also requires students, one of which is to have the ability to think creatively. Teaching and skills assessment in 21st century vocational education is to organize skills, knowledge and attitudes into four categories: ways of thinking, ways of working, tools for working, and living in the world [3]. Working, living and studying in the 21st century requires the development of a number of skills, competencies and personal flexibility [4], [5].

The quality of learning technology education, vocational education and training helps develop individual knowledge of science and technology in a wide area of work that requires specific technical and professional competences and job skills [6]. Vocational education graduates are expected to be competitive and competent in the world of work. Kincheloe stated that vocational education graduates are also expected to become productive individuals who are able to work as workers and have readiness to face job competition [7].

The success in creating graduates who are competent and have high abilities cannot be separated from the role of lecturers, teaching materials, and existing facilities in the learning process in the classroom [8]. Success in learning activities is also largely determined by learning skills and intelligence. Learning skills and intelligence are the key to a person's success in the 21st century, besides that skills are also very important in facing the era of the industrial revolution 4.0 which increasingly requires abstract skills commonly referred to as high order thinking skills [4].

The Mechanical Engineering Education Study Program is one of the undergraduate level vocational / vocational education programs in Higher Education. Graduates from this study program are expected to be able to pass on their knowledge to vocational students. The Directorate General of Higher Education explained that an important requirement in learning in higher education is that lecturers should empower students' potential by training various skills, especially those related to higher-order thinking skills (HOTS) [9].

CAD is one of the courses in the PTM study program. CAD (Computer Aided Design) is a computer program that allows a designer to design engineering drawings by rapidly transforming geometric drawings [10][11]. Computer Aided Design (CAD) is a branch of computer graphics science. By utilizing computer graphics, a person can draw, design and plan through AutoCAD drawings, which are usually used by planners and

designers to express their ideas in the form of drawings or models [10].

This CAD course requires students to think critically in solving problems. One of the problems that often arise in CAD courses is the weak thinking ability of students in solving given problems. Most students still have difficulty understanding the material presented so that when given the assignment they find it difficult to complete. Some students are still less active in learning activities even though the current learning paradigm is no longer oriented to Lecturers (Teacher-Centered Instruction) but rather oriented to students (Student-Centered Instruction) [12].

Based on observations during learning activities, the following results were obtained: (1) student learning outcomes in CAD courses were still low; (2) most students still have difficulty understanding the material so that students are still confused even though it has been practiced in front of the class; (3) students are not active in learning activities, (4) there are no teaching materials, especially modules that can make students active and can solve their own problems.

There is a lot of knowledge, skills and information that students have, but they are still difficult to relate to the conditions they are currently facing. Instead of being able to solve the problem, their knowledge seems irrelevant to the problem they are going to solve. The impact of these problems is low student learning outcomes and ultimately a decrease in the quality of graduates of the Mechanical Engineering Education study program.

Efforts made to be able to overcome the problems that are being faced are by developing teaching materials which contain HOTS in it. HOTS is a thinking process of students at a higher cognitive level that is developed from various cognitive concepts and methods and learning taxonomies such as problem solving methods, bloom taxonomy, and learning, teaching, and assessment taxonomies [13].

In the process of teaching and learning, the availability of textbooks is one of the essential components that must exist because textbooks serve as a guide for students and their teachers of any level of education to be actively engaged in classroom practices [14]. One of the learning goals through HOTS is to make sure that students can analyze, evaluate, and create their knowledge [15].

The National Center for Competency Training explains "teaching materials are all forms of materials used to assist teachers or instructors in carrying out the learning process in class, these materials can be in the form of written or unwritten materials" [16]. Teaching materials have an important position in learning and have an effective influence in increasing the activities and learning outcomes of students.

One of the functions of teaching materials for teachers is to improve the learning process to be more effective and interactive, and for students it is as a guide for students who will direct all their activities in the learning process and is a substance of competencies that they should learn and master, as well as additional learning resources for students [17]. According to its form, teaching materials are divided into four types, namely printed teaching materials, listening teaching materials, listening point-of-view teaching materials, and interactive teaching materials [18]. According to how it works, teaching materials are divided into five types, namely non-projected teaching materials, projected teaching materials, audio teaching materials, video teaching materials, and computer teaching materials.

Higher-order thinking skills (HOTS) are a popular concept in American education. This differentiates critical thinking skills from lower-level learning outcomes, such as those achieved by rote memorization. HOTS includes synthesis, analysis, reasoning, understanding, application, and evaluation. Higher order thinking skills include critical thinking and creative thinking. Critical thinking is a term associated by most people with higher order thinking skills [19]. Creative thinking is also a higher order thinking skill and is just as important as critical thinking [19]. Creative thinking is the process of realizing new ideas. Like critical thinking, creative thinking is also required to be active.

HOTS is the ability to think critically, logically, reflective, meta-cognitive, and creative thinking which is a high-level thinking ability. The teacher is required to carry out the HOTS-based learning process so the students are able to solve the HOTS problem. The HOTS problem must be able to measure the transfer of knowledge, problem-solving and critical thinking. The HOTS problem is a measurement instrument used to measure high-level thinking skills, namely thinking skills that are not just remembered, understand, or apply [20].

It is hoped that HOTS-based teaching materials will be an alternative to teach students to develop higher order thinking skills and skills and to improve students' ability to design drawings using CAD.

2. METHOD

This type of research is Research and Development. The researcher first develops and validates HOTS-based teaching materials in CAD courses. After it has been developed and validated, the researcher uses the book for the 4th-semester students.

The development model used is the ADDIE development model: Analyze, Design, Develop, Implement, and Evaluate. ADDIE is a product development concept. The ADDIE concept is applied to

build performance-based learning. The educational philosophy for the ADDIE application is that deliberate learning must be student-centered, innovative, authentic, and inspirational [21]. The ADDIE development concept is as follows:

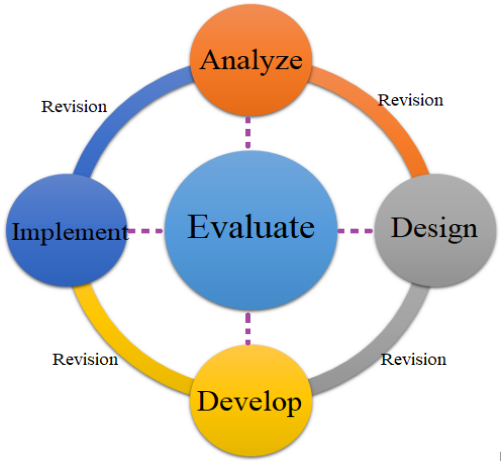

Figure 1. The ADDIE development concept. [22]

The trial resulted in findings of weaknesses, deficiencies, product errors, and suggestions submitted by respondents to the developer. This trial was carried out 3 times and was carried out on different respondents to produce maximum teaching material products so that they could be used in daily learning activities.

The subject of product validation was 2 experts, namely material experts and media experts. Material experts from lecturers who take CAD courses while media experts are people who understand the design of the teaching materials being developed. While the product trial subjects in this study were Mechanical Engineering Education students.

Data collection instruments used questionnaires and tests. The questionnaire instrument is in the form of an assessment sheet in the form of a validation sheet containing assessment items which will be filled in by media experts, material experts, and test subjects. The instrument test in the form of a mastery test of this material is presented in the form of a test menu page on multimedia products that can be directly operated by the user. The test page contains 20 items in the multiple-choice form which represent each subject as the main material in multimedia products. The test is used to capture quantitative data to determine the effectiveness of the research product in this development.

The instrument sheet was analyzed using trend data categories. The results in the form of a score from the assessment are then converted into values using a trend table [23].

Table 1. Categories of data trends

Interval	Category
($\bar{X}_i$ + 1,80 Sbi) < X	Very good
($\bar{X}_i$ + 0,60 Sbi) < X ≤ ($\bar{X}_i$ + 1,80 Sbi)	Well
($\bar{X}_i$ – 0,60 Sbi) < X ≤ ($\bar{X}_i$ + 0,60 Sbi)	Enough
($\bar{X}_i$ – 1,80 Sbi) < X ≤ ($\bar{X}_i$ – 0,60 Sbi)	Less
X ≤ ($\bar{X}_i$ – 1,80 Sbi)	Very less

Information:

- X$\bar{i}$ (average ideal score) = ½ (maximum score + minimum score)
- SBi (ideal standard deviation) = 1/6 (maximum score - minimum score)
- X = actual score

Each data includes the minimum score obtained from (smallest scale x number of aspects of assessment x number of respondents). The maximum score is sought by (highest scale x number of aspects of assessment x number of respondents). After getting the maximum and minimum values, the average ideal score ($\bar{X}_i$) and the ideal standard deviation (SBi) are sought. Average ideal score ($\bar{X}_i$) and ideal standard deviation (SBi).

Test data analysis is an analysis of data obtained from student learning outcomes tests after working on the pre-test and post-test questions.

The average rating uses the following formula:

$$\bar{X} = \frac{\Sigma X}{n} \qquad [24]$$

Information:

- $\bar{X}$ = Average
- X = Student scores (pre-test / post-test)
- n = Number of students

3. RESULTS AND DISCUSSION

This research and development consist of 5 (five) main steps, namely: analysis, product design, product development, product implementation, and product evaluation.

3. 1. Analysis

The development of HOTS-based teaching materials begins with an analysis. The data obtained from this preliminary study are as follows:

3. 1.1. Field Analysis

Field analysis is carried out to see the conditions of the lecture process directly (observation). The results of the field analysis included: (1) lack of enthusiasm for students in participating in learning because the material was only delivered using books and blackboards; (2)

educators only rely on variations in teaching methods, namely lectures, demonstrations, and discussions; (3) educators have difficulty in delivering CAD material; (4) lecturers and students have difficulty obtaining teaching materials in accordance with the material; (5) lecturers and students need materials that are in accordance with current conditions, which can attract student attention; (8) lecturers and students need one of the teaching materials so that it can support the learning process contained in the material on book media.

3.1.2. Needs Analysis

Analysis of development needs is carried out to obtain information about the extent to which the development of HOTS-based teaching materials in CAD courses is needed in optimizing the implementation of the learning process and learning outcomes of CAD. The data in the first step were taken from the results of observations and the results of interviews with students who took this CAD course. The data from the results of this first step are in the form of field requirements for teaching materials in CAD courses in the mechanical engineering education study program.

Analysis of the needs of students shows some of the opinions and comments of students about this CAD learning process. They argue that they have not had much more varied learning experiences. The learning method that is more often used by lecturers in delivering subject matter is demonstration but too fast. The use of teaching materials in delivering material is still lacking. Sometimes lecturers use the media when delivering material but it doesn't make students' attention increase. Students have difficulty absorbing the material presented by the lecturer even though students must really understand the material presented because after finishing the material they will continue with related courses, namely CAD.

3.2. Product Design

The results obtained from the design stage are: first, the researcher makes a flowchart. The flowchart is a flowchart in making HOTS-based teaching materials. The goal is that the development of HOTS-based teaching materials does not expand and lead to other learning. The flowchart is a flowchart that contains the main points of material that will be included in the development of HOTS-based teaching materials. Next, making a storyboard that will be used to describe the shape of each display in each frame in the HOTS-based teaching materials developed.

3.3. Product Development

The development of HOTS-based teaching materials products as a whole discusses CAD materials. The media production process is also based on pre-made prototype designs, flowcharts, and storyboards as well as other supporting materials for the manufacture of products. The target users of HOTS-based teaching materials are second-semester students who are taking CAD courses.

The initial product that has been developed is checked first before the initial product is validated and tested on students. Checking is carried out internally, namely starting with checking the overall running of the program. Broadly speaking, HOTS-based teaching material products developed at this early stage contain:

- Material, consisting of material about CAD which will be taken for 1 semester.
- The evaluation, contains practice questions and practice drawing that has been learned. This exercise serves to check the level of students' understanding of the material they are studying. Questions are made based on the level of high thinking ability (HOTS)
- Profile, which contains the developer profile.

3.4. Implementation

HOTS-based textbook products that have been completed before being tested by the developer; (1) Do physical checking and the contents of the book as a whole so that this book is declared a fixation according to the needs after which the researcher asks colleagues to check the book being developed; (2) Textbook products that have been developed and examined by peers will then be assessed and validated by material experts and material experts as validators.

Validation is contained in a questionnaire filled out by both material experts and media experts in accordance with the assessment aspects of each validator. Initial product validation was carried out by one media expert and one material expert. In the validation of material experts who become validators of Android-based learning media products are lecturers who teach CAD courses, while in the validation of media experts are media expert lecturers in the Mechanical Engineering Education study program Faculty of Teacher Training and Education Sriwijaya University.

The evaluation data of material expert validators and media experts were used to determine the quality of this HOTS-based textbook. The validator lecturer provides an assessment to be revised until the product is deemed worthy of being tested on students.

The results of the expert validation are as follows: The results of the material expert's assessment can be concluded that the HOTS-based Textbook developed has a "Very Good" rating with an average of 4.45. And the results of the media expert's assessment concluded

that the HOTS-based Textbook developed had a "Very Good" rating with an average of 4.34.

3.5. Evaluation

The product is declared feasible by the experts then implemented and assessed by students in the form of a trial. Android-based learning media product trials at each stage will be assessed by students and revised based on deficiencies in the product. Suggestions and criticisms from students given in each trial will also be revised to improve this Android-based learning media. The trial consisted of (1) individual trials conducted by 5 students and they gave an assessment, then the results of the assessment in the first stage would be analyzed to become a revised language; (2) Limited trials were carried out by 15 students who then also gave an assessment of the product being developed and then revised again; (3) After the revision, a field trial was carried out by 30 students. The assessment results from the field trials were revised to become the final product.

From the results of the students' assessment in the one-on-one trial, it can be concluded that the HOTS-based Textbook developed has a 4.02 assessment with the criteria of "Good". From the results of students' assessments in the small group trial, it can be concluded that the HOTS-based Textbook was developed as an assessment of 4.32 with the criteria "Very Good". Meanwhile, from the results of students' assessments in the large group trial, it can be concluded that the HOTS-based Textbook developed has a 4.54 rating with the criteria of "Very Good".

4. CONCLUSION

HOTS-based textbooks in CAD courses are declared VALID. The results of the material expert's assessment can be concluded that the HOTS-based Textbook developed has a "Very Good" rating with an average of 4.45. And the results of the media expert's assessment concluded that the HOTS-based Textbook developed had a "Very Good" rating with an average of 4.34.

HOTS-based textbooks on CAD courses are stated to be PRACTICAL. From the results of the students' assessment in the one-on-one trial, it can be concluded that the HOTS-based Textbook developed has a 4.02 assessment with the criteria of "Good". From the results of students' assessments in the small group trial, it can be concluded that the HOTS-based Textbook was developed as an assessment of 4.32 with the criteria "Very Good". Meanwhile, from the results of students' assessments in the large group trial, it can be concluded that the HOTS-based Textbook developed has a 4.54 rating with the criteria of "Very Good".

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