Development of a Flipbook-Based Inventor Drawing Teaching Module to Improve Learning Outcomes in the Manufacturing Technical Drawing Subject

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ABSTRACT

This study developed a Flipbook-based Inventor Drawing teaching module to improve learning outcomes in the Manufacturing Engineering Drawing subject at SMKN 10 Semarang. The objectives of the study were to develop an Inventor Drawing teaching module, analyze the feasibility of the teaching module and determine the impact of its implementation on learning outcomes. The study used the Research and Development (R&D) method with subjects of class XI Welding Engineering 2 students of SMKN 10 Semarang. The module was considered feasible if the validation from media experts and material experts reached the valid category. Data collection instruments included validation sheets and Pre-Test and Post-Test tests. The results of the study were that the validation from media experts obtained a score of 90.34%, and material experts 88.80%, both of which were in the very valid category, the average student score increased from 68.80 (pre-test) to 80.34 (post-test) with a moderate category, and the classical passing percentage reached 94%, exceeding the minimum standard of 75%. The conclusion of the study was that the Flipbook-based Inventor Drawing module was effective in improving student learning outcomes in the Manufacturing Engineering Drawing subject.

Keywords: development of teaching modules, autodesk inventor, flipbook

1. INTRODUCTION

A teaching module is a unit of work in a course of instruction that is virtually self-contained and a method of teaching that is based on the building up skills and knowledge in discrete units [1]. Some argue that schools are responsible for adapting to the developmental needs of every learner [2]. A module has placidly defined, objectives; preferably in behavioral form. In addition, it is defined as varieties of teaching methods that will fixate on cumulating methods that can best realize the creative and constructive engagement with learning activities that leads to understanding [3]. Observation activities carried out by researchers using the interview method on teachers and students were carried out precisely in the Welding Engineering, Machining, and Marine Engineering departments, of the three departments observed that had received learning using Autodesk Inventor software only in the Welding Engineering

Department, and even then, it was only an elective subject. If we look at other schools, almost all of the use of manufacturing drawing designs has switched to Autodesk Inventor software. In addition to the PC infrastructure that is not ideal or still with a group system that causes gaps in student competency. According to the Manufacturing Engineering Drawing subject teacher, it was conveyed that educators need interactive teaching modules that are in accordance with the provisions in the curriculum. This means that students lack access to books or modules or other interactive learning sources. Although researchers agree that problem-solving learning and project-based learning methods are very appropriate to use in the learning process. Such factors certainly create a gap in student competency in manufacturing drawing design competency if no solution is sought.

"The development of information and communication technology (ICT) has significantly

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influenced the innovation of teaching materials, leading to the widespread adoption of digital-based teaching modules by educators." [4]. One of the new innovations in the development of teaching materials is the use of electronic modules, which are books in the form of software that can be opened and read by students anytime and anywhere. With the development of teaching materials in the form of E-Modules, it is hoped that it can reduce boredom and increase student interest in the learning process. The use of digital modules in education provides several advantages, including the ability to innovate in teaching methods, transition from traditional printed materials to electronic formats, and enhance student engagement and learning outcomes [5]. As a transformative force, ICT continually evolves, presenting new opportunities and challenges for education stakeholders, requiring thoughtful integration to harness its full potential in enhancing learning outcomes and shaping the future of education [6].

Flipbook is one of the interactive E-Module innovations that can be applied to the learning process. Flipbook software contains digital teaching modules, allowing students to use them independently on computers, laptops, or other devices. Flipbook is a program or application that allows you to create E-books or electronic books with output in exe, html, zip formats, and can include pdf files, images, videos, or animations. In addition, this program can create an attractive appearance to change books into flip-flop pages like books. The Flipbook tool is used to change books or learning materials into more interactive electronic books with animation, audio, and navigation. Digital flipbooks are similar to electronic books, but the advantage is that they can be opened page by page and are supported by animations, videos, writing, and images related to the book. Asrial explain that there is a characteristic that when the flipbook is rotated quickly the images give the illusion of movement or animation [7]. The above problems are a challenge for researchers to find the best alternative solutions in order to create learning that emphasizes student learning outcomes. So, researchers will develop more innovative and creative teaching modules utilizing technology, namely Flipbook-based electronic teaching modules that will facilitate teacher and student access to learning materials and support student independent learning. However, it is compiled while still meeting the rules of components that must be in the curriculum. The purpose of this study is to develop an Inventor Drawing teaching module to improve student learning outcomes, analyze the feasibility of the teaching module, and determine the impact of implementing the Inventor Drawing teaching module on learning Manufacturing Engineering Drawing at SMKN 10 Semarang.

2. LITERATURE REVIEW

The integration of modern teaching methods and digital tools is crucial for enhancing student learning outcomes in technical subjects. Flipbook-based modules and CAD software like Autodesk Inventor provide an innovative way to merge theoretical knowledge and practical skills, which are essential in manufacturing technical drawing.

2.1 Flipbook-Based Learning Modules

Flipbooks as educational tools are highly interactive, visually engaging, and accessible, making them effective for delivering complex content. Studies have shown that the visual and interactive features of flipbooks enhance student understanding and retention of information [8]. They are particularly effective when combined with practical examples and multimedia features like video tutorials and QR codes, which enable self-paced learning [9].

2.2 Autodesk Inventor in Education

Autodesk Inventor is widely used in technical and engineering education due to its ability to model both 2D and 3D designs accurately. The software supports project-based learning approaches, enabling students to connect theoretical concepts with real-world applications. Research has highlighted its role in improving spatial visualization skills and enhancing competency in technical drawing [10].

### 2.3 Learning Outcomes in Technical Drawing

The teaching of manufacturing technical drawing requires methods that balance theory and practice. Flipbook modules, when aligned with curricula and standards like problem-solving learning and project-based learning, have proven effective in technical education settings. For example, the inclusion of practice-oriented tasks and multimedia in modules facilitates better understanding and application of technical concepts, as demonstrated [11].

2.4 Impact of Interactive Modules on Learning Outcomes

Interactive teaching materials such as flipbooks significantly improve learning outcomes by accommodating different learning styles. Studies on blended learning methods have shown increased engagement and understanding when students use materials that allow for independent and repeated study [12]. The improvement in pre-test and post-test scores, as observed in various studies, supports the effectiveness of these tools in enhancing comprehension and application in technical subjects.

3. METHOD

This research employs the Research and Development (R&D) method, which involves creating and validating educational products to ensure their effectiveness and applicability [13]. The research procedure used in this study is the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) as shown in Fig. 1. The ADDIE development model has the advantage of being simpler, more organized, and widely used in open development modules, the ADDIE model is considered as a valuable source of additional information by providing good teaching practices. [14].
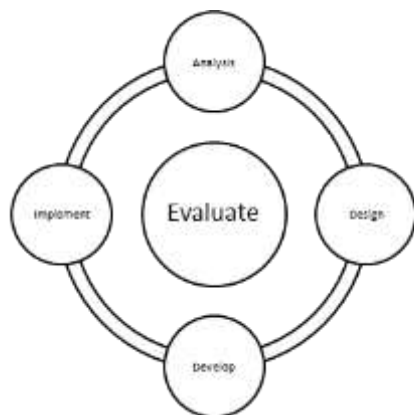
Figure 1. ADDIE Research Model Scheme

The research design used is Pre-Experimental Design with One-Group Pretest-Post-test Design model. This design is used because there is a pretest before being given treatment, the results of the treatment can be known more accurately because they can be compared with the conditions before being given treatment. This design can be described as given in Table 1.

Table 1. Research Design

Group	Pre-test	Treatmen	Pos-test
Class	O_1	X	O_2

Description:
O1: Pre-test (before treatment)
X: Flipbook-based teaching module treatment
O1: Post-test (after treatment)

The research on the development of the Flipbook-based Inventor Drawing teaching module was conducted at SMKN 10 Semarang. This school is located at Jl. Kokrosono No. 75, Panggung Kidul, Kec. Semarang Utara, Semarang City, Central Java. The research location was chosen as a follow-up to the collaboration between UNNES and SMKN 10 Semarang due to the need for the Inventor Drawing teaching module which is expected to support the learning process to be more optimal.

Population is a generalization area consisting of: objects/subjects that have certain qualities and characteristics determined by researchers to be studied and then conclusions drawn [15]. The population that is the focus of this study is class XI Welding Engineering students at SMKN 10 Semarang. Sampling in this study was selected using a purposive sampling technique, namely a sampling technique based on certain considerations made by the researcher himself. The sample in this study only used one class with a non-random sampling method, but from a population of three classes so that one class could be taken, namely 35 students of class XI Mechanical Engineering 2. The experimental class, or the class that received treatment, is a type of class where students conduct experiments using Flipbook-based learning modules.

The independent variable in this study is Flipbook-based teaching materials on the Inventor Design material, and the dependent variable is the learning outcomes of the Inventor Drawing material on the technical drawing subject, and its impact on cognitive aspects. The data collection techniques used were tests and questionnaires, while to analyze the data using a normality test (to find out whether the data obtained is normally distributed or not), a homogeneity test (to find out whether the variance of samples that have been taken from the same population is uniform), t-test, n-gain test (to find out how much increase from the pre-test and post-test data).

The test method used in this study was a multiple-choice formative test as an assessment of cognitive aspects (pretest and post-test). This study used a pre-test and post-test to determine how effective the Flipbook-based teaching module was used on students of class XI Welding Engineering 2 SMKN 10 Semarang before and after it was implemented. The questionnaire method in this study was intended for media experts, namely media expert teachers at SMKN 10 Semarang and media expert lecturers at the Department of Mechanical Engineering UNNES as a means to determine whether or not the Flipbook-based Inventor Drawing teaching module was feasible. Furthermore, material experts, namely material expert teachers at SMKN 10 Semarang and material expert lecturers at the Department of Mechanical Engineering UNNES as a means to determine the suitability of the contents of the Flipbook-based Inventor Drawing teaching module used at SMKN 10 Semarang, and for students as a means to determine the level of student understanding of the Inventor Drawing material. The instruments used in this study were questionnaires and tests. The questionnaire used in this study used an expert instrument grid which was then adjusted to the statement items that were in accordance with the conditions at SMKN 10 Semarang. The test used in this study was a multiple-choice formative test. The test questions consisted of 25 questions. The instrument is used as an evaluation tool to collect data on the test method which in this case is the pretest and posttest. The

validity test of the test instrument is carried out by validity testing and reliability testing.

4. RESULT

Some things that will be studied in this development research include: module development results; module feasibility analysis results; module impact analysis results.

4.1. Module Development Results

The ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model was used in this study. This development research was conducted in the following steps:

4.1.1. Analysis

Analysis is the first step in this study. Curriculum analysis and student needs are part of this stage.

4.1.1.1. Curriculum Analysis

Based on direct observation of subject teachers in class XI Welding Engineering and observation of learning activities, the researcher found suitable material for the development of this Inventor Drawing teaching module. The material that is suitable to be developed in the Inventor Drawing teaching module is the material for drawing Sketch 2D and 3D. The material for drawing Sketch 2D and 3D was chosen because it is in accordance with the material at the level of class XI Welding Engineering on the competence of drawing using CAD technology applications. The purpose of this curriculum analysis is to obtain the information needed to determine Learning Achievements (CP), Learning Objectives (TP), materials, evaluations, and module design concepts.

4.1.1.2. Student Needs Analysis

The purpose of the student needs analysis is to collect data that will be used to determine the learning process, student learning characteristics, and the development of learning media needed by students. Based on direct observation of students in class XI Welding Engineering g, the researcher found several student needs in learning: students need creative teaching modules, students need interesting teaching modules and there is a gap in student abilities in using Autodesk Inventor.

The Inventor Design teaching module must be evaluated based on the analysis stage. Curriculum analysis and student needs analysis are sources of evaluation. Based on this analysis, the material for drawing 2D and 3D sketches was chosen to be taught in the Inventor Drawing teaching module because it is in accordance with the material in class XI Welding Engineering about the ability to draw using CAD.

4.1.2. Design

The next stage is design. After the design stage, the second stage in module development will include a table of contents, cover, foreword, instructions for use, glossary, brief description of the material, learning achievements, learning objectives, material descriptions, summaries, evaluations, and bibliographies. The following are the results of the module design:

4.1.2.1. Material Adjustment

This study uses 2D and 3D Sketch using Autodesk Inventor because it is in accordance with the material given to class XI Welding Engineering students about drawing skills using CAD technology.

4.1.2.2. Teaching Module Design Planning

This study uses 2D and 3D Sketch using Autodesk Inventor because it is in accordance with the material given to class XI Welding Engineering students about drawing skills using CAD technology. The development of teaching modules in the process of drawing 2D and 3D Sketches is clarified with tutorial instructions in the form of narratives, barcodes, and videos (Figs. 2 and 3). The provision of barcodes uses the help of Canva while the provision of videos uses the help of Heyzine.

Figure 2. Module View

Figure 3. Addition of Features Barcode and Video Tutorial

4.1.2.3. Implementation

After the teaching module was developed, the implementation stage of this study was to apply it in a real classroom environment. This study used a one-group pre-test and post-test design; in other words, this study was conducted on one group and without a control class. The study was conducted in class XI Welding Engineering 2, totaling 35 students, by giving pre-test questions first before being given treatment. After the Flipbook-based Inventor Drawing teaching module was implemented, the class was then given post-test questions. The data obtained from the pre-test and post-test questions were then processed to find the level of effectiveness of the teaching module based on the increase in learning outcomes. However, before that, the pre-test and post-test question instruments were tested for validity and reliability in class XI Welding Engineering 1, totaling 31 students.

4.1.2.4. Evaluation

In this study, the evaluation stage can be applied to each stage of ADDIE. The purpose of this stage is to make improvements so that the resulting teaching module is more perfect. The final result of the development of this teaching module is an evaluation of the feasibility of the teaching module obtained from the results of the validation questionnaire of media experts and material experts. While the effectiveness of the teaching module is obtained from the completeness of student learning outcomes by comparing the pre-test results (before receiving the teaching module development treatment) with the post-test results (after receiving the teaching module development treatment). The final results of the evaluation stage show that the product developed in the form of a Flipbook-based Inventor Drawing teaching module has the criteria to be very feasible to use during learning and has an impact in the form of increased learning outcomes.

4.1.2. Module Feasibility Results

The feasibility of the module and media was analysed by the researcher, then analysing the feasibility of the teaching module created using the percentage formula for the total instrument score according to :

$$Feasibility\% = \frac{actual\ score}{expected\ score} x\ 100\%$$

Description:

Actual score = total score of the instrument that has been filled out by the respondent
Expected score = total score of the instrument assuming each item is answered

Furthermore, the data of the teaching module feasibility instrument based on Flipbook by the expert team was analyzed through a descriptive presentation test, which resulted in the following (Table 2):

Table 2. Percentage Classification of Module Feasibility

Percentage	Criteria
76% - 100%	Very Eligible
51% - 75%	Eligible
26% - 50%	Quite Eligible
0% - 25%	Less Eligible

Analysis of the module's feasibility by experts and referring to the specified classification. The results of the feasibility analysis are as follows (Table 3):

Table 3. Module Feasibility Results

No	Type of Validator	Percentage of Eligibility	Eligibility Classification
1.	Media Expert 1	88.97%	Very Eligible
2.	Media Expert 2	91.72%	Very Eligible
3.	Material Expert 1	84%	Very Eligible
4.	Material Expert 2	93.60%	Very Eligible

From the table above, it can be seen that the percentage of eligibility of media expert 1 is 88.97%, media expert 2 is 91.72%, and the average percentage of eligibility is 90.34%. While the percentage of eligibility of material expert 1 is 84%, material expert 2 is 93.60%, and the average percentage of eligibility is 88.80%. These results indicate that the percentage of eligibility of the Flipbook-based Inventor Drawing teaching module is in the classification range between 76% - 100% which means that the Flipbook-based Inventor Drawing teaching module is Very Eligible for use.

4.1.2. Module Feasibility Results

In this study, the N-gain score, obtained by comparing the difference between the Post-test and Pre-test scores with the difference between the SMI, or ideal maximum score, and the Pre-test, was used to determine the increase in students' critical thinking skills. In addition, the N-gain data also showed an increase in ability, namely critical thinking skills, as well as students' ranking in the class. To calculate the N-Gain test, the following formula can be used:

$$N - Gain = \frac{S\ pos - S\ pre}{S\ maks - S\ pre}$$

Description:

N-Gain = N-gain Value
Spos = Post-test Value
Spre = Pre-test Value
Smaks = Maximum Value

The results of the N-Gain Test that have been conducted are presented in the following Table 4:

Table 4. N-Gain Test Results

	Pre-test	Post-test	Spos – Spre	Smaks – Spre	N-Gain Skor
Average value	68.80	80.34	11.54	19.66	0.59

Based on the Table, the results of N-Gain in the experimental class N-Gain = 0.59 were obtained for improving student learning outcomes. As for knowing the N-Gain classification, you can see the following Table 5:

Table 5. Normalized Gain Criteria (N-Gain)

N-Gain Value Range Criteria	Criteria
$-1.00 \leq$ N-Gain < 0.00	Decreased
N-Gain $= 0.00$	Constant
$0.00 <$ N-Gain < 0.30	Low
$0.30 \leq$ N-Gain < 0.70	Medium
$0.70 \leq$ N-Gain ≤ 1.00	High

5. DISCUSSION

In this study, the research and development (R&D) method is used, and R&D research is research that produces products. The resulting product is an open module Inventor Drawing based on Flipbook for the subject of Manufacturing Engineering Drawing. ADDIE is a research design model. The feasibility of the Flipbook-based Inventor Drawing teaching module conducted by media experts shows a very feasible category where the expert validation assessment looks at the aspects of function and benefits, where this teaching module can help teachers to clarify the delivery of material, and the appearance of consistent module material, and the aspect of selecting learning materials is very appropriate with the development of science and technology today so that the module is very easy to learn by students (user friendly), in addition to the use of simple, straightforward, easy to understand, and communicative language. Furthermore, the results of the assessment conducted by material experts show the feasibility of the Flipbook-based Inventor Drawing teaching module in the very feasible category, where the expert validation assessment sees that the material is very easy to learn, because there are examples of material exercises so that students are immediately directed to practice drawing 2D and 3D sketches following the steps or following the video tutorial, the module material does not complicate student learning activities, each paragraph consists of only one main idea so that students can easily conclude the contents of each material, and the use of simple, straightforward language and is very easy for students to understand. According to the theory that Flipbooks are equipped with images, sound and video, with the features in them are practically used to improve student learning outcomes [7]. Thus, it can be concluded that the activities carried out in the Flipbook-based

The researcher conducted an N-Gain test to determine whether there was an average increase. The results showed that students in the Moderate category had better learning outcomes with an N-Gain score of 0.59 and a pre-test score of 68.80 and a post-test score of 80.34. These results are appropriate because the N-Gain score is in the range of $0.30 \leq$ N-Gain < 0.70. The use of the Flipbook-based Inventor Drawing teaching module has an impact on improving learning outcomes based on the N-Gain calculation from the pre-test results (before being treated) and post-test (after being treated). A good teaching module can be used by students and teachers to facilitate learning activities. The Flipbook-based Inventor Drawing teaching module is an innovation in teaching modules that has been developed so that it has an impact on improving student learning outcomes. In accordance with the theory of that Flipbooks equipped with images, sound and video, with the features in them are practical to use to improve learning outcomes [9].

Inventor Drawing module have contributed to improving student learning outcomes. This phenomenon is in accordance with the theory that teaching modules are feasible and effective to use to improve student learning outcomes [7].

6. CONCLUSION

Based on the results of the research and development of the Flipbook-based Inventor Drawing teaching module to improve learning outcomes in the Manufacturing Engineering Drawing subject at SMKN 10 Semarang, the researcher can draw the following conclusions: The development of the Inventor Drawing Module is designed for class XI Welding Engineering at SMKN 10 Semarang using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). This module is designed to improve learning outcomes with a problem-solving learning approach and project-based learning, covering introductory Autodesk Inventor material, 2D and 3D drawing menu functions, practical exercises, and additional features such as video tutorials and barcodes. The module's feasibility from media experts gave an assessment of 90.34% (very feasible) because the module is considered effective in delivering the material, consistent in appearance, easy to learn, and uses communicative language. Meanwhile, material experts gave an assessment of 88.80% (very feasible) because the module is considered to make it easier for students to understand and practice the material through examples and video tutorials, with simple language and paragraphs focused on one main idea. The impact of the implementation carried out based on the hypothesis test, there is a significant increase in learning outcomes, where the average pre-test score of 68.80 increased to 80.34 in the post-test and with an N-Gain score of 0.59 (moderate category). This module makes it easier for students to

learn independently, understand the material, and improve learning outcomes.

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