

Optimizing control structure and branching learning with flipbook-based e-module for software engineering students

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Abstract: This research highlights the significance of developing innovative learning media to enhance effective learning for class X Software Engineering (RPL) students at SMK Negeri 4 Malang. The study addresses the need to improve student engagement and deepen understanding of concepts, particularly in Control Structure and Branching material. The primary objective is to create an interactive and innovative Flipbook-based e-module as practicum media to support the learning process. Using the Research and Development (R&D) method with the ADDIE model (Analyze, Design, Develop, Implement, Evaluate), this research employs a systematic and structured approach in developing learning products. The Flipbook-based e-module achieved a feasibility score of 90% from material experts and 97.5% from media experts, indicating its high validity and feasibility. During the trial phase, the e-module obtained feasibility score of 89% from a small group and 90% from a large group, resulting in an average feasibility score of 89.5%. These findings demonstrate that the Flipbook-based e-module is highly suitable for implementation in the Vocational Basics subject for class X RPL students at SMK Negeri 4 Malang. Additionally, the small group test showed a student learning motivation score of 85.4%, while the large group test yielded 87%, with an average of 86.2%. This indicates that the developed product significantly supports students' learning motivation, proving its high validity in improving engagement and understanding. These results affirm the Flipbook-based e-module is potential as an effective learning tool for vocational education.

Keywords : e-module; flipbook; branching; control structure

1. Introduction

SMK Negeri 4 Malang is one of the vocational secondary education institutions in Malang City that focuses on vocational education. Software Engineering (RPL) is one of the flagship programs among eight majors which equips students with practical skills to support them in entering the workplace. This program equips students with skills in programming, application design, system analysis, and deepens their understanding of information and technology (Cico et al., 2021). In order to provide the students with the skills required, practicum modules are needed. However, the effectiveness of the current practicum modules has been becoming one of the objections due to its unattractiveness in visual elements which can encounter students' interest. Furthermore, the students' difficulty in independently understanding the materials has raised concerns about the module's effectiveness, as its format is considered incomplete. This issue hinders the achievement of optimal learning outcomes (Rahmatsyah & Dwiningsih, 2021).

The limited interactivity and completeness of the material in the practicum module has created a direct impact on students' ability to understand key concepts in software engineering. Those factors cause lack of confidence in students learning activity independently, as well as inhibiting the mastery of skills needed in the workplace. Therefore, an innovative approach is needed to improve the quality of the learning media used ([Jiang, 2022](#)).

Based on those problems, the solution offered is the development of an interactive and interesting flipbook-based e-module. Therefore, this research aims to: (1) Develop the flipbook-based e-module that facilitates student access to practicum modules and (2) Increase students' motivation and contribute to the quality of learning in class X RPL SMK Negeri 4 Malang. The learning media developed focuses on Control Structure and Branching material which in future it is expected to be presented with animation, visualization, and interactive features that support students' learning experience. Furthermore, the dynamic exposure the students attain can boost their engagement and help them to understand the Control Structure and Branching material more deeply. In addition, the utilization of personal devices in learning can provide students with opportunities to be more explorative in understanding technical concepts and software experiments. Through this approach, students can obtain practical experience that is relevant to the workplace, so that they are better prepared to face challenges in the development of the information technology industry.

2. Methods

2.1 Type of research

This research is a Research and Development (R&D) which aims to develop a flipbook-based practicum module for grade X Software Engineering (RPL) students at SMK Negeri 4 Malang. In order to direct the development process, this study adopted the ADDIE development model, known for its five main stages ([Branch, 2018](#)). Figure 1 shows the research procedure and the relationship of each stage in the ADDIE development model.

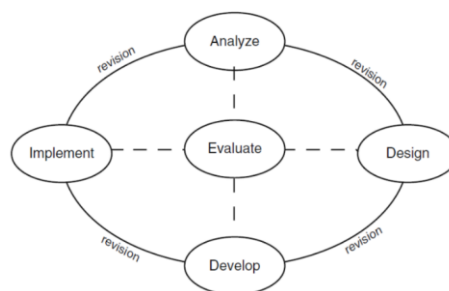


Figure 1. The Stages of the ADDIE Development Model ([Branch, 2018](#))

The process of developing a flipbook-based module by utilizing the ADDIE model involved a series of systematic and structured steps. The stages of the ADDIE model are described below:

a. Analyze

The first stage was analysis, where initial research was conducted to understand the needs and characteristics of students, as well as evaluate existing practicum materials ([Spatioti et al., 2022](#)). This analysis included identifying learning objectives, student profiles, and an in-depth understanding of the material that will be presented in the module. This stage also involved collecting preliminary data from students to ensure the module can be tailored to their specific needs.

b. Design

The next stage was design, where based on the results of the analysis, the initial prototype, structure, format, and content of the flipbook-based practicum module were designed ([Stapa & Mohammad, 2019](#)). This design included creating scenarios for using the module, visual arrangements, and organizing content to be relevant to the needs and characteristics of students.

c. Develop

After the design was completed, the development process was conducted, which began with the creation and preparation of the practicum module based on the prototype and design that has been made ([Almelhi, 2021](#); [Rini et al., 2024](#)). The process involved integrating visual and interactive elements in accordance with instructional design principles.

d. Implement

The next stage was implementation, where the practicum module was introduced and integrated into the learning process in class X RPL SMKN 4 Malang. Teachers and students were actively involved in utilizing this module, and during implementation feedback was collected from students and teachers to identify potential improvements. Feedback was collected through questionnaires, which were then analyzed to improve the module before the final stage of evaluation ([Adeoye et al., 2024](#)).

e. Evaluate

The final stage was evaluation (evaluate). In this stage, an assessment of the effectiveness and efficiency of the flipbook-based practicum module was conducted.

2.2 Research subjects

The pilot test subjects consisted of XI grade RPL students (10 students for the small group test) who had already taken the control structure material and X grade students (20 students for the large group test) who were currently taking the control structure material. This sample size was chosen based on similar research guidelines to obtain preliminary data from the small group trial and more general data from the large group trial ([Almelhi, 2021](#)).

2.3 Data collection technique

Data collection techniques were conducted through interviews and observations. Data collection using questionnaires was also carried out to assess the feasibility of the product and find out the effect of learning motivation after using the developed media. Data collection is done both quantitatively and qualitatively.

2.4 Instruments

The instrument applied in this research was a questionnaire in the form of checklist questions, where respondents were given an assessment based on a Likert scale. Not only by rating using that tool, but students can also fill a box which provides their suggestions. Therefore, the data obtained from filling out the questionnaire were quantitative and qualitative data. There were three types of



questionnaires applied, namely: (1) material expert validation questionnaire, (2) media expert validation questionnaire, and (3) user test questionnaire. As a reference for assessment in the use of teaching materials and student learning motivation, researchers utilized a Likert scale that has been determined by size (1-4) and responded using a checklist sign (✓). Additionally, respondents can provide criticism or suggestions regarding the products developed. The measurement scale applied is a four-level likert scale (Georgiev & Georgiev, 2023). The aspects assessed to determine learning motivation can be seen in Table 1.

Table 1. Aspects of Student Motivation Assessment (Leenknecht et al., 2021; Rusdi et al., 2022; Votaw & Witkiewitz, 2021)

No	Aspect	Criteria
1	Perseverance in doing tasks	<ul style="list-style-type: none"> - Can work for a long time - Does not easily stop before finishing - Actively discuss with friends in completing the task
2	Tenacious when facing difficulties	<ul style="list-style-type: none"> - Not easily discouraged in doing the task - Not ashamed when experiencing failure - Easily bounce back to be better - Does not have external encouragement to perform as well as possible
3	Prefer to work independently	<ul style="list-style-type: none"> - Doing tasks according to ability - Confident during learning activities
4	Able to defend his opinion	<ul style="list-style-type: none"> - Able to convey opinions in discussion forums - Confident in deciding something - Able to take responsibility for his opinion
5	Quickly bored with tasks that are given routinely	<ul style="list-style-type: none"> - Likes things that are logical in nature
6	Likes to find and solve problems	<ul style="list-style-type: none"> - Has a strategy or way of solving problems
7	The level of aspiration to be achieved with the activities carried out	<ul style="list-style-type: none"> - Has a plan to be achieved with the activities carried out - Eager to achieve goals through the activities carried out
8	Devotion and sacrifice	<ul style="list-style-type: none"> - Giving all energy and thoughts to achieve the expected goals

2.5 Analyze data technique

Quantitative data were collected through a four-level Likert scale questionnaire and qualitative data in the form of suggestions and comments from students and experts (Georgiev & Georgiev, 2023). Quantitative data were processed using excel tool based on Equation 1 to calculate the average value and percentage according to the validity criteria described in Table 2.1. Qualitative data were thematically analyzed to identify suggestions for improvement and integration of feedback in the overall evaluation.

$$V = \frac{\sum T_{se}}{\sum T_{sh}} \times 100\% \quad (1)$$



Description:

- V = Score sought
- $\sum T_{se}$ = Total score obtained
- $\sum T_{sh}$ = Total maximum score assumed
- 100% = Constant

As a basis for making decisions on the validity of teaching materials, the validity criteria in Table 2 are applied.

Table 2. Criteria for Validity (Georgiev & Georgiev, 2023)

Score	Criteria
85,01% - 100,00%	Highly valid or can be applied without revision
70,01% - 85,00%	Quite valid or can be applied but needs minor revisions
50,01% - 70,00%	Less valid or cannot be used because it needs major revisions
01,00% - 50,00%	Invalid or should not be used

The data obtained from the student learning motivation assessment test of the Flipbook-Based E-module Learning Media can be accumulated using Equation (1). Table 3 presents the percentage qualifications used as guidelines in determining the criteria for student learning motivation.

Table 3. Criteria for learning motivation percentage results (Leenknecht et al., 2021)

Score	Criteria
85,01% - 100,00%	Very High
70,01% - 85,00%	High
50,01% - 70,00%	Low
01,00% - 50,00%	Very Low

3. Results

The results of the development were carried out by utilizing the ADDIE (Analyze, Design, Develop, Implement, Evaluate) due to a systematic and structured approach performed by this model to the development of learning products model which are described as follows:

3.1 Analyze

Analyze is the initial phase in the ADDIE development procedure to analyze the needs of the product in the field. Researchers divided the analysis phase into two parts: an analysis of the learning process and an assessment of the needs for learning media. Data was gathered through interviews conducted by the researchers with respondents, where questions were prepared beforehand. The activities carried out during the analysis phase include the following (Misesani et al., 2020):

- a. learning process analysis

The analysis carried out was to find out the problems that occur during the learning process. Data was obtained by conducting interviews with research subjects. Interview activities were carried out with the aim of obtaining clear information through communication, and it is assumed that it can provide an overview of the learning process in basic vocational subjects based on the scope of the material and teaching materials needed.

Interviews were conducted with teachers and students of class X RPL. According to the vocational basic teachers, practicum modules were used to teach algorithms during learning activities. However, due to learning limitations and lack of media, many students did not perform perfectly in doing the final project. Students also possessed obstacles in obtaining material related to control structures and branching.

Based on the results of interviews with sources, supporting media for learning in theory and practice were still not available. This allowed students not to achieve the expected competencies. There were many information media applied by teachers to conduct independent learning ([Vallejo-Correa et al., 2021](#)). Therefore, the right solution to solve this problem is to develop Flipbook-based e-module Learning Media on Control Structure and Branching Materials.

b. Learning media need analysis

The availability of learning media is fundamental and indispensable in learning activities to attract the attention of students in general. The need to master Control Structure and Branching in vocational basics subjects is crucial due to its connection to the steps that must be taken in solving a problem. This must certainly be considered by students to avoid misinterpretation in implementing the theory presented in a practicum.

The availability of practicum modules in pdf form in vocational basics subjects can be converted into online media according to the needs of current learning objectives. Learning media development can be in the form of interactive flipbooks that can contain audio, video, and animation ([Drastiawati et al., 2022](#)). Material packaged in digital form is more easily accessible anytime and anywhere. In addition, the use of this media can also be utilized for a long time, because the storage of summarized material is more practical and efficient ([Ballangrud & Nilsen, 2021](#)).

3.2 Design

The next stage was the design. This phase aims to provide an overview of the design of basic vocational learning media development. Some of the things that were done at this stage were designing display designs, materials or evaluations, and learning devices ([Yao, 2021](#)). In line with this opinion, the researcher described the activities at the design stage, including designing material, designing module structures, designing flipbook-based module learning media. The result of this stage is a module framework that will be developed later ([Deng et al., 2024](#)).

The material design in the module was compiled based on the results of interviews conducted with subject teachers. The material applied was control structure and branching material that suits the needs of students ([Syahidi et al., 2019](#)). The presentation of the material referred to various sources applied by the teacher, which were sourced from printed books, e-books, and the internet. The presentation of the material will be made interesting with learning evaluation in the form of practicum exercises. The design of the structure in the module was made by taking into account the learning objectives. The module structure contains, among others: (1) Foreword, (2) Table of Contents; (3) Learning Objectives; (4) Learning Activities: (a) Branching if or 1 condition, (b) Branching if else or 2 conditions, (c) Branching if nested or more than 2 conditions, (d) Branching utilizing switch cases; (5) Summary; (6) Practice Tasks.

3.3 Develop

The development stage (develop) is to realize the product that has been designed as a flipbook-based module. The steps that must be taken at this stage include (Jihe et al., 2021): (1) compiling material according to the topic (control structure and branching) based on the standard e-module format; and (2) compiling evaluations according to the material. The development of flipbook-based modules as learning for basic vocational subjects was carried out on flipbook software that can provide animation effects on the material. The flipbook-based module is first made in docx format which is converted to pdf, then in the software it is packaged into html format. Figure 2 is a description of the products produced at the develop stage:

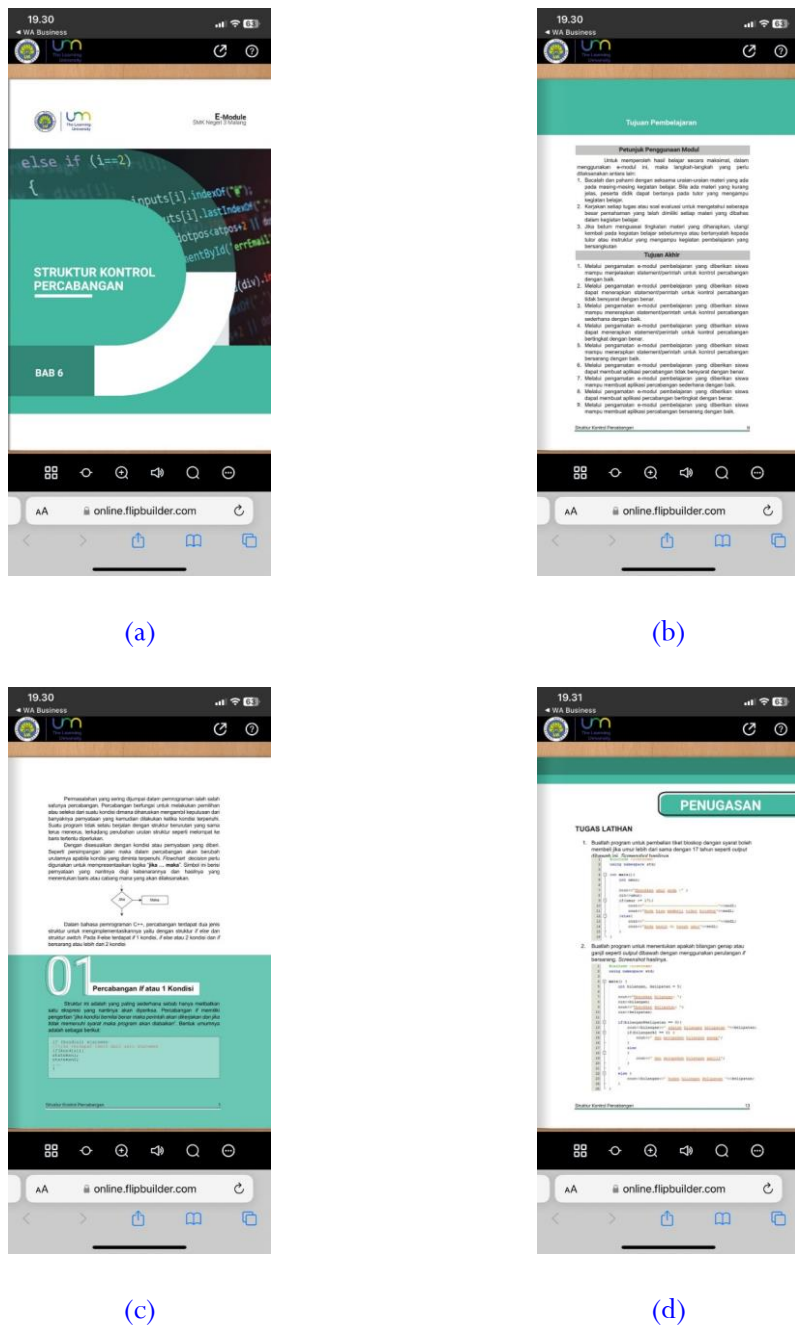


Figure 2. (a) Cover, (b) Learning objectivitas, (c) Material content, and (d) Practicum activity

3.4 Implementation

Since the media has been developed, the next stage was to implement it, starting with the validation stage by material experts and media experts, followed by small group and large group trials (Prasetyo et al., 2024). The implementation stage will be discussed in the sub-discussion of the discussion.

3.5 Evaluation

The evaluation stage in the ADDIE model was the final stage which aims to assess the effectiveness and quality of the product that has been developed. This evaluation is carried out thoroughly to ensure that learning objectives are achieved and the product meets user needs. Two types of evaluation were conducted, formative and summative. Formative evaluation was conducted during the development process to identify weaknesses and improve the product continuously, such as through expert validation, small group trials, and large group trials (Schube et al., 2022). Meanwhile, summative evaluation was conducted after the product has been developed to assess the overall success of the product in actual implementation, such as measuring its impact on student motivation and learning outcomes. The results of this evaluation stage became the basis for further improvement or development of similar products in the future.

4. Discussion

4.1 Material expert validation

The learning media developed was designed with an easily accessible structure and according to the competency standards that students need to master. This e-module presents material with supporting images for each basic vocational topic, which was presented in a simple way and utilized language that is easy to understand according to the level of student development. In addition, the material is presented in the form of specific learning activities, making it easier for users to utilize this e-module. Figure 3 shows the Details of the material expert validation results for each aspect.

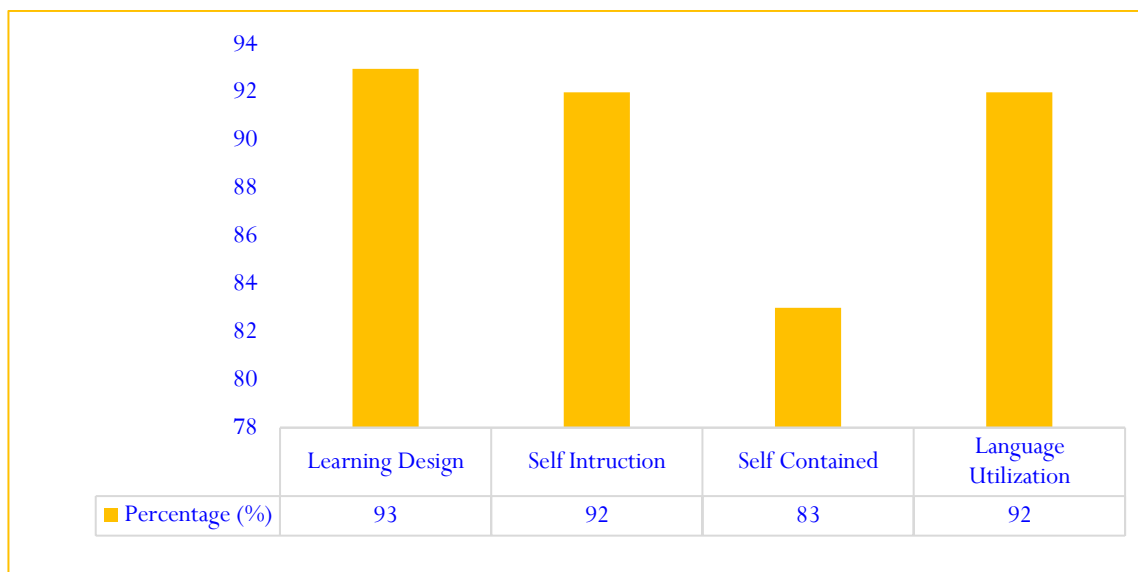


Figure 3. Material expert validation data analysis chart

Based on the results of the assessment of basic vocational materials by material expert validation, the average percentage of feasibility was 90%. The self contained indicator needs to be developed because it achieved the smallest percentage of 83%. The self contained indicator obtained a low score because the material in the flipbook media has not fully covered all the information needed for independent learning. Therefore, students still acquire additional sources to understand the content completely. Evaluation is carried out to add literature related to the material presented in the media (Hunger et al., 2023).

The features of e-modules for basic vocational subjects demonstrate that the teaching materials are designed for independent learning (self-instruction), allowing them to be used without relying on external assistance (Dilaines et al., 2024). The assessment of the self-instruction aspect is in line with the learning objectives that were systematically arranged, reflected the competencies that must be mastered, the use of communicative language, and were equipped with examples and illustrations in the form of images or videos that can help students understand the material. This was in line with the learning design indicator which gained the highest percentage of assessment at 93%.

4.2 Media expert validation

The results of media expert validation of Flipbook-Based E-module were feasible with an average percentage of 98%. The details of the media expert validation results are presented in Figure 4.

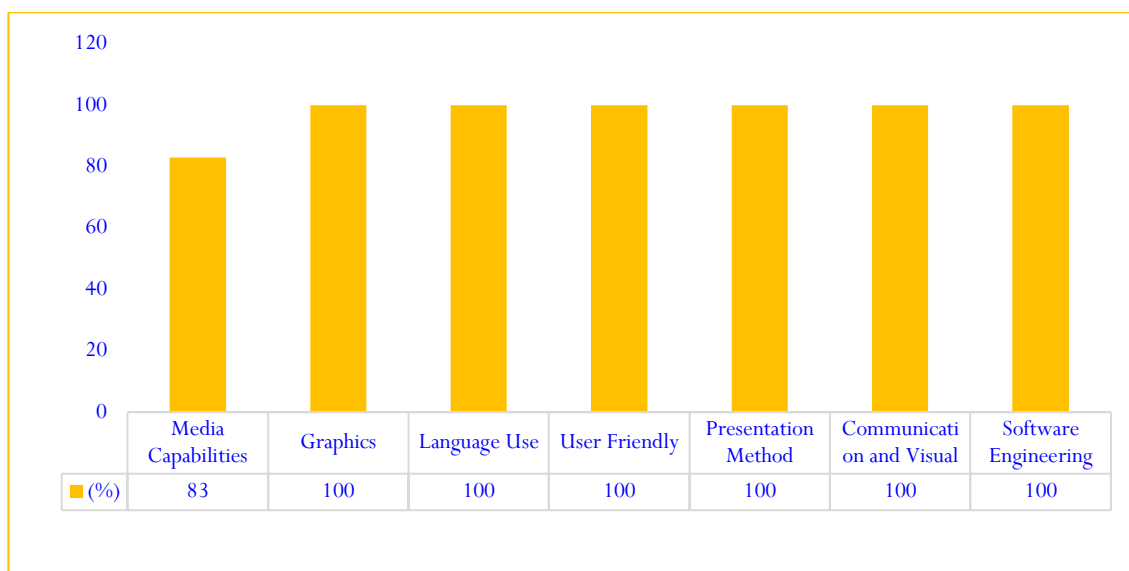


Figure 4. Media expert validation data analysis chart

All indicators of assessment attained a maximum rating from the expert. Therefore, the results of the media expert validation gained an average of 97.5%. Furthermore, the e-module design was considered user-friendly with an attractive and communicative appearance by displaying visual explanations in the form of videos and images which can help students to understand the material and connect it to real life. However, the media's ability to support changes in student learning behavior only scored 83%. This indicates that the module needs to add interactive multimedia elements, such as more simulations or animations to increase student engagement. Additionally, The percentage of assessment by material experts and media experts can be more easily understood through visualization in Figure 5.

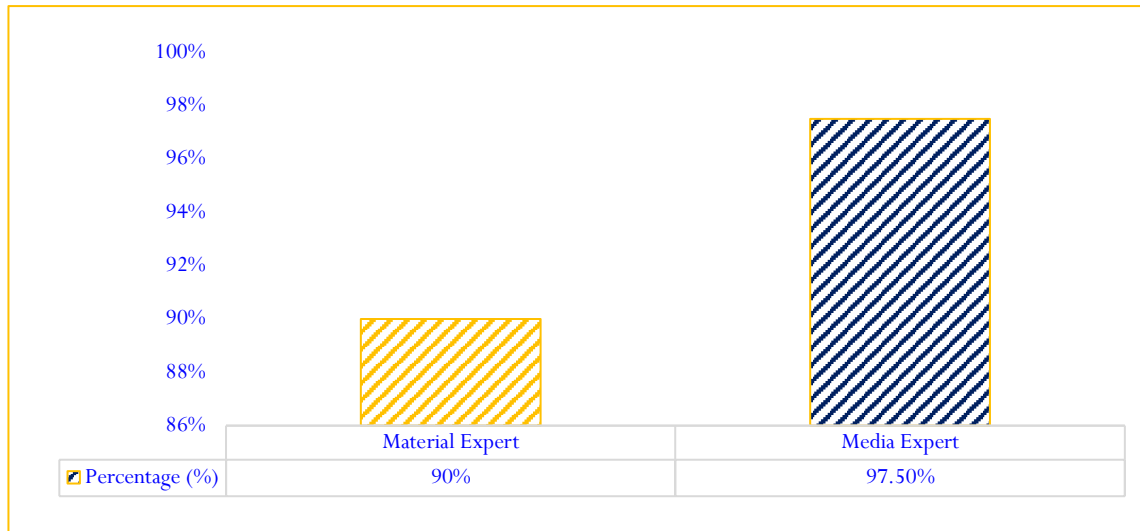


Figure 5. Validation of material experts and media experts

Based on Figure 5, both experts have given an assessment of the feasibility of the product developed with a percentage gain above 85%. Based on the provisions in Table 2, the acquisition of this percentage indicates that the product developed was suitable for testing. Therefore, the next step was to conduct trials in small groups and large groups.

4.3 Small group and large group trials

After obtaining the results of expert assessment with highly valid scores, Flipbook-based E-module learning media was then tested on students. Two stages were conducted in this test, a small group trial consisting of 10 students who have taken control structure material and a large group consisting of 20 students who were currently taking control structure material. Details of the results of the small group and large group tests on each aspect can be seen in Figure 6 and Figure 7.

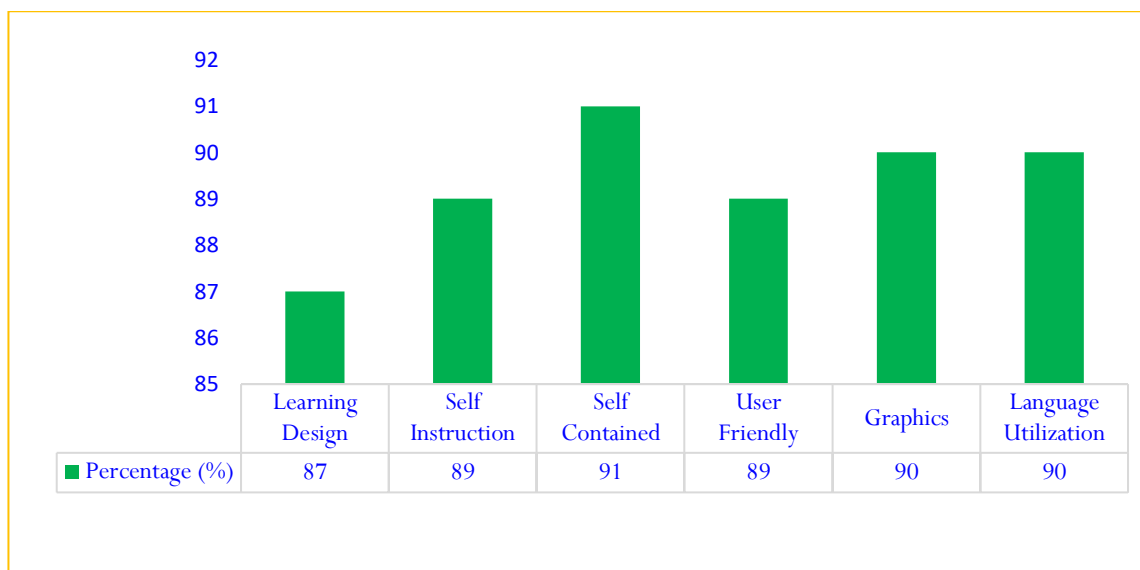


Figure 6. Graphical analysis of small group test data

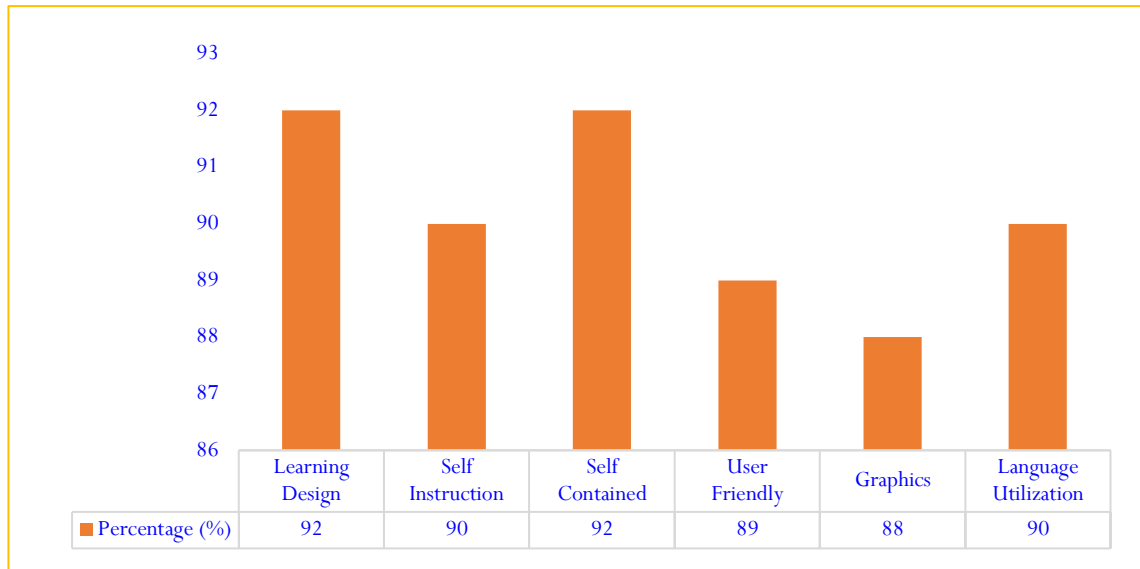


Figure 7. Graphical analysis of large group test data

Based on Figure 8, the average percentage of the small group test was lower than the percentage in the large group test (Figure 4.5). The large group test data was higher in value, proving that the Flipbook-Based E-module Learning Media was getting better. Some students in the small group test results have given feedback that the module navigation could still be simplified, and wanted more visual illustrations in the material. After the evaluation and distribution in the large group test, the module obtained a higher average score than the small group. The result also revealed the average percentage of small group test results reached 89% and the large group test was 90% (Figure 8).

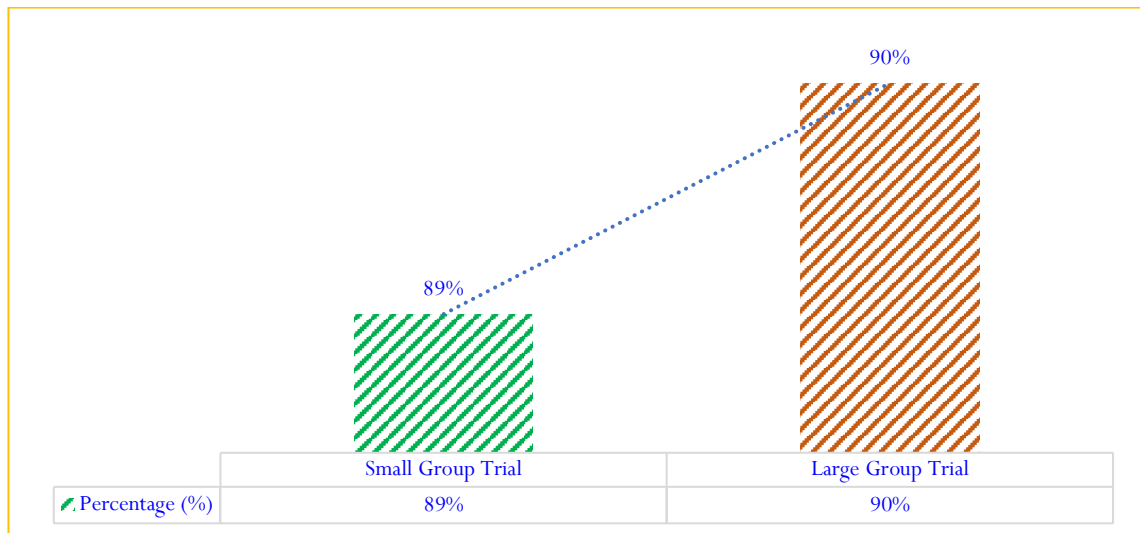


Figure 8. Average percentage of small group and large group tests

Based on Figure 8, the overall results in the small group and large group tests are in the very feasible category. The flipbook-based e-module developed has an attractive appearance, use of color, and typography.

4.4 Student learning motivation

The assessment of student learning motivation in small group and large group trials using flipbook-based e-modules was accumulated using Equation (1), with the criteria for assessing learning motivation contained in Table 1. To find the average overall learning motivation assessment, a percentage calculation was made from the two trials.

The small group trial stage produced data on the level of student learning motivation with an average percentage value of 85.4%, while the large group trial obtained an average percentage value of 87%. The level of student learning motivation in the small group was lower than the level of student learning motivation in the large group. This shows that the product developed can foster student motivation in learning. The average accumulation of the two student learning motivation data was 86.2%, which conclude that student learning motivation using the flipbook-based e-module developed by the researcher is highly valid. For more details, the following is a visualization of the assessment of student learning motivation in Figure 9.

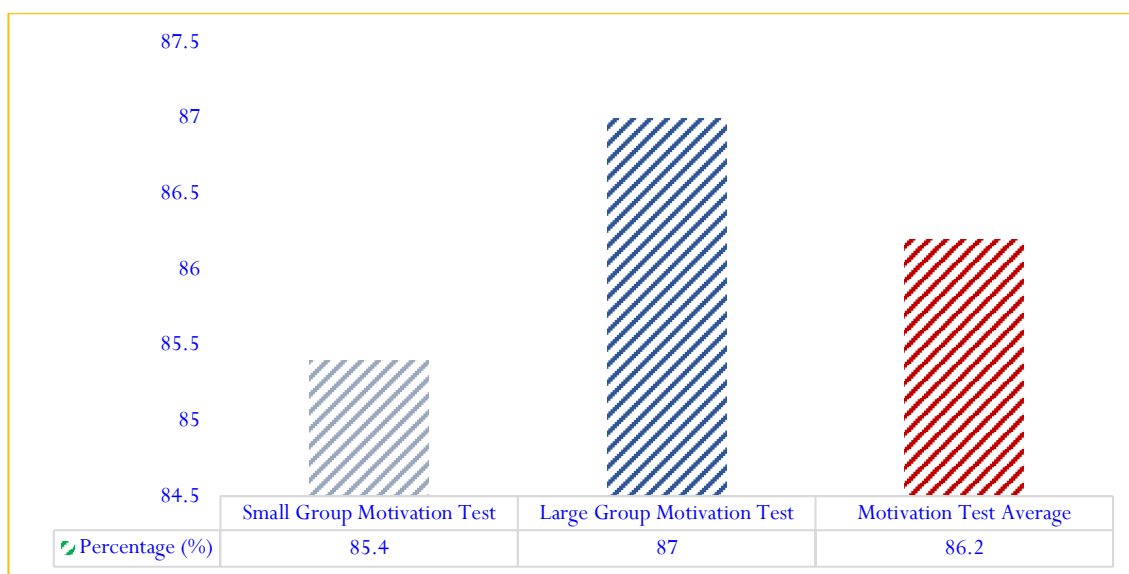


Figure 9. Student learning motivation data

Based on Figure 9, the percentage increase in the large group trial indicates that the flipbook-based e-module has a consistent positive impact on student learning motivation, even when applied to a wider group.

5. Conclusion

Based on the results of literature studies and observations, a Flipbook-based E-module Learning Media was developed as teaching material in basic vocational subjects for the RPL Department of SMKN 4 Malang. The developed product can be applied by utilizing the android platform, accessed via internet network. Additionally, evaluations, e-module containing text, images, animations, and videos are also available to ease the students' needs in comprehending the lesson.

The developed Flipbook-Based E-module Learning media obtained 90% of product feasibility from material experts, which indicates that the product has highly valid/ feasible criteria. In line, the percentage of assessment results from media experts is 97.5%, illustrating that the product developed has valid/ feasible criteria for testing at the next stage. Furthermore, the percentage

value of the product test results in the small group is 89%, while the test results in the large group are 90%. Therefore, the average percentage of product feasibility at the small and large group test stage is 89.5%. This percentage proves that the Flipbook-Based E-module Learning Media was developed, fulfill the feasible criteria to be applied to the basic vocational subjects of class X RPL SMKN 4 Malang.

The percentage of students' learning motivation level after utilizing Flipbook-Based E-module Learning Media can be observed in small and large group tests. At the small group test stage, it produced data on the level of student learning motivation with a percentage value of 85.4%, while in the large group test, the value of student learning motivation was 87% with an average result of learning motivation of 86.2%. The percentage value proves the criteria for student learning motivation which is highly valid in utilizing the developed product.

Author's declaration

Author contribution

Ria Febrianti conceived of the presented idea and developed the media and performed the computations. **Yurike Wardani** helps develop the media. **Tuwoso** and **Wahyu Nur Hidayat** verified the analytical methods. All authors discussed the results and contributed to the final manuscript.

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Conflict of interest

The authors declare that there are no competing interests related to the research or publication of this article. The research was conducted independently with no financial, professional or personal influences that could affect the results or interpretation of the data.

Ethical clearance

Verbal informed consent was obtained for subject information to be published in this article. The research conducted was in accordance with the Declaration of Helsinki, which means that it adhered to ethical principles in research involving humans, including respecting the rights of participants and the safety of subjects during the research process.

AI statement

This article is the author's original work, written from original research and no sections or figures are generated by AI. English is checked using Grammarly and has been verified by the authors.

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