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The Production of An Interactive E-Module in the Course of Concepts and Aplications Building Information Modelling Civil Engineering Department

Maulin Assyura[1*], Muvi Yandra[2]
[1,2] Civil Engineering, Faculty of Engineering, Universitas Negeri Padang, Indonesia
[*]Corresponding author, e-mail: assyuramaulin@gmail.com

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ABSTRACT

This research was motivated by the problems that exist during initial observations, namely the absence of learning media in the form of modules on the learning process of Concepts and Applications Building Information Modeling (BIM) course. Based on these problem, this study was aim to create a valid and practical learning media in the form of an Revit Structure interactive electronic module (e-module) for the Concepts and Applications of Building Information Modelling (BIM) course. This study uses the Research and Development (R&D) method which adapts the DDD-E model. The instrument used is a learning media assessment questionnaire for media experts, material experts, and students. Based on product evaluation of Revit Structure interactive electronic module-based learning media on the course of Concept and Application BIM by media experts from all aspects obtaining an assessment of 93,1% with very valid criteria, while assessment by material experts from all aspects obtained an assessment of 85.8% with very valid criteria. The assessment with the small trial stage with 8 students as respondents obtained an average score of 89.4% which was categorized as very practical and the large-scale testing stage with 18 students as respondents obtained an average value of 91,2% which was categorized as very practical. Based on the results of the assessment, the resulting media was declared feasible and practical to use for interactive electronic module-based learning media on the Concept and Aplication of Building Information Modelling course.

Keywords: *Learning Media; Concept and Aplication Building Information Modelling; Emodule interactive*

INTRODUCTION

Building Information Modelling (BIM) is a digital representation of the physical and functional characteristics of a building. As such, it serves as a shared knowledge resource for information about a building, forming a reliable basis for decisions during its life cycle from inception onward [1]. BIM is a technology or system in the field of Architecture, Engineering and Construction (AEC) that is capable of demonstrating or simulating all project information into a three-dimensional (3D) model.

BIM is the virtualization of planned construction projects with the aim of reducing uncertainty, solving problems, increasing productivity and analyzing potential impacts. BIM stores all construction project information starting from planning, implementation, maintenance, to

CIVED Journal of Civil Engineering and Vocational Education
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http://cived.ppj.unp.ac.id/index.php/CIVED

demolition. Apart from being able to virtualize construction projects, BIM is also able to produce cost calculations and project management [2]. Basically, BIM provides the opportunity to encourage 3D models from various different disciplines so that the information exchange process becomes more efficient and efficient in construction implementation [3].

The regulation of BIM in Indonesia refers to the attachment to PUPR Ministerial Regulation Number 22 of 2018 which states "The use of BIM must be applied to non-simple state buildings with the criteria for an area of more than 2000 m2 (two thousand square meters) and more than 2 (two) floors." [4]. Because of these regulations, BIM has become a popular technology used by construction service companies because this technology is able to detect irregularities designs in order to minimize errors in development projects. This is because BIM has very complete dimensions starting from 3D BIM to 10 Dimention of BIM.

Figure 1: Dimension of BIM

Advances in construction technology that are adapted to field needs and the many benefits that can be obtained by using BIM technology are the reasons for adopting BIM in the learning process at the Department of Civil Engineering, Padang State University, which is named Concepts and Applications Building Information Modelling (BIM) course.

Based on the findings of initial observations carried out with the lecturer who taught the Concept and Application of Building Information Modelling course, namely Mrs. Risma Apdeni, S.T, M.T., it was concluded that there were no teaching materials in the form of modules created by the lecturer to support the implementation of learning in this course. Apart from that, the BIM Concepts and Applications course is a new course so students are still in the process of adapting to BIM. This adapting process can be helped by the availability of Building Information Modeling (BIM) learning media.

Considering that there is no learning module in the Building Information Modeling (BIM) Concepts and Applications course in the Civil Engineering Department, creating open materials in the form of this module is an urgency. One form of teaching material in the form of an interesting module is an interactive electronic module (e-module), namely a module that is packaged systematically and planned in an electronic version so that it can be accessed via

Journal of Civil Engineering and Vocational Education
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Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

the internet either via a PC (personal computer) or smartphone. This is in accordance with Minister of Education and Culture Regulation no. 22 of 2016 concerning Education Process Standards, one of the contents of which reveals the use of information and communication to increase the efficiency and effectiveness of learning [5].

This interactive e-module has more advantages than other teaching materials because it can provide a new, more interesting atmosphere and make it easier for students so they can learn actively and independently because it can be accessed anywhere and anytime.

METHODS

Types of Research

This study used the Research and Development method (R&D), which is a research and development method with the aim of producing a product which is then tested for the effectiveness of the product [6]. This research uses the DDD-E (Decide, Design, Develop, Evaluate) development model in accordance with the model for developing learning multimedia.The DDD-E research model can be seen in Figure 2.

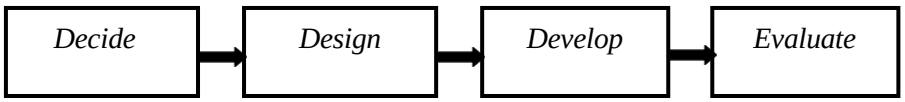

Figure 2: DDE-E Procedure

Place and Time of Research

This research was carried out in the July-December 2023 semester at the Department of Civil Engineering, Faculty of Engineering, Padang State University, located on Jalan Prof. Dr. Hamka, Air Tawar Padang, West Sumatra.

Research Subject

1. Validity Subjects
   a. Media Expert
      The material experts consist of two lecturers consisting of a lecturer who teaches BIM courses and a structure lecturer who is tasked with testing aspects of the suitability of the content of the interactive e-module.
   b. Material Expert
      Media experts consist of two expert lecturers in the field of media and educational technology who are tasked with assessing products using everything from interactive e-module display design to ease of product access.
2. Practicality Subject
   Product practicality trials were carried out with small group trials and large group trials on students of the Building Engineering Education Study Program in 2021 who had passed the Planning Drawing course. Small group trial subjects can be taken on a small scale of 4-14 and can be taken on a large scale of 15-50 respondents [7].
   a. Small Group Trial
      The small group trial subjects in this research were 8 Building Engineering Vocational 2021 students who had passed the Planning Drawing course.
   b. Large Scale Trial

Journal of Civil Engineering and Vocational Education
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The large scale trial subjects in this research were 18 Building Engineering Vocational 2021 students who had passed the Planning Drawing course.

Research Procedure

Decide

This stage aims to determine program objectives and materials with the stages of determining learning objectives and materials, determining the theme of the media created, developing prerequisite abilities, and assessing resources. The procedure of Decide consist of:

1. Determine Learning Objectives
2. Determine the Media Theme
3. Developing Prerequisite Capabilities
4. Assessing Resources

Design

This stage aims to obtain an initial product design in designing an interactive e-module based on the information obtained at the decide stage. The steps at this planning stage are:

1. Determine the Content Outline
2. Creating a Flowchart
3. Determine the Design and Layout (Specify Screen Design and Layout)
4. Create Storyboards
5. Making Learning Media Validation Instruments

Develop

This stage is related to the validation and creation stages of the modules designed at the design stage. At this stage a product will be produced in the form of an interactive e-module.

1. Validation of the Learning Media Validity Questionnaire
2. Making learning media in the form of interactive e-modules

Evaluate

This stage aims to check the entire design process of the learning media created, namely interactive e-modules. Next, an evaluation was carried out with experienced experts through a validity test and ended by testing student responses to the interactive e-module created.

1. Validation of Learning Media
2. Practicality of Learning Media

Research Instrument

Research instruments are tools used to measure observed phenomena, whether in the form of natural phenomena or social phenomena [8]. Research instruments are also tools or facilities used to collect data so that research is more effective and efficient and obtains better results, in the sense of being more careful, complete, accurate and systematic so that it is easy to process [9]. The research instrument used in this research was a questionnaire. The questionnaire in this study uses a rating scale which is a statement questionnaire followed by columns to indicate levels starting from strongly agree to strongly disagree.

1. Validity Instrument
   a. Media Validity Instrument
      The aspect of media validity instrument contain of format, organization, attractiveness, letter shape and size, space (blank space), and consistency.
   b. Material Validity Instrument
      The aspect of material validity instrument contain of self instruction, self contained, stand alone, adaptive, and user friendly.

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2. Practicality Instrument
   The aspect of practicality instrument that used on small group and large scale trial contain of appearance, ease of use, and the benefits of e-modules.

Data Analys

The data analysis technique used in this research is statistical analysis technique because the data obtained from validators and respondents is data in the form of numbers [10]. The data obtained from the analysis of learning media was collected for further analysis and presented in table form using a Likert scale.

Table 1. Likert Scale [11]

Number	Assesment	Scor				
		SS	S	N	TS	STS
1.	Positive	5	4	3	2	1
2.	Negative	1	2	3	4	5

The scores listed on the instrument sheet are then explained using the formula as follow

$$NV = \frac{S}{SM} x\ 100\%$$

Information:
NV = Validity Value
S = Total score obtained
SM = Maximum score

The results of the assessment scores from each material expert validator, media expert, small group trial, and large scale trial are then averaged to determine the validity and practicality of the module. The following criteria for the feasibility of the average analysis can be seen in Table 2 [12].

Table 2. Validity Value Categories

Validity Value (%)	Category
81 – 100	Very Valid
61 – 80	Valid
41 – 60	Quite Valid
21 – 40	Less Valid
0 – 20	invalid

while the average feasibility criteria for the analysis can be seen in Table 3 [13].

Table 3. Validity Value Categories

Practicality Value (%)	Category
81 – 100	Very Practice
61 – 80	Practice
41 – 60	Quite Practice
21 – 40	Less Practice
0 – 20	inpractice

CIVED Journal of Civil Engineering and Vocational Education
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Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

RESULT AND DISCUSSION

Decide

A. Determine Learning Objectives and Materials

This research is limited to creating an interactive Revit Structure e-module in the Building Information Modeling (BIM) Concepts and Applications course so that the material and objectives set are adjusted to the structure material, which is

1. Students can learn what Autodesk Revit is.
2. students are able to understand and explain the form and function of components in the initial appearance of Revit.
3. students are able to know, explain, and differentiate components and their functions in the Revit interface.
4. students are able to plan a simple 2-floor building structure (columns, beams, foundations, floors and walls).

B. Determine the Media Theme

In this research, the module created is an interactive Revit Structure e-module using the Canva application.

C. Develop Prerequisite Skills

Based on the results of observations with 2021 Building Engineering Education students, information was obtained that students have the ability to use document opening applications such as Adobe Reader or WPS Office as well as the ability to access Google Form links and the ability to scan barcodes.

D. Assess Resources

After conducting observations in the Civil Engineering Department, it was discovered that students in the building engineering education study program had PCs or smartphones to access and use e-modules.

Design

A. Determine the Content Outline

Every material, image and practice question in this e-module is adapted to the learning outcomes of the BIM Concepts and Applications course.

B. Creating a Flowchart

This stage is to describe the sequence and structure of the research carried out as a guide in carrying out the research.

C. Determine the Design and Layout (Specify Screen Design and Layout)

This process is carried out by designing a layout or template that will be used with the Canva application

Figure 3. Layout

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

D. Create Storyboard
Storyboard creation is done by entering material into a template that has been created using the Canva application.

E. Making Learning Media Validation Instruments
This stage includes creating a questionnaire that will be used to validate the media and practicality testing.

Develop

A. Validation of the Learning Media Validity Questionnaire
This stage includes questionnaire validation carried out by a questionnaire expert. After validation and improvements have been made, the questionnaire is declared valid and can be used for research.

B. Making learning media
At this stage, the e-module is created according to the design and flowchart that was created at the design stage. Making e-modules using the Canva application with the help of a laptop.

Evaluate

A. Validation of learning media
At this stage, media validation and material validation of the module are carried out. If there are deficiencies, improvements will be made to the module until the module can be declared suitable by experts.

1. Product Revision
At the media validation stage, there are revisions in the form of suggestions and input for adding a list of tables and a list of images as well as reducing title information. Meanwhile, in material validation, there are revisions to improve questions and access links to practice questions, reducing backgrounds, as well as adding images to the final project.
2. Media Assessment
   a. The results of the media expert assessment carried out by two media expert lecturers can be seen in Table 4.

Table 4. Media Expert Product Validation

Assessor	Aspect	Score Acquisition	Max Score	Persentage	Category
Media Expert Lecturer 1	Format	15	15	100,0%	Very Valid
	Organization	18	20	90,0%	Very Valid
	Attractiveness	28	30	93,3%	Very Valid
	Letter Shape and Size	15	15	100,0%	Very Valid
	Blank Space	8	10	80,0%	Valid
	Consistency	20	20	100,0%	Very Valid
Final Result		**104**	**110**	**94,5%**	**Very Valid**
Media Expert Lecturer 2	Format	14	15	93,3%	Very Valid
	Organization	19	20	95,0%	Very Valid
	Attractiveness	27	30	90,0%	Very Valid
	Letter Shape and Size	14	15	93,3%	Very Valid
	Blank Space	9	10	90,0%	Very Valid
	Consistency	18	20	90,0%	Very Valid
Final Result		**101**	**110**	**91,8%**	**Very Valid**

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Based on the results of the media validation calculations carried out, validation achievement levels were obtained, namely 94.5% and 91.8%, if the average value was calculated, the results were 93.1%. So it can be concluded that the product in the form of an interactive Revit Structure e-module is included in the very valid category.

b. The results of the material expert assessment carried out by two material expert lecturers can be seen in Table 5.

Table 5: Material Expert Product Validation

Assessor	Aspect	Score Acquisition	Max Score	Persentage	Category
Material Expert Lecturer 1	Self Instruction	44	50	88,0%	Very Valid
	Self Contained	9	10	90,0%	Very Valid
	Stand Alone	10	10	100,0%	Very Valid
	Adaptive	10	10	100,0%	Very Valid
	User Friendly	14	15	93,3%	Very Valid
Consistency		**87**	**95**	**91,6%**	Very Valid
Material Expert Lecturer 2	Self Instruction	40	50	80,0%	Valid
	Self Contained	8	10	80,0%	Valid
	Stand Alone	8	10	80,0%	Valid
	Adaptive	8	10	80,0%	Valid
	User Friendly	12	15	80,0%	Valid
Consistency		**76**	**95**	**80,0%**	**Valid**

Based on the results of the material validation calculations carried out, validation achievement levels were obtained, namely 91.6% and 80.0%, if the average value was calculated, the results were 85.8%. So it can be concluded that the product in the form of an interactive Revit Structure e-module is included in the very valid category.

B. E-Module Practicality

1. Small Group Trial

The results of the small group trial assessment carried out by 8 students can be seen in Table 6.

Table 6. Small Group Trial

Num	Aspect	Score Acquisition	Max Score	Percentage	Category
1.	appearance	174	200	87,0%	Very Practice
2.	ease of use	216	240	90,0%	Very Practice
3.	benefits of e-modules	182	200	91,0%	Very Practice
Final Result		**572**	**640**	**89,4%**	**Very Practice**

Based on the results of the calculations carried out, the small group trial rate was obtained at 89.4%, which shows that the interactive e-module is in the very practical

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

category. In carrying out small group trials, there were still suggestions from students that were useful for improving the product, including setting the image size and light intensity in the background.

2. Large Scale Trial

The results of the small group trial assessment carried out by 18 students can be seen in Table 7.

Table 7: Large Scale Trial

Num	Aspect	Score Acquisition	Max Score	Percentage	Category
1.	appearance	402	450	89,0%	Very Practice
2.	ease of use	504	540	93,3%	Very Practice
3.	benefits of e-modules	407	450	90,4%	Very Practice
Final Result		**1313**	**1440**	**91,2%**	**Very Practice**

Based on the results of the calculations carried out, a large-scale trial level was obtained of 91.2%, which indicates that interactive e-modules fall into the very practical category.

Discussion

The media validity test was carried out by two expert media validators, namely expert lecturers in the field of media and educational technology. This media validity test obtained an overall result with a percentage of 93.1% in the very valid category. Each media aspect that was assessed obtained different results, including the format aspect with a result of 96.7%, the organizational aspect with a result of 92.5%, the attractiveness aspect with a result of 91.7%, the shape and size aspect letters with a result of 96.7%, the blank space aspect with a result of 85.0%, and the consistency aspect with a result of 95.0%.

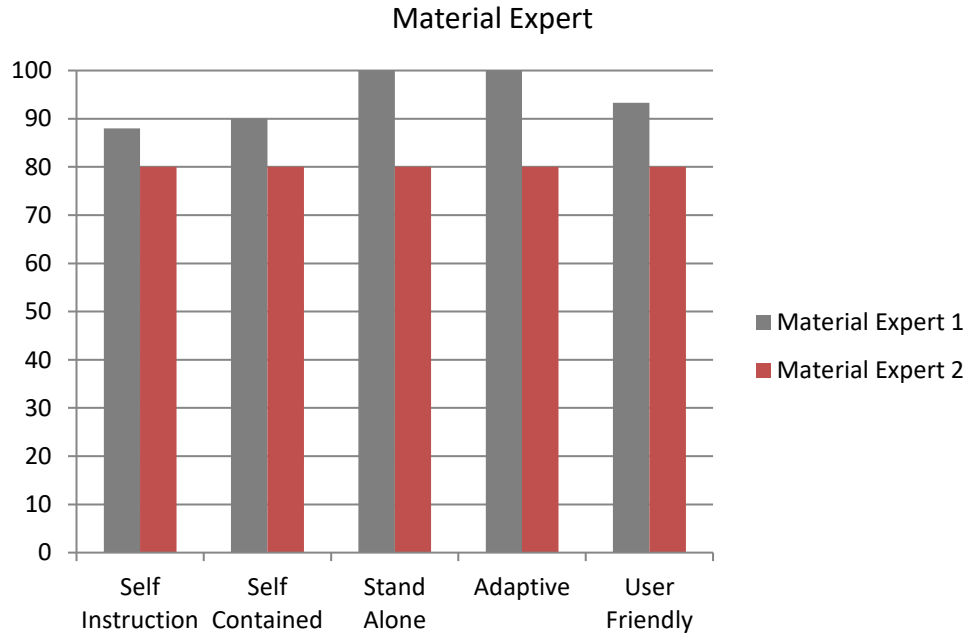

Figure 4. material expert validation graph

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

The material validity test that was carried out obtained an overall result with a percentage of 85.8%, which means the e-module is in the very valid category. Each aspect assessed had different results, including the self-instruction aspect with a result of 84.0%. the self contained aspect with a result of 85.0%, the stand alone aspect with a result of 90.0%, the adaptive aspect with a result of 90.0%, and the user friendly aspect with a result of 86.7%.

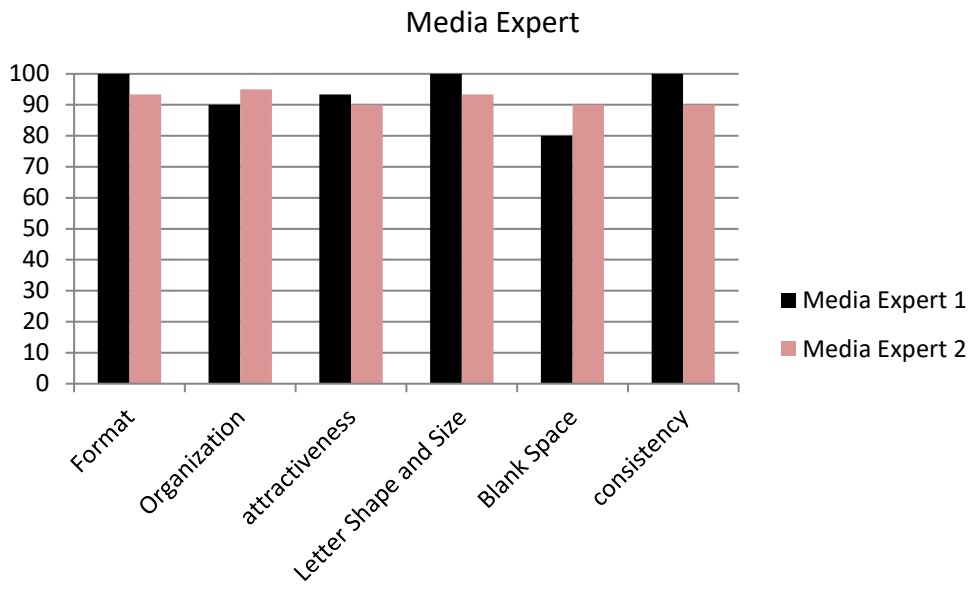

Figure 5. Material Expert Validation Graph

The practicality test that was carried out using small group trials and obtained test results with a percentage of 89.4% in the very practical category. Each aspect element obtained different results, including the appearance aspect which obtained a result of 87.0%, the ease of use aspect with a result of 90.0%, and the module usability aspect of 91.0%. In carrying out this small group trial, suggestions and input were obtained from students consisting of reducing the intensity of the background image and enlarging the image contained in the e-module.

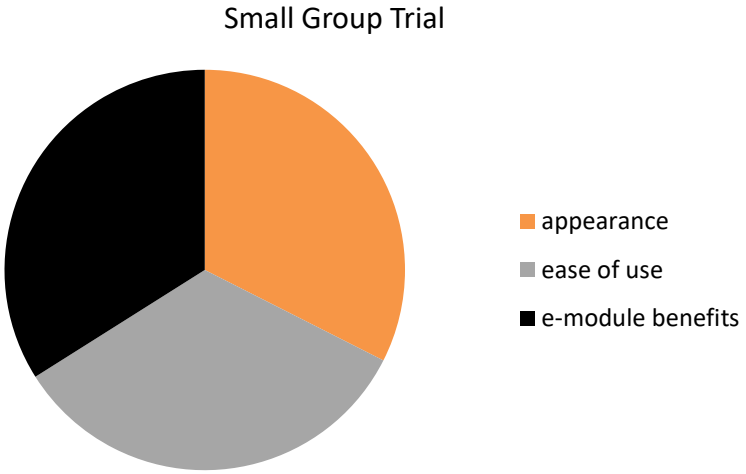

Figure 6. Small Group Trial graph

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Large-scale trials with a percentage of results obtained of 91.2%, which indicates that the interactive e-module created is in the very practical category. Each aspect element has different results, including the appearance aspect with a result of 89.3%, the ease of use aspect with a result percentage of 93.3%, and the module usability aspect with a percentage of 90.4%.

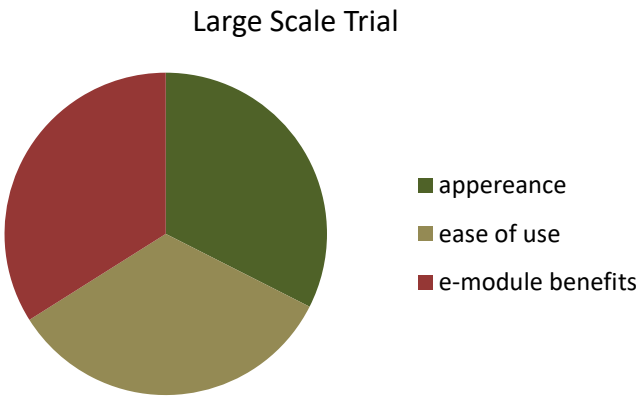

Figure 7. Large Scale Trial graph

CONCLUSIONS

Based on research and analysis of data analysis results, the following conclusions can be drawn:

1. The validity of the Revit Structure interactive e-module in the Concepts and Applications of Building Information Modeling course was obtained with a material percentage of 85.8% falling into the very valid category and a media percentage of 93.1% falling into the very valid category.
2. Practicality testing carried out using small group trials resulted in a score of 89.4% in the very practical category. Meanwhile, large-scale trials achieved results of 91.2% in the very practical category.
3. The Revit Structure interactive e-module on the Concepts and Applications of Building Information Modeling (BIM) course is very valid and very practical to use in the learning process.

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