



Development of Reinforced Concrete Floor Slab Mockup Media to Improve Student Competence

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ABSTRACT

The objectives of this study are: (1) Developing floor slab reinforcement mockup media as a means of better building structures learning. (2) Identifying the feasibility level of mockup media product development for floor slab reinforcement. This study applies research and development methods by developing mockup-type learning media. The development procedure used is ADDIE. The assessment of the feasibility of learning media is carried out by giving questionnaires to two experts; a material expert and a media expert, and 22 students in small-scale trial respondents. The results of the study are as follows, (1) the development of mockups as learning media in the form of (a) Analysis phase: literature study and field study on media needs. (b) Design phase: basic calculations and preparation of instructional media model designs. (c) Development phase: manufacture of learning media products and validation of a team of experts. (d) Implementation phase: small group test. (e) Evaluation phase: analysis of the data results and is the final phase of the development process related to the final model of learning media. (2) The media assessment by material experts were 93.75%, categorized as very decent. The results of the media assessment by media experts were 96.53%, categorized as very decent. The media feasibility test for small-scale students is 90.63% categorized as very feasible. Based on these results, it can be concluded that the learning media product of the floor slab reinforcement mockup is declared suitable for learning.

Keywords: *Floor plate, Media, Mockup, Learning, Reinforcement.*

1. INTRODUCTION

The industrial development has led to an increasing need for professionals. More importantly, human resource development should be attempted, in order to answer the needs of an exceptional human resource to meet the standard of an advanced industry. The government takes part in this initiative by issuing Presidential Regulation Number 8 of 2012 [1] regarding the Indonesia Qualification Framework, a human resource qualification framework integrating the educational, work training, and working experience sectors through a work recognition scheme. A work recognition scheme or commonly known as work competence certification is a process of giving a certificate based on the competence proficiency obtained after passing the competency assessment held by a certification agency. The competency assessment can be held by a certain university that cooperates with a certified certification agency.

A university in Surakarta that establishes a competency assessment is Sebelas Maret University. The competency assessment is established under the name of Sebelas Maret University Institution for Professional Certification (SMU IPC). SMU IPC covers 20 proficiency assessments encompassing the Faculty of Agriculture and Teacher Training and Education. One of the schemes offered in the program is the Building Engineer Proficiency Scheme (BEPS). The institution regulation number 8 of 2014 [2] mentioned that a professional building engineer should have the competency of designing, implementing, and supervising the work regarding the structure of a building. The scheme of BEPS SMU IPC has been used to assess 3 departments of Sebelas Maret University, which are: 1) an undergraduate student of the Building Engineering Department, 2) an undergraduate student of the Civil Engineering Department, and 3) a diploma student of Civil Engineering.

The test material given to the accession is based on the Decree of the Minister of Manpower No. 192, 2016 [3] concerning how a building engineer has the competence to design, implement and supervise the construction of a multi-story building. This regulation is then outlined in the Indonesian National Work Competency Standard (SKSNI). There are 28 competency units in the Building Engineering Proficiency Scheme that have to be passed by the assessee in order to obtain a certificate of acknowledgment. One of the competency units which have to be passed is designing a building structure both low-rise buildings and high-rise buildings. The superstructure of the building itself consists of the structures of some components which are located above the ground level such as; columns, beams, slabs, stairs, and roofs. The assessee must possess an excellent comprehension of both the theoretical and practical aspects of each of the competency units assessed. One of them is a comprehension of floor slab reinforcement.

Comprehension of floor slab reinforcement structure is needed due to its thin and rather complex reinforcement structure. The concrete slab is a thin structure that is designed through reinforced concrete with a horizontally directed plane and the load works perpendicular towards the plane. The thickness of the slab tends to be smaller than the width or length of the slab [4]. Based on the observation and the interview obtained by the students doing the competency assessment on the BEPS scheme, they faced difficulty regarding the assessment material, particularly in the superstructure part. The interview conducted by the researchers towards the model lecturer and the assesses carries out a statement which implies that the learning process in the department whose students are joining the competency assessment in SMU IPC on Building Engineer Scheme especially the lesson regarding the building structure is still conventional. The students have insufficient comprehension of floor slab reinforcement design due to the lack of learning media which pictures the real field situation in the class.

The learning media needed is a media that can deliver or distribute the information of the activity in the learning process, in an effective and efficient way [5].

Conducted by Ekayani (2017) [6] stated that a learning media has some functions: 1) elaborating the information in order to make it less verbalizes, 2) handling the time, space, energy, and sense constraints, 3) bringing up the passion in learning, students can interact with the source of learning directly, 4) giving chance for the students to learn independently based on their skill, auditory kinesthetic capability, and visual capability, 5) giving similar stimulus, adjusting the same presumption and experience.

One of the learning media which can be used to picture the real form of a certain real object is mockup. Moreover, mockups can be used as a tool to depict the real circumstances regarding the process as well as how

an object works [7]. The use of media makes data presentation more interesting and reliable, facilitates data interpretation, summarizes information, and increases students' understanding [8].

Research conducted by Hasanah (2020) [9] stated some strengths of mockup as a learning media in the learning process, as follows: 1) giving the direct experience of a complex object so a concrete object can be learned, 2) depicting the structure of an object in a clear way, 3) depicting a clear workflow of an object, 4) simplifying an object which cannot be shown directly in a classroom.

The decision a using mockup media can support the teachers in delivering abstract materials to become more concrete. Through the use of this media, the learners can also acquire the most positive impact on the participants' learning performance [10]

Based on the problem description mentioned before, research needs to be conducted which aims are as follows:

- 1) Developing a floor slab reinforcement mockup media.
- 2) Acquiring feasibility level data of floor slab reinforcement mockup media product.

2. METHOD

The research method applied was the research and development method. This research method aims to produce a particular product and to examine its feasibility and effectiveness. This research applied the ADDIE development phase which consists of five main phases; Analysis, Design, Development, Implementation, and Evaluation, which was developed by Branch, (2009) [11] and implemented by [12]. This research was conducted campus of Sebelas Maret University. The data were taken from an interview, observation, and questionnaire distribution. The primary data of this research were obtained from the questionnaire distribution and the interview transcript. On the other hand, the secondary data were the assessment form and the competency assessment inquiry from the assessment.

3. RESULT AND DISCUSSIONS

3.1. Results

3.1.1. Analysis Phase

In developing the learning media, the first step to be done is analyzing the need for the learning media needed according to the result of the observation done previously. According to the observation result, the learning process of the department whose students are involved in the Building Engineer Proficiency Scheme competency assessment of SMU IPC still needs to be improved. The development of the learning media is

needed, it will be an additional learning media for the students to improve their comprehension of floor slab reinforcement.

3.1.2. Analysis Phase

The phase after analyzing the learning media needs is designing the learning media which aims to picture the real form of floor slab reinforcement for the learners. In this phase, the analysis result will be the foundation for establishing the learning media in a precise way, covering the calculation of the floor slab reinforcement which will be applied in the making process of the shop drawing which covers the top view, right side view and front view and isometric projection image.

3.1.3. Design Phase

The phase after analyzing the learning media needs is designing the learning media which aims to picture the real form of floor slab reinforcement for the learners. In this phase, the analysis result will be the foundation for establishing the learning media in a precise way, covering the calculation of the floor slab reinforcement which will be applied in the making process of the shop drawing which covers the top view, right side view and front view and isometric projection image.

3.1.4. Develop Phase

After finishing the shop drawing design, the next step is the tools and materials used in the assembling process. The steps in the assembling process of the floor slab reinforcement mockup can be described as follows:

The first step of the mockup development is making the sketch using acrylic as the material. The sketching process is very important because it will determine the form and the conformity of the mockup. The sketch drawing process is assisted by software namely Corel Draw X7. This sketch is drawn by paying attention to the design at the beginning, which is made by applying the scale determined which is 1:5.

The next step is to cut the acrylic using a laser cut machine. The acrylic is cut according to the sketch by the cutting service. The use of a laser cut machine aims to get a precise cutting result. The cutting process can be done conventionally using a drill and the drill bit. However, the result cannot be as precise as when it is cut using the laser cut machine because there will be a rough mark caused by the drill bit.

The third phase is the formation of reinforcement using wire. A roll-shaped wire is straightened and cut according to the determined length. The length of the cut wire is adjusted to the length of the acrylic that has been cut and added by the length of the bend or hook and the length of the distribution. A 2.5 mm wire is used as main reinforcement, a 1.5 mm wire is used as section

and shrinkage reinforcement, and a size 1 mm as stirrup reinforcement of the beam surrounding the plate. At this phase, the LAN cable wire is also used to substitute the binding ties. The LAN cable which has been cut is then burned, to ease the tying process.

The wire which has been cut is then painted using a brush. The paint used is an oil paint, diluted with thinner. The main reinforcement is given a primary paint color. To produce another color, the solution is to mix two or more paint colors to produce the desired color. The drying process lasts for a minimum of 12 hours under the sun or at least 24 hours of aerating. The wires must be dried to the maximum dry level to avoid the wires sticking to each other because the paint is not completely dry and the paint can easily peel.

Before assembling the acrylic, some holes are made in it as a place to hang the wires. Giving a mark on the acrylic should be done in order to determine on which part the acrylic will be perforated, the marking process is done on the acrylic coating paper. All the marks are made, and the acrylic is then placed on a wooden base and clipped using paper clips. Acrylic can be perforated only if it has been clipped to the base properly.

The acrylic which has been through the cutting process is then assembled according to the design. The assembling process can be done by using paper tape as temporary clamps. The ends of each of the acrylic pieces are connected and then covered with paper tape. The function of paper tape as a temporary clamp is not only given on one side, but several sides to prevent the acrylic from detaching from one another. The pieces of acrylic have previously been sanded to provide texture so the glue can bond perfectly.

The perfectly dried wire is then bent according to the design. After that, the wire is attached to the perforated acrylic. Installation begins with the main reinforcement, the secondary reinforcement, and shrinkage reinforcement alternately. The wire installation must pay attention to the position of the first and second layers of reinforcement. After the wires installation process is done, all wires are tied using copper wire one by one.

The final phase is finishing. This phase is carried out by installing a concrete deck made out of cut erasers. The concrete deck is glued using acrylic glue. At this phase, the acrylic coating paper is peeled off and the paint residue is cleared from the media.

After the media has been assembled according to the design, some instruments for evaluation are arranged, and the mockup is evaluated by experts and students. The instrument used needs to be validated in order to synchronize the suitability of the statement points toward the existing media. In the next phase, the media will be assessed by some experts to see how appropriate the media is if it is used as learning media in the

classroom. The assessment was carried out by 1 person each from media experts and material experts.



Figure 1 Floor Slab Reinforcement Mockup on the 1:5 Scale.

3.1.5. Implementation Phase

The implementation phase was carried out on 22 students joining the competency test on the Building Engineering Proficiency Scheme which was divided into 3 stages of data collection. Students are given inquiries as a benchmark for material comprehension. At the time of implementation, 2 media were provided as a comparison, namely the slab reinforcement mockup media as a 3-dimensional medium and the floor slab reinforcement image media as a 2-dimensional medium. Students were asked to work on the problem twice. In the first work, students were not given any media. After the first work was completed, then the students were given a mockup media for floor slab reinforcement and worked on the questions again. Based on the test results, there are several differences shown between the assessment without media and the use of reinforcement mockup media.

3.1.6. Evaluation Phase

Based on the results of the assessments, constructive suggestions will be drawn to develop similar media in the future. Existing evaluations will also be used to revise products according to the notes given during the evaluation.

3.1.7. Feasibility Level of Floor Slab Reinforcement Mockup as a Learning Media.

3.1.7.1. Material Expert Validation Result

In assessing the feasibility of the material applied in the development of learning media, the researcher assigned the lecturer as a validator of the assessment. The aspects assessed are the suitability aspect, the accuracy aspect, and the completeness aspect.

Table 1. Material Experts Evaluation.

No	Aspects*	Score Obtained	Total Score	%
1	Conformity	21	24	87.5
2	Accuracy	30	32	93.75
3	Fullness	4	4	100
Sum		55	60	93.75

3.1.7.2. Media Expert Validation Result

In assessing the feasibility of the learning media which has been developed as a media in learning, the researchers assigned the lecturer as the validator of the assessment. The aspects that are assessed are the media quality aspects, media form aspects, and realistic aspects.

In assessing the feasibility of the material applied in the development of learning media, the researcher assigned.

Table 2. Media Experts Evaluation.

No	Aspects*	Score Obtained	Total Score	%
1	Media Quality	61	64	95.31
2	Media Form	15	16	93.75
3	Realistic	8	8	100
Sum		84	88	96.35%

3.1.7.3. Limited User Testing

This limited user test was conducted on 22 students who carried out competency tests for the BEPS SMU IPC scheme in 3 periods. This process is carried out in order to assess the learning media from learning aspects, aspects of media form, aspects of media quality, and aspects of media function.

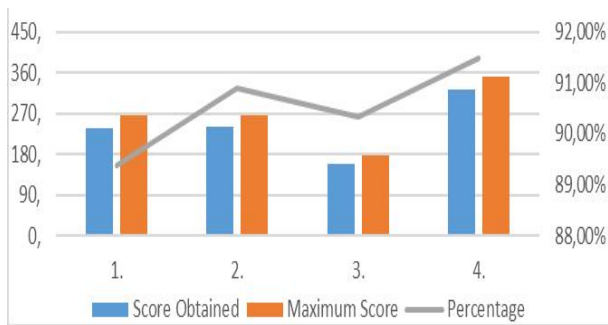


Figure 2 Students' Evaluation on Limited User Testing.

Based on the results of observations and interviews, it was found that when the competency test was carried out on the SMU IPC Building Engineering Proficiency Scheme, students experienced difficulties when working on the superstructure material. During lectures in subjects related to the upper structure of the building, students feel less than optimal in comprehending the material provided because the media used does not support the lecture process so each student's understanding of the material will be different. From the questionnaire results given at media assessment, the researcher concluded that students needed related learning media. Moreover, students explained that the presence of this media helped them in understanding the material for slab reinforcement. Based on the data obtained, it can be concluded that media is needed that can illustrate the material for slab reinforcement which can increase student comprehension.

3.2. Discussions

3.2.1. Media Evaluation According to Expert Analysis Phase

Learning media that have been designed are then evaluated in order to determine the feasibility level of the learning media. Learning media in the form of floor slab reinforcement mockups have been evaluated by material experts and media experts. The material expert gives an assessment regarding the suitability of the model with the design and size, the accuracy of the placement of the reinforcement, and the size and completeness of the type of reinforcement. The measuring tool used is a written questionnaire with a total of 15 questions. Quantitative results obtained through the assessment of material experts amounted to 93.75%. For the aspect of suitability of the model with the design and size of 87.5%, the aspect of the accuracy of reinforcement placement and size is 93.75%, and the aspect of the completeness of the type of reinforcement is 100%. In general, the results of the assessment of material experts explain if the learning media that have been made have very decent criteria. Details of the results of the assessment by material experts documented by the researcher.

The media expert's assessment obtained a quantitative result of 96.35%. The measuring tool used is a written questionnaire with a total of 22 questions. Media expert's judge based on the durability of the materials used, the durability of the colors applied, the durability of the series, ease of use, attractive shapes and paint colors, suitability of sizes, and realistic aspects. From the calculation of the media expert's assessment of various aspects, the percentages were obtained: the aspect of media quality was 95.31%, the aspect of media form was 93.75% and the realistic aspect was 100%. In general, the results of the media expert's assessment stated that the learning media that had been made had very decent criteria. Details of the results of the assessment by media experts are documented by the researcher.

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3.2.2. Evaluation According to Students.

After the assessment by material experts and media experts, the researcher obtained suggestions and input. Furthermore, an assessment process was carried out by students through limited user testing. This limited user testing was conducted on 22 students who carried out competency tests for the BEPS SMU IPC in 3 periods. This process is to assess learning media from learning aspects, aspects of media form, aspects of media quality, and aspects of media function. The results obtained from this student assessment were declared very feasible by obtaining an average score of 90.63%, with the following details of the assessment: from the learning aspect a score of 89.39% was obtained, from the aspect of media form a score of 90.9%, from the aspect of media quality is 90.34% and from the function aspect the media gets a score of 91.48%. The results of student assessments were documented by the researcher.

Interviews with students as media users were conducted to find out their responses regarding the media developed. Interviews were conducted after the testing process by students. Student responses regarding the learning media for floor slab reinforcement mockups

were positive. Students felt that the media helped in understanding floor slab reinforcement. As stated by students after the assessment as follows:

"Yes, I think this tool really helps to understand more about floor slab reinforcement. At the time when I was working on questions like this, I really had no idea, so I was confused about what to do with the questions." (gal2.mhs3.suk.w.P.21-08-21/14.15-14.30).

"Obviously you can, especially so far there's very little learning on campus with tools or media. So yes, it's usually only shown via pictures or PPT. so if I don't really understand what a two-dimensional image actually looks like in the field. If, for example, learning on campus uses tools like this, it will obviously really help students, because we need it" (gal2.mhs4.ra.w.P.09-10-21/14.15-14.30).

From the statements of the students during the interview above, it was concluded that the media products that had been made were stated to help students in understanding the reinforcement of floor slabs. Thus,

In the learning process, an educator is required to develop creativity and use interesting learning by using media, so it is expected to help educators in delivering the subject matter well [13].

The use of media contributes to students' understanding of the material because the media functions as a tool that transmits knowledge/messages from educators to students. This is supported by the results of Nugroho's research (2020) [14] which states that the media helps the learning process by adding variations in verbalism. A good learning and teaching process will have an impact on the achievement of learning objectives and also able to provide satisfaction with student learning outcomes [15]. The results of the questionnaire on the use of mockups to students above support the theory Kevin Moore, and Carol Jone, (2017) [16] explains that for engineering experts the needs of generation z students include strong analytical skills, practicality, ingenuity, creativity, good communication skills, understanding the principles of business, management, and leadership, high ethical standards and professionalism.

4. CONCLUSIONS

Based on the research data and the research discussion, the conclusions can be drawn as follows:

1) The procedure for developing a floor slab reinforcement mockup learning media includes five ADDIE stages consisting of the Analysis stage which includes literature study activities and field studies regarding media needs, the Design stage which includes basic calculations and the preparation of media model designs learning, the

Development stage of making learning media products and validating a team of experts, the Implementation stage where small group tests are carried out, and the Evaluation stage regarding the analysis of result data and is the final stage of the development process related to the final model of learning media.

- 2) The feasibility level is based on expert judgment and test results
 - a. Material Experts
The level of feasibility of learning media based on the assessment of material experts is 93.75%. Learning media is in the feasibility category, which is very feasible.
 - b. Media Experts
The feasibility level of learning media based on the media expert's assessment is 96.35%. Learning media is included in the feasibility category, namely very feasible.
 - c. Media Testing
Testing conducted on 22 students obtained a feasibility level of 90.63%. Learning media is in the feasibility category, namely very feasible.

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