



Educational media design for learning basic programming in branching control structure material using problem-posing learning model

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Abstract

Basic programming is one subject that tends to be difficult for students to learn. Along with the development of technology, several researchers have provided solutions to solve this problem, by developing educational games, educational media, interactive learning media, and other auxiliary media. However, on average they have not used or adhered to the syntax of various existing learning models. This study focuses on designing educational media that uses the problem-posing learning model to study the material of branching control structures in basic programming learning which is recommended as a learning medium for vocational high school students. Educational media named TOLSYASUPI-EduMed. We use the highest type of research and development (R&D), the level 4 that we adopted to be adapted into a number of steps that are in line with the needs of this research area. Observation techniques are used as a form of generative research which is a type of user experience research, to explore information before designing a product/application. The side that we highlight here is how the form of educational media design by following the syntax of the problem-posing learning model. Then do an A/B testing which is assessed by experts to choose the best design with results that are type B designs with a percentage of 90.9%. We also state the analysis of the functional aspects of educational media to strengthen the validity of this design idea.

1. Introduction

Basic programming is one of the compulsory subjects for basic expertise in vocational secondary schools throughout Indonesia, for the fields of technology, information, and communication expertise [1]. According to Aulia Akhrian Syahidi, Arifin Noor Asyikin, and Asy'ari [2] basic programming subjects have a function as the initial foundation for students to practice mindset (logic), student creativity, and understand programming languages and as a basis for learning subjects other related. According to Lita Likmalatri [3] basic programming as a subject that has the purpose of building a basic understanding for students and as an initial introduction to understanding programming languages.

However, the fact is that in basic programming learning there are still many obstacles and problems. One of them is that students tend to still find it difficult to understand some of the material in the scope of basic programming.

This is evidenced by the results of observations and interviews conducted by researchers in several schools, the results are very suitable with the facts that have been submitted before. The observation results are by distributing questionnaires to students who have studied and who are still learning basic programming material, they tend to dislike basic programming subjects, learning tends to be boring, they tend to experience difficulties in branching control structure material as the most difficult material for students, compared to other material. Then the results of interviews with some of their basic programming teachers tend to convey that they are aware that when implementing basic programming learning is still done in conventional ways and practices also tend to be rarely done, this is because students are still difficult to be able to continue to the next material, repetition of the material continues absorbing to understand the material is still low, then the use of other assistive media is not done, it does not apply learning models that have the potential so that learning is not monotonous and looks more active and vibrant, consequently student learning motivation is also low and the final effect is student learning outcomes low with a large number of students participating in remedial.

We also prove the excavation of problems from several researchers who said that basic programming learning has many obstacles and tends to be difficult for students to learn, which research has been delivered by [4][5][6][7][8][9]. We see that the average researcher agrees that learning basic programming is not easy.

From these constraints, researchers have provided good solutions in the form of design recommendations and proposals for the development of educational games, educational media, interactive learning media, other auxiliary media, and even proposing instruments to design basic programming learning. But it still tends to be minimal to collaborate by adhering to the syntax of the learning model. Educational games, educational media, and interactive learning media that take advantage of the development of computer technology, tend to have great opportunities to make learning better, can increase student motivation, and have a very good effect.

There are several studies that we have adopted, have recommended the development of educational media with problem-posing learning models in mathematics learning, namely from research from Tsukasa Hirashima, Takuro Yokoyama, Masahiko Okamoto, and Akira Takeuchi [10] who propose an interactive learning environment by designing and the development of a computer-based environment to assist learning mathematics by disguising it as integrating sentences for story matter material, the name of the application is called MONSAKUN.

Along with developments in education, rapid technological changes, and artificial intelligence in the use of educational media, the research conducted by Ahmad Afif Supianto, Yusuke Hayashi, and Tsukasa Hirashima [11] in the form of expanding the performance domain of the MONSAKUN application is analyzing thinking the learner when experiencing problems when interacting to solve problems in the sentence integration arrangement provided by the MONSAKUN system. Then in the research Ahmad Afif Supianto, Yusuke Hayashi, and Tsukasa Hirashima [12] expanded the performance of the MONSAKUN system by recommending the design of a scaffold system that aims to overcome obstacles when learners are faced with the problem of arithmetic words. Furthermore, from Ahmad Afif Supianto, Yusuke Hayashi, and Tsukasa Hirashima [13] who continue to expand the performance of the MONSAKUN system by analyzing and investigating what actions are carried out by the learner when faced with solving arithmetic word problems. The latest developments from MONSAKUN were examined by Ahmad Afif Supianto and Muhammad Hafis [14] who used log data to explore patterns and data relationships to understand learning experiences and identify students.

In the study of Hisayoshi Kunimune and Masaaki Niimura [15] who proposed the use of the problem-posing method to develop problem solving skills in basic programming learning and to develop educational media that supported the application of problem-posing methods to actual classroom learning, in this study the scope of material using language C programming, the constraints they faced were in the form of students' lack of understanding of the flow of the problem-posing method on educational media, most likely this was not a preliminary study done to ensure that students could understand the problem-posing method as little as possible.

Research from Aulia Akhrian Syahidi, Ahmad Afif Supianto, Herman Tolle, dan Tsukasa Hirashima [16] which has proven that there are 75 scientific articles that have collaborated learning models into educational games, educational media, educational interactive media, or those with the namesake. Where the application varies greatly in terms of subjects, education level, effects, and the number of populations/samples used. This means that the discovery of a small number of scientific articles provides an opportunity to collaborate between educational media and the syntax in the learning model.

Based on several previous studies, it is still minimal to provide solutions to basic programming subjects by collaborating educational media with learning models. So from that, researchers now have the idea to collaborate, previously from Aulia Akhrian Syahidi, Herman Tolle, and Ahmad Afif Supianto [17] conducting research in the form of a preliminary study in the process of manually applying learning models to basic programming classes in algorithmic materials and flow charts as a means to validate and determine the extent to which problem-posing learning models can be applied in the classroom, can be understood by students, and provide effects. The results show that by applying the problem-posing learning model there is an increase in student activity, student learning outcomes, and also students tend to be good at understanding what is done in the syntax of problem-posing learning models, this research is the basis and continuation of the current research.

The research area that we propose is to design educational media by adhering to the syntax of the problem-posing learning model to study the material of branching control structures in basic programming learning using the visual basic programming language to adjust the curriculum in schools. The results of this study will be the basis for developing educational media applications and are recommended as learning media for vocational high school students in actual classes in future research.

2. Research Method

Research and development (R&D) methods according to Richey and Klein [18] which focus on analysis from beginning to end, which includes design, production, and evaluation. The design which means the activity of making a product plan that will be made with a specific purpose, which begins with a needs analysis carried out through research and literature studies. Producing means the activity of making a product based on the design made in the previous stage. Evaluation is the activity of testing and assessing how high the product meets the specified specifications.

Methodologically, according to Richey and Klein [18] research and development has four levels of difficulty, namely: (1) Level 1 - Researching without testing; (2) Level 2 - Not researching but testing; (3) Level 3 - Research and test to develop existing products; (4) Level 4 - Research and test to create products that do not yet exist.

In this study, we adopted a research and development method with a level 4 type that is researching and testing to create products that do not yet exist. Figure 1 is the adoption of a level 4 R&D model that is adapted to the existing research domain.

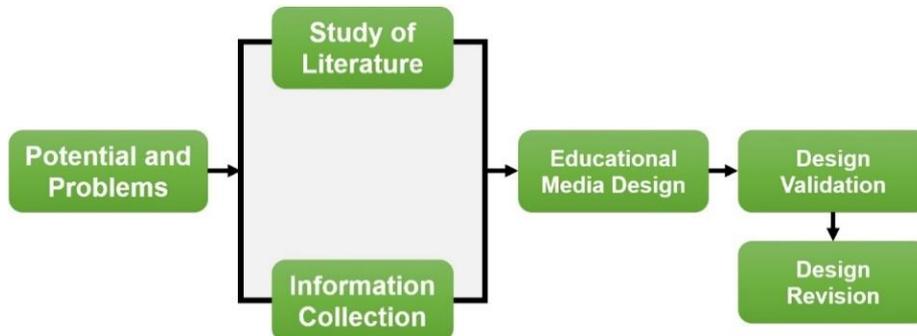


Figure 1. Level 4 R&D Model

The highest research and development method (level 4) is research that can create new products that are creative, original, and tested [18]. Creating creative new products means creating new products that have added value and have never existed. Original means original, no one else has made it. Tested means that the product has been empirically proven its quality through various field tests. To create a tested new product, research is needed to produce a design, then development that means making and testing the product that has been produced.

The first step is exploring potential, see Figure 2 and problems, see Figure 3, a potential is everything if empowered will have benefits so that it has added value. While the problem is a deviation between what is expected and what happens. The next stage is conducting literature studies and gathering all information related to potential and problems. The study of literature is to find and collect all forms of scientific research that have relevance. Collecting information by observation (related to the adoption of the user experience method) to the field by reviewing conditions and to stakeholders. Based on the previous stages, it was continued by designing the appropriate educational media. The design of educational media is then validated by people who are considered experts and practitioners who are in accordance with their fields. Validation can be done by means of focus group discussions, where experts and practitioners are asked to provide assessments and suggestions for improvements to the design of the educational media. Then the researchers made improvements to the design of educational media in accordance with the results of validation from experts and practitioners. After the design of educational media was improved, the design of the educational media was tested internally.

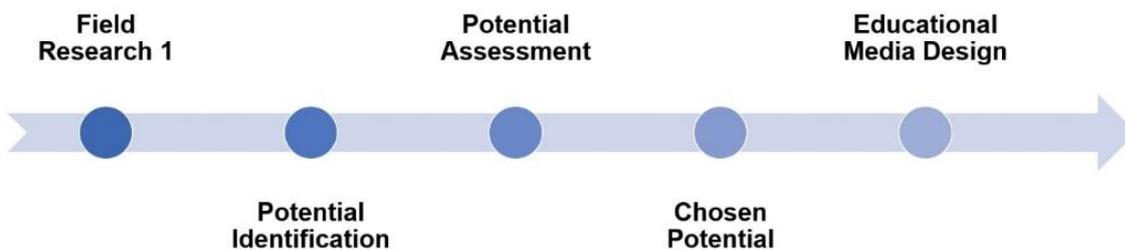


Figure 2. Find Potential Steps

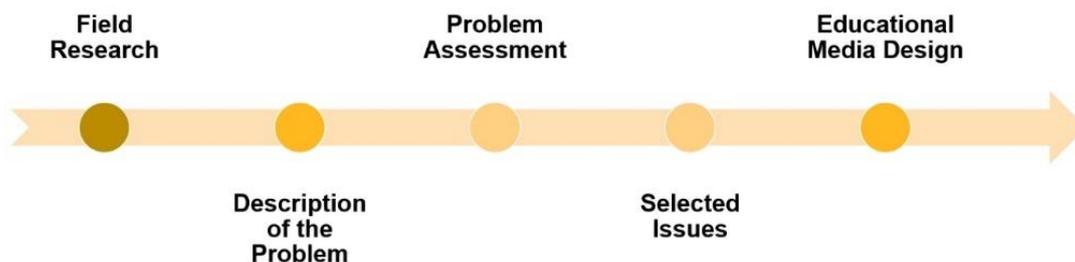


Figure 3. Problem Finding Steps

In relation to the design of educational media, the researchers adopted methods that exist in user experience (UX), according to [19], which is generative research with the type of observation technique to carry out excavation/information gathering.

The theory of Edward A. Silver [20] the problem-posing learning model is an action in building new problems and questions that aim to explore certain conditions or reformulate problems based on the problems that have been given.

According to Stephen I. Brown and Marion I. Walter [21] that problem-posing has the potential to create a completely new orientation to the problem, then who is responsible, and what they must learn. Given a situation where learners are asked to produce problems or ask questions, even allowed to modify them.

In Tsukasa Hirashima's study, Takuro Yokoyama, Masahiko Okamoto, and Akira Takeuchi [10] explained the essence of problem-posing implementation was that students could make various problems and submit them, possibly also making the same problem repeatedly, even making simpler problems useful in the learning process.

Furthermore, from Suryosubroto [22] who has the opinion that one of the suitable learning models to improve student learning activities is to apply the problem-posing learning model. Problem-posing is used to lure students to find knowledge gained through efforts to find relationships in the information learned, so as to improve student learning activities in the classroom.

The syntax of the problem-posing learning model according to Amin Suyitno [23] is as follows:

1. The teacher explains the subject matter to students. The use of props to clarify concepts is highly recommended.
2. The teacher gives examples of sufficient questions.
3. Students are asked to send 1 or 2 challenging questions, and the students concerned must be able to solve them. This task can also be done in groups.
4. At the next meeting, randomly, the teacher tells students to present their findings in front of the class. In this case, the teacher can determine students selectively based on the weight of the questions posed by students.
5. The teacher gives home assignments individually.

3. Results and Discussion

Adapting and adopting research and development (R&D) methods with level 4, the stages of the media education modeling process are presented in the following sub-section.

3.1 Potential and Problems

The first stage is to explore potential and problems, based on the background that the problem that occurs with the highest value of the problem is the difficulty of students in learning basic programming subjects, especially in the material of branching control structures. The potential is to make students understand the material, make students more active, make students able to think and solve problems and motivate students by proposing the design and development of educational media that collaborate with the problem-posing learning model as the highest potential value.

3.2 Study of Literature

The literature study that we conducted is looking for all related topics so that it can support the problem-solving in this study. Literature studies were obtained through research results and other scientific sources on the same topic, namely relating to educational media using the problem-posing learning model that had been done before. The study of literature used can be used as a theoretical basis in conducting this research.

3.3 Information Collection

Observation techniques from the UX point of view and when used to design products are exploration, generally carried out to obtain a better understanding of the willingness of users, user tasks, and environments that are declared comfortable by the user. This is what is used to explain all the requirements and ideas that can inspire in the design. Observation techniques in this domain have benefits if researchers cannot interact directly with end users. When observing the researcher makes an objective and careful note. In this study we mixed observation activities with questions to get a better understanding of what is needed by end users, we immediately interacted with potential end users. Prospective end users here are the ten-grade vocational high school students in the multimedia expertise field who take basic programming subjects and will use the educational media. Collection of information by means of this observation is carried out to prospective end users and also experts who have developed and have conducted research in the field of educational media. The results obtained in broad outline from the collection of information is that the educational media designed can be used easily, simply, not make it difficult for the user, can be a solution to the problems that have been found, can have a good effect on learning, adjust the material in curriculum, and educational media must adhere to the syntax of problem-posing learning models.

3.4 Educational Media Design

Design appropriate educational media based on previous stages. We have made 2 pieces of educational media design recommendations submitted to experts, then the selection is done using the A/B testing method adapted from

[24][25]. In this study, we used 11 experts consisting of 5 media experts and 6 material experts. These experts are selected based on criteria that have a minimum of 5 years working in the area of research or project creation. Experts play a very important role in the design stage until the final stage of development and evaluation. One design recommended with the highest value is type B media with a final value of 90.9% based on the results of A/B testing by experts. This type B educational media adheres to the problem-posing learning model which on average all experts agree with the type of open-posing which is to provide students the opportunity to ask questions into the system they have by educational media, so that it fosters, sharpens knowledge, and ways of thinking of students, then recommends other students to solve questions that have been asked by previous students. The educational media proposed by the design is given the name TOLSYASUPI based on the desktop. For the architectural design of the TOLSYASUPI-EduMed system shown in Figure 4, which has also been discussed with experts.

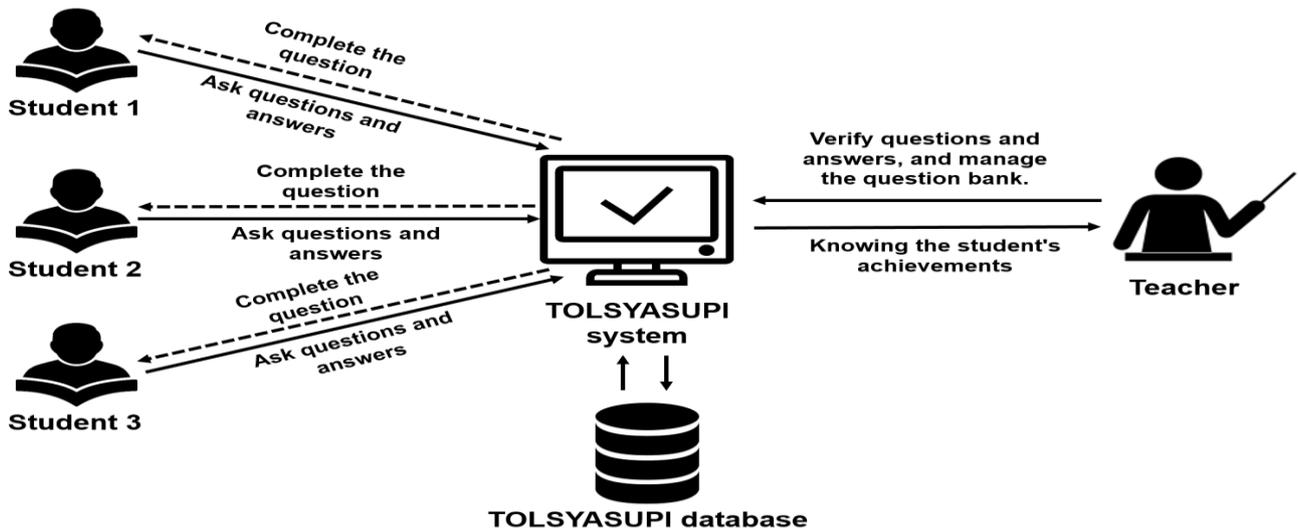


Figure 4. Design of TOLSYASUPI-EduMed System Architecture

In Figure 4 is a form of educational media architecture design TOLSYASUPI, which explains that students submit questions and answers to the TOLSYASUPI system, then are accommodated in the TOLSYASUPI database, the teacher will directly verify the recommendations of questions and answers, if valid student questions and answers continue to the question bank and if it is still not valid then it must be revised, see Figure 5, then the teacher determines which questions are raised in the quiz, then all students complete the questions provided based on the quiz that has been raised in the TOLSYASUPI system, then when the students have completed the quiz, they will get information on the acquisition of value and also feedback in the form of any questions that are right and wrong.

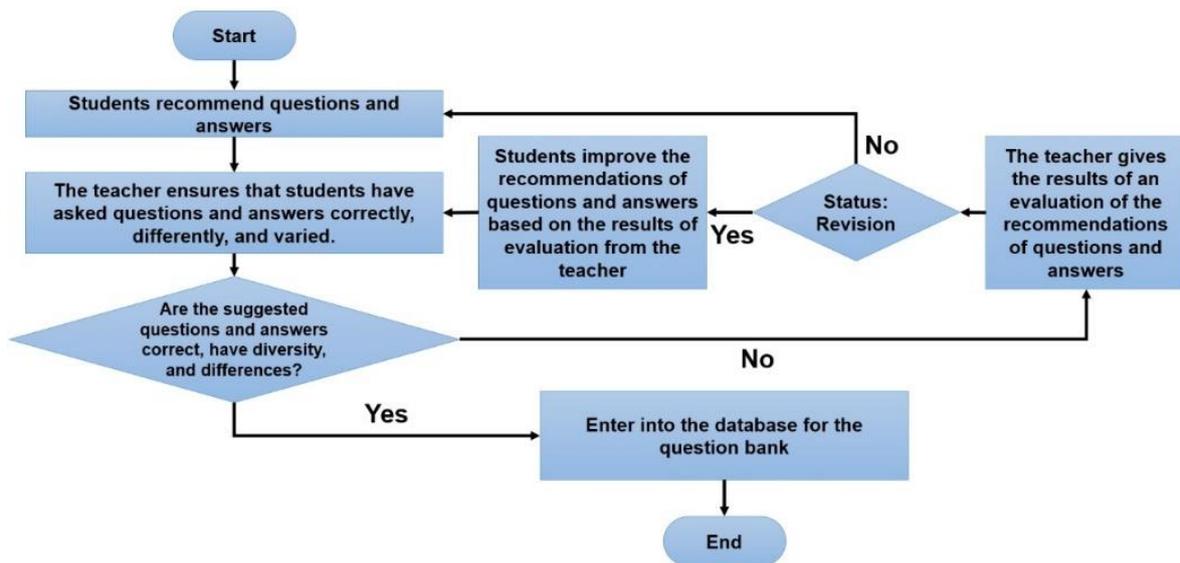


Figure 5. Flow Chart for Protocols in Verifying Questions and Answers

From the flow diagram of Figure 5, for the protocol in verifying the recommendations of questions and answers, students must first go through a process to recommend questions and answers, then the teacher must ensure whether the questions and answers to recommendations by students are correct, different, and have diversity. If it meets the protocol, it is directly entered into the database for the question bank. If it does not fulfill, the teacher will give the results of an evaluation in the form of what is corrected by the students from the recommendations to questions and answers. Then the teacher states the status, whether revised or not. If revised, the students correct according to the instructions that have been delivered by the teacher, and re-enter the recommendations of questions and answers into the system, until it is certain to have successfully entered the question bank. If it is not revised, students must make a (recent) recommendation of questions and answers that are certain to be correct, have differences and diversity.

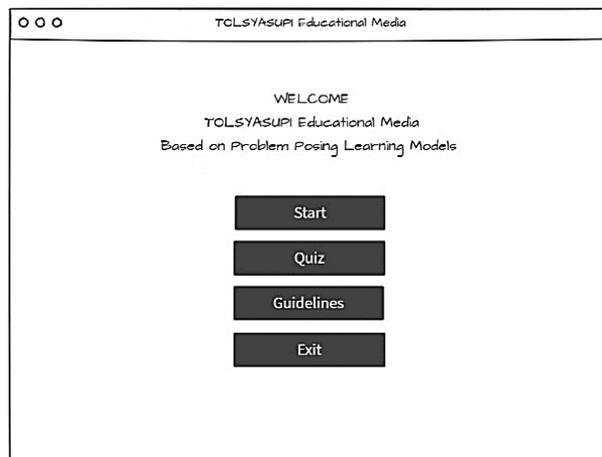


Figure 6. Main Page Interface Design

Figure 6 is a design of the main page interface, made simple, consisting of 4 buttons, namely start, quiz, guidelines, and exit.

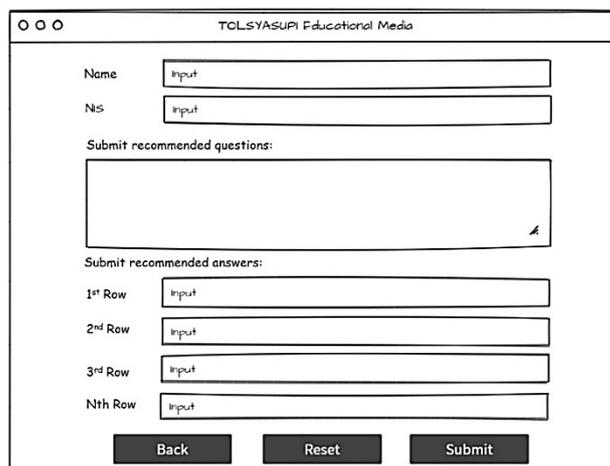


Figure 7. Design Submission Questions and Answers Page

Figure 7 is a draft interface page for asking questions and answers, which is the main syntax of the problem-posing learning model, namely students are required to ask questions freely in connection with the material delivered by the teacher at the previous meeting, then in this educational medium, the students are added. In this educational media, we adhere to the system proposed by [10] with close-posing on math subjects. However, the more side that we offer in this educational media is problem-posing with the type of open-posing, with basic programming subjects, and also raising pages for submitting questions and answers. In the form name and student number, the system is intended so that the system can detect who has and has not asked questions and answers, and how many times they submitted it. On the form to submit a recommendation for questions, students fill in questions according to the scope of the material. Then in the form to submit a recommendation for answers, students fill in the answers in the form of the order in the lines of the appropriate program code. There is also a back, reset and submit button.

The screenshot shows a web browser window titled 'TOLSYASUPI Educational Media'. The page contains a login form with two text input fields labeled 'First Name' and 'Last Name'. Below the input fields is a dark button labeled 'Continue'.

Figure 8. Interface Design Login Page on Quiz

Figure 8 is the interface design of the login page when students will complete the question.

The screenshot shows a web browser window titled 'TOLSYASUPI Educational Media'. The page displays 'Question Number' and 'Timer' fields. Below these is 'Question 1' with a list of items (1, 2, 3). At the bottom, there are three lines of 'Program Code Lines' and two buttons labeled 'Outline' and 'Submit'.

Figure 9. Interface Design Page Drag and Drop Interaction Quiz Sequence

Figure 9 is the design of the quiz page interface that we named Sequence Drag and Drop Interaction Quiz. Where students will interact by arranging the lines of program code in the correct order, which they must first examine the questions that arise and make sure the sentence cards are arranged correctly.

The screenshot shows a web browser window titled 'TOLSYASUPI Educational Media'. The page is titled 'Result page' and contains a table with the following data:

Total Questions	Score	Time Required
30	100	00:20:01

Below the table is a dark button labeled 'Preview'.

Figure 10. Design Results Page Interface

When students have completed all the quizzes, they will automatically bring up a results page in the form of obtaining the value and their working time, see Figure 10. Also provided is a preview button that later serves as a button for students to see feedback from their performance after completing the quiz in the form of information about which questions are right and wrong, which they have done.

Figure 11 (a to g) is a simulation of the usage scenario of the TOLSYASUPI-EduMed design, which will be applied to the branching control structure material for basic programming learning.

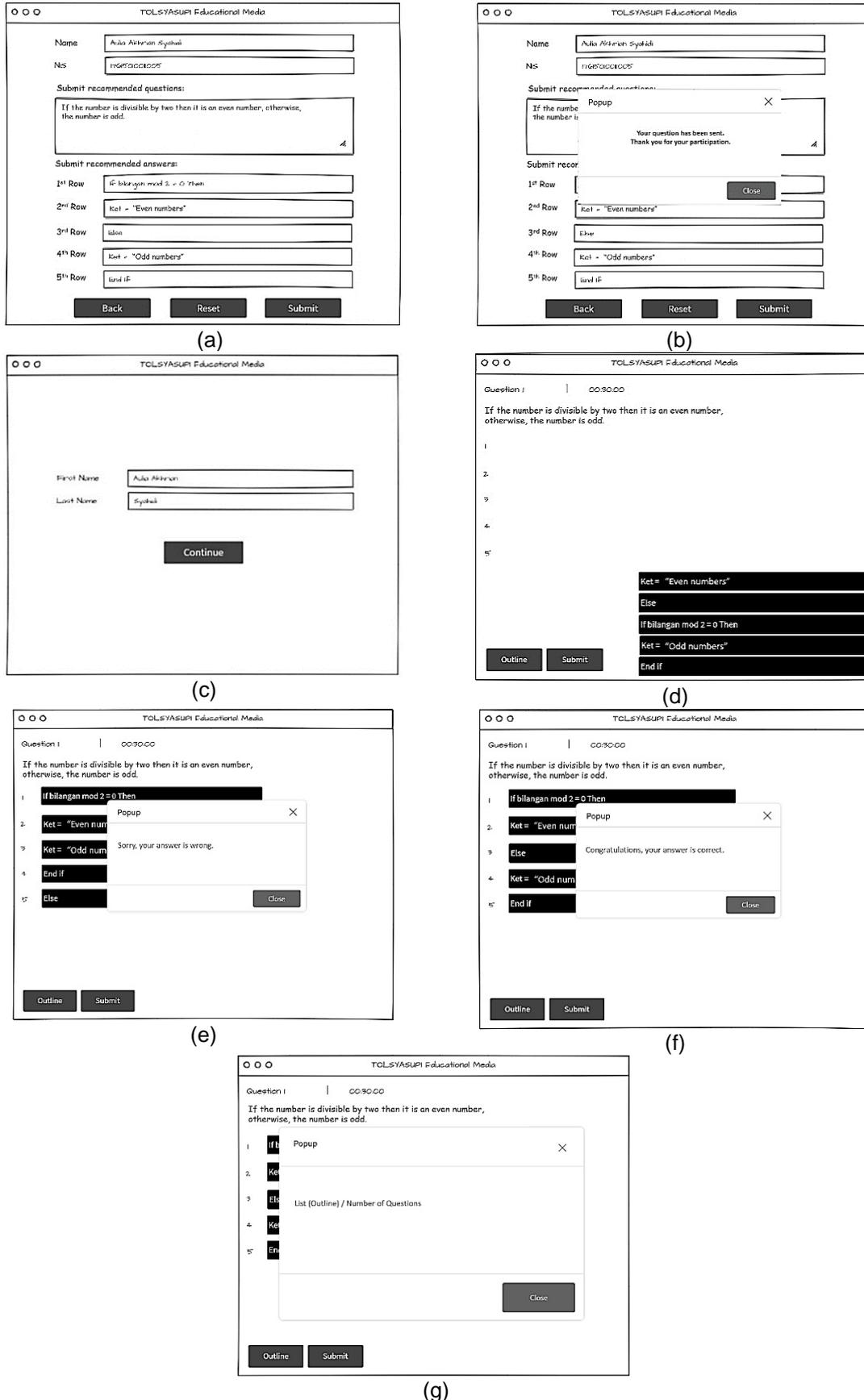


Figure 11. Design of the Simulation of the Use of TOLSYASUPI-EduMed

Functional analysis in the design of this educational media, to find out what components are needed and desirable expectations from the TOLSYASUPI-EduMed, are presented in Table 1. This functional analysis will be involved when conducting black box testing when educational media has been developed.

Table 1. Functional Analysis of the TOLSYASUPI-EduMed Design

Number	ID	Components	Expected Result
1	SB	Start Button	Users can access the start button to go to the page asking questions and answers
2	QB	Quiz Button	Users can access the quiz button to go to the question completion page
3	GB	Guidelines Button	Users can access the guidelines button to display information on how to use the application
4	ExB	Exit Button	Users can access the exit button to exit completely from the application
5	NF	Name Form	Users can access and fill in the name form
6	NsF	NIS Form	Users can access and fill out NIS forms
7	AFQ	Ask Form Questions	Users can access and fill out forms to ask questions
8	SFA	Submit Form Answers	Users can access and fill out forms to submit answers
9	BB	Back Button	Users can access the back button to return to the main page
10	RB	Reset Button	Users can access the reset button to delete all data entries on all forms
11	SB1	Submit Button 1	Users can access the submit button to send questions and answers to the system
12	PN1	Popup Notification 1	The system sends a notification that the question was submitted successfully, the user can find out
13	CBatPN	Close Button at PN	Users can access the close button in notification popup 1 to exit the notification
14	FNF	First Name Form	Users can access and fill in the first name form
15	LNF	Last Name Form	Users can access and fill in the last name form
16	CB	Continue Button	Users can access the continue button to proceed to the problem solving page
17	OB	Outline Button	Users can access the outline button to see a list of questions
18	SB1	Submit Button 2	Users can access the submit button to send answers to the system
19	QN	Question Notification	The system can bring up notifications of questions to what users can see
20	TN	Timer Notification	The system can bring up a timer system to provide workmanship quota to users, users can see it
21	DDB	Drag and Drop Button	Users can access the buttons that can be carried out drag and drop action to properly arrange the program code line
22	PN2	Popup Notification 2	The system sends a notification that your answer is incorrect / correct, the user can see it
23	RPN	Result Page Notification	The system can bring up information about the results obtained by the user when they have completed all the questions on the quiz, the user can see the score and processing time
24	PB	Preview Button	Users can access the preview button to check information about feedback in the form of any questions whose answers are right or wrong

3.5 Design Validation and Revision

After the design selection using the A/B testing method, it has been ensured that the design of this type B educational media has been regularly validated by experts and practitioners who also fill in the results of suggested

A/B Testing - Validation of Selection of TOLSYASUPI-EduMed Educational Media Initial Design

Hint:

- This validation sheet is intended to explore information and decisions from Mr/Mrs as Experts in assessing and selecting designs/initial designs from the educational media called TOLSYASUPI-EduMed.
- The instrument used on this validation sheet was adapted from R. Kohavi and R. Longboham (2015) and Siroker D, Koomen P (2013).
- The assessment, decision, suggestion, and criticism of Mr/Mrs are very useful to determine the initial design of this TOLSYASUPI-EduMed educational media to proceed to the development stage.
- In connection with this matter, please Mr/Mrs to give their choice by giving a mark on one of the designs we propose, giving the following score:
81% -100%: Very Strong
61% -80%: Strong
41% -60%: Enough
21% -40%: Weak
0% -20%: Very Weak
- Comments and suggestions from you, please write them in the column provided.
- For your help and willingness, we thank you.

Expert Name

Your answer

A/B Testing

Choose the initial design of the following educational media!

Design A



Design B



Design A

Design B

Score:

Your answer

Reasons for Choosing Design / Suggestions / Comments

Your answer

Figure 12. A/B testing Method Questionnaire

From Figure 12 is a questionnaire for the initial design selection which can also be accessed in the following link: <http://bit.ly/ABTestingValidation>, where experts are faced with two designs, then they check by accessing a separate file that contains the detailed form of each design is submitted, after that they make a selection by voting, giving a score, and giving reasons for choosing a design, suggestion, or comments.

The results of expert validation to determine the initial design of educational media using the A/B testing method are presented in Figure 13 and Figure 14.

One of the recommended designs with the highest value is based on Figure 13 and the comments in Figure 14 are design B with a value of 90.9%, experts strongly agree. This A/B testing is only done once because the value has exceeded 75% and experts have agreed on design B. This design B educational media adheres to the strength of the problem-posing learning model, which most experts agree with the type of open-posing, which is giving students the opportunity to ask questions into their systems through educational media, so as to encourage, sharpen knowledge, and ways of thinking students, then recommend other students to solve questions in the quiz section, where the questions raised in the quiz section are questions that have been asked by previous students. The questions presented in the quiz section are in the form of lines of program code arranged randomly. The students will first understand what problems they have to solve based on questions, then answer them by arranging the lines of program code lines to be structured and appropriate according to the rules of the programming language that will be used later.

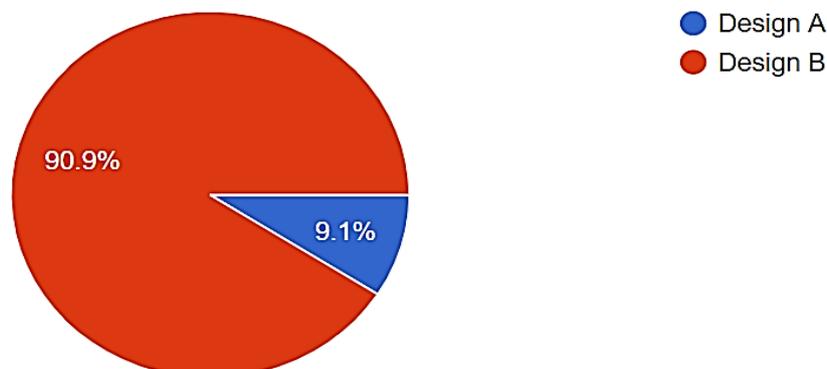


Figure 13. Diagram of the Results of the Initial Design Selection

Reasons for Choosing Design / Suggestions / Comments

11 responses

I tend to like design B because it's quite simple and tends to be easy to use.
Tend to design B, because it is detailed and simple.
From the interaction side, it tends to be more comfortable design B, UX and UI are also quite supportive
Tend to design B, very simple, but good.
Design B with an attractive UI and UX tend to be good. Simple.
I like the design B, especially when asking questions.
Because it is quite interesting and clear.
It tends to be very interesting, detailed, and I like the quiz design with drag and drop.
I like the quiz section.
Complete and unique.
Unique, very simple, but has a good contribution to propose and solve problems in programming. The quiz section is also for practicing student thinking flow.

Figure 14. Results of Reason/Comments Selection of Initial Design

Researchers make periodic improvements to the design of educational media by the results of validations from experts and practitioners. So, it can be recommended to develop the next stage by adjusting R&D research thoroughly. After the design of educational media was improved, the design of educational media was tested internally which will be carried out in the next research plan for the stages of the development process of TOLSYASUPI-EduMed which might consist of three validation aspects, namely assessing the suitability of educational media as learning media, problem design aspects, and the usability aspect will be done 3rd times validation iterations if possible. Validation is carried out through focus group discussions, where experts and practitioners are asked to provide assessments and suggestions for improvement at the development stage of TOLSYASUPI-EduMed, after validation is done and the results are feasible, but it cannot be denied that it is always validated again until the development stage and reaches the stage end, if it has been completed and appropriate to ensure that this educational media is feasible to be implemented in actual learning for research purposes.

4. Conclusions and Future Work

Based on the design of educational media that have been proposed under the name TOLSYASUPI-EduMed, it is hoped that it can be one solution to solve the problem of students' difficulties in learning the material of branching control structures in basic programming learning. TOLSYASUPI-EduMed's educational media has embraced the syntax of the problem-posing learning model with the type of open-posing, where if viewed from several other educational media in the basic programming domain, it is still minimal in instilling the syntax of learning models in the flow of educational media interactions. The design that has been produced is through extracting information from the side of user experience from potential media end-users and also experts and practitioners. TOLSYASUPI-EduMed's educational media has been validated by experts and practitioners with very good results, but validation continues until the final stages of development and ensures that this educational media product is feasible after going through several stages of validation and testing. Functional analysis of TOLSYASUPI-EduMed needs has also been proposed.

The future work that we are proposing is to perfect all stages to develop TOLSYASUPI-EduMed, then carry out various kinds of validations with several aspects, test, and implement them in the process of basic programming learning in real classes.

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