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Engaging Vocational Students with Construct-Based Games: A Study on Software and Game Development Interest

Althaf Dhava Mureno[a,1,*], Aede Hatib Musta'amal[b,2]
[a] Faculty of Engineering, Universitas Negeri Malang, Malang, Indonesia
[b] Faculty of Social Sciences and Humanity, Universiti Teknologi Malaysia, Johor Bahru, Malaysia
[1] althaf.dhava.1905336@students.um.ac.id*; [2] aede@utm.my
* corresponding author

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ABSTRACT

The transformation of learning in the era of technological disruption and the pandemic has caused face-to-face classroom learning to transform into online learning or blended learning. Basic Software and Game Programming lessons have skills in identifying and applying how to develop software and games properly. In the school environment, there are still many students experiencing difficulties in fostering interest in learning; this is because the process of honing their skills in the form of media is less attractive. This research focuses on developing a website-based educational game learning media for Basic Software and Game subjects with the scope of Structured Programming elements that can increase students' interest in learning. The development methodology applied in this research is the MDLC model. The MDLC development model has six research components, including (1) Concept, (2) Design, (3) Material Collecting, (4) Assembly, (5) Testing, and (6) Distribution. This research will use a questionnaire as a research instrument, and the selection of analysis techniques in this development uses quantitative analysis.

I. INTRODUCTION

The development of technology and science that occurred in the era of disruption and pandemic became rapid; this triggered a change in every aspect of human life, including education. One of the changes in education is that the learning method has undergone a change that creates new learning, namely blended learning or face-to-face learning to online learning. [1]. The advantages of learning with technology are that it can create an effective learning climate for slow learning students, stimulate them to do exercises, and adjust learning understanding according to ability. [2]. One of the supports in the world of education is learning media. Learning media is anything that can be used to channel messages to stimulate students' attention and interest and achieve learning objectives. [3].

The benefit of learning media with the use of technology today is that it helps students in learning activities; they do not need to come to schools or certain educational institutions. [4]. They can access learning media anywhere and anytime using technology such as the Internet, smartphones, or computers. The forms of learning media used today are video, animation, interactive games, and others. Interactive learning media is designed to help teachers present teaching materials, and it is hoped that students will easily understand what is being conveyed. In addition, the learning media can be modified to make it more exciting and easier to understand and make the learning atmosphere fun. [5].

The utilization of interactive learning media has been applied at various levels of school, including in vocational education at Vocational High Schools (VHS) [6], [7], [8], [9]. VHS is one form of formal education that organizes honesty education in secondary education as a continuation of Junior High School. VHS education aims to prepare graduates who are competent in the world of work, can socialize in society, and meet professional needs and the needs of future generations to face the era of global competition.

Fundamentals of Software and Game Development is a subject that contains competencies that underlie the mastery of software development skills and game technology. This subject is equipped to understand customer needs and wants and User Experience (UX) in the design process as an application of customer-oriented principles.

Based on initial observations at Public VHS 9 Malang and VHS Telkom Malang, researchers found problems in learning the Basics of Software Development and Games, namely, as many as 80% of students experienced obstacles, among others: (1) Students tend to get bored with conventional media; (2) Students prefer to learn with educational media, and (3) Students prefer to play games. From these observations, the teacher's learning process still uses conventional methods, namely the lecture method and PowerPoint media. Hence, the teacher is the only center of the learning process. This is the cause of the lack of active students participating in learning the Basics of Software Development and Games.

Another problem found during the observation is the level of student interest in learning the basics of software development and games with structured programming elements, which is only 54% and included in the low category. Some of the things that result in students' lack of interest in learning the Basics of Software Development and Games with Structured Programming elements include the absence of enthusiasm or encouragement desired by students, which leads to interest, participation, and activeness, lack of interest in learning media and supported by students who are not fully familiar with Structured Programming. Lack of interest in student learning will have an impact on student achievement. [10], [11], [12]Therefore, to overcome these problems, a solution is needed in the form of innovations in the learning process at school, especially the learning media used.

Learning in the current era applies blended learning, which is combined or mixed learning. This method is present by mixing face-to-face learning with technology-based learning. Students can also access and follow the learning either online or offline. [13]. So that students can learn easily through technology anywhere and anytime, such as by using computers or laptops and smartphones at school or at home.

Based on the problems and research that have been described, this research is aimed at developing a learning media in the form of an interactive puzzle game with the title "Development of Construct-Based Educational Games in Learning the Basics of Software Development and Games to Measure the Level of Learning Interest of Vocational Students" so that it can be used for supplementary learning media in learning the basics of software programming and games at VHS. This interactive game-shaped learning media is web-based and has main features, including (1) Level, (2) Achievement, (3) Score, and (4) Health Bar. The objectives of the development research are as follows:

1. Developing Construct-based Educational Games for Learning the Basics of Software Development and Games
2. Measuring the validation level of Construct-Based Educational Game learning media on Learning the Basics of Software Development and Games
3. Measuring the level of Learning Interest from the development of Construct-Based Educational Games in Learning the Basics of Software Development and Games

II. METHODS

The development model in this research aims to develop a website-based educational game learning media for the Basics of Software Development and Games using the MDLC (Multimedia Development Life Cycle) model. The MDLC model is a model of developing a media or application that is a combination of visuals such as images, animated videos, and audio. [14].

This MDLC model has six stages: conceptualization, design, material collecting, assembly, testing, and distribution. This model is one of the most famous multimedia-based software development models. [14]. In practice, the six stages do not have to be sequential; they can exchange positions. However, the concept stage remains the first stage to be done.

The MDLC development model is intended for multimedia or learning media developers, so the development stages are based on the multimedia manufacturing process. By using this model, developers can use it directly without modifying other development models to suit the multimedia product to be created. It can help solve the problems being studied, and there is a correspondence between the names of the stages in the method and what is done at that stage so that it is more accessible and easier to understand how the development of multimedia devices will be carried out.

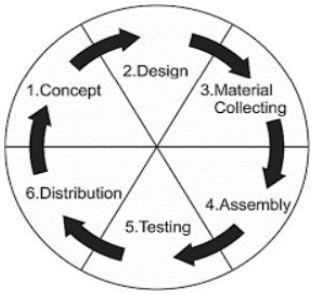

Fig 1. *Multimedia Development Life Cycle (MDLC)*

The MDLC method was selected based on the type of research taken, namely development research. Based on the picture, the following explanation can be given:

1. Concept: The concept stage is the stage to determine the initial concept and idea of developing a multimedia product. At this stage, data collection will begin in the initial observation. Then an analysis will be carried out to determine the user or audience and the purpose of the product being developed. At this stage, multimedia elements such as images, colors, text, and others will be adjusted to the interface and navigation of multimedia products.
2. Design: The Design stage is creating product specifications, including architecture, style, user interface,

and material requirements for the program to be developed. The design process is detailed to avoid making new decisions at the material collection and manufacturing stages. The design stage will use flowcharts and storyboards through the Figma application to describe the description of each scene and program flow.

3. Material Collecting: The material collection stage is carried out to collect materials or assets needed in the development of educational game learning media, "StackDCode." The material collection stage can be done in parallel with the assembly stage. However, it is also possible that the material collecting and assembly stages will be done linearly and not in parallel.
4. Assembly: The Assembly stage is the stage of making products based on wireframe designs and flowcharts and collecting materials such as images and materials that have been done before.
5. Testing: The testing stage is the stage of conducting a trial or trial and error of the product that has been developed. After passing the making of the application, it will be tested first to make sure there are errors before being tested on students. This stage is called the alpha test stage, where experts conduct testing.
6. Distribution: The distribution stage is the stage after the application product has been validated by material and media experts. Then, the product will be distributed as a feasible learning media so that it can be used by students and educators in schools. At this stage, the product will be stored in a storage medium such as a cloud or via the internet so that any student data will also be stored in the cloud database.

The collection technique is carried out to collect data used to determine the effectiveness and efficiency of the product developed. The stage is observation, followed by data collection using a questionnaire or questionnaire with a Likert scale of 1-5.

At the testing stage, severe expert validation will be carried out by media experts and material experts. Media expert validation is carried out using a media validation questionnaire to know the weaknesses and strengths of the learning media being developed. Media expert validation is carried out by media practitioners or lecturers who are experts in Game Evaluation Framework. In contrast, material expert validation is carried out by distributing material validation questionnaires so that the weaknesses and strengths of the learning material design developed can be known. Productive teachers of the Basics of Software and Game Development Subjects of the Software and Game Development Expertise Program carry out material expert validation. After obtaining and processing the desired data, it can be determined based on Table I and Table II below.

TABLE I Expert Validation Assessment Criteria

No	X-Score	Criteria	Follow-up
1	85% - 100%	Very Good	Very decent and does not need to be revised
2	70% - 85%	Good	Decent and needs a bit of revision
3	50% - 70%	Average	Less feasible and revised to taste
4	01% - 50%	Bad	It is not feasible and needs more revisions

TABLE II Interest Level Criteria

No	Percentage	Criteria
1	$81\% < Pm \leq 100\%$	Very High
2	$61\% < Pm \leq 80\%$	High
3	$40\% < Pm \leq 60\%$	Average
4	$20\% < Pm \leq 40\%$	Weak
5	$Pm \leq 20\%$	Very Weak

III. Result and Discussion

This research produced a Learning Media product, "StackDCode," in the form of Educational Games for website-based students. StackDCode is used as a supporting tool in the teaching and learning process and as a measuring tool for student interest in learning Basic Software Programming and Games. The MDLC (Multimedia Development Life Cycle) method is the development method. The MDLC method has six stages, including the following: (1) Concept; (2) Design; (3) Material Collecting; (4) Assembly; (5) Testing; (6) Distribution. In practice, the six stages do not have to be sequential; they can swap positions. However, the concept stage remains the first stage to be done.

The development of StackDCode has several advantages: (1) It can be used on various devices; (2) it can be accessed through the website; and (3) there is no need to install it. "StackDCode" has gone through several stages of testing, namely: (1) Media expert validation and (2) Material expert validation. The material is compiled based on the learning outcomes of the Basics of Software Development concerning changes in learning outcomes in the independent curriculum. The material is presented in text, PowerPoint, PDF modules, and learning videos that students can download. Table III shows the elements of the software and game development expertise program and the Basics of Software and Game Development subject.

TABLE III Software and game development skills program elements

Element	Learning Outcomes
Structured Programming	Learners can perform structured programming, including the application of data structures consisting of

static data (arrays of both dimensions, length, data types, sorting) and dynamic data (List, stack), the use of data types, looping, and branching control structures in software development projects and games.

Learning materials are obtained through the website of the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia, Modules, and the Internet. As for image illustrations using personal assets, it has been confirmed that the illustrations are free from copyright. Use Adobe Photoshop CC 2019 and Adobe Illustrator CC 2018 for image illustration maker applications. Product creation using an application called Construct 3. Construct 3 is an HTML5-based game maker application or tool specialized for 2D platforms developed by Scirra. In making applications using Construct 3, there is no need to use a special programming language because all commands used in EvenSheet consist of events and actions. The design and material that has been prepared will be realized through the application.

Web-based educational games can be accessed through the website https://stackdcode.itch.io/stackdcode using smartphone devices and computers or laptops to facilitate the process of creating a teaching and learning atmosphere between educators and students that is more interactive and more fun. The developed StackDCode features are described as follows.

A. Level

Fig 2. Level StackDCode

Level selection has three options, and students will be able to enter the next level by completing three projects in each level, and automatically, the next level will be opened; this is done so that there is no cheating, and students can focus more on each level played. Each level has a different level of difficulty. Including the following:

1. Level 1 Stack by Code: Students will complete a game as a stacking puzzle project based on the missing code and programming algorithm that will be the answer choice.
4. Level 2 Stack by Algorithm: Students will complete a game as a stacking puzzle project based on programming algorithms and programming codes that will be the answer choice.
3. Level 3 Stack by Pseudocode: Students will complete a game as a stacking puzzle project based on program output and programming pseudocode, which will be the answer choice.

Each level has three projects that students must complete. Students can enter the next project by completing one project at each level, and the next project will automatically open; this is done so that there is no cheating, and students can focus more on completing each project. Each project has different problems or problems, including the following:

1. Level 1 Stack by Code:
    1. Addition Programming
    2. Branching Programming
    3. Addition and Averaging Programming

Fig 3. Level 1 StackDCode

2. Level 2 Stack by Code:
    1. Programming the Perimeter and Area of a parallelogram
    2. Programming Sum of 2 Matrices
    3. Student Assessment Programming

Fig 4. Level 2 StackDCode

3. Level 3 Stack by Code:
    1. Programming Circle Area Calculation
    2. Age Selection Programming
    3. Tax Programming

Fig 5. Level 3 StackDCode

B. Achievement

Fig 6. Achievement

The achievement feature is used as a result of students completing a level every time they play StackDCode. It also stimulates students' interest in learning. [15] To achieve a goal of earning stars as a form of appreciation for completing a level.

C. Score

Fig 7. Score

The score in StackDCode has two values, namely the addition and subtraction of points. If the student answers with the correct puzzle arrangement, the system will display a pop-up that tells the addition of 5 points; if the student answers with the wrong puzzle arrangement, the system will display a pop-up that tells the reduction of 3 points.

D. Health Bar

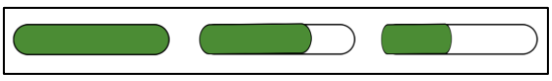

Fig 7. Health Bar

Health Bar or Life Capacity in StackDCode has three rows. Lives will be reduced if the student answers with the wrong arrangement, and if the life runs out, the student will repeat the project. This feature is given to the StackDCode system so that students can be careful when arranging puzzles, and it will pose a challenge for students.

This study validated media and material experts with respondents as validators, namely lecturers of Informatics Engineering Education, State University of Malang, and VHS Telkom Malang City teachers. Media expert validation aims to know the level of feasibility of learning media that has been developed. The results of media expert validation are shown in the following Table IV.

TABLE IV Media Experts Validation Results

No	Aspects	Tsev	Tsh	Percentage	Criteria
1	Software Engineering	36	40	90,00%	Very Good
2	Learning Design	50	55	90,91%	Very Good
3	Communication Visual	41	45	91,11%	Very Good
	Total	**127**	**140**	**90,71%**	**Very Good**

Based on the results of media expert validation, StackDCode has very feasible criteria. This is based on Table IV, which shows that the results of the media expert validation carried out get a percentage value of 90.71% and are included in the criteria very feasible. In the media expert validation stage, the Software Engineering aspect gets a value of 90.00%, the Learning Design aspect is 90.91%, and the Visual Communication aspect is 91.11%. From the results of media expert validation, validators provide suggestions for adding a zoom feature in the coding section because the image is too small when accessed via a mobile device and instructions for users or students who want to start using learning media even though a Help menu has been provided on the Home Menu.

TABLE V Revision media expert validation

Before	After
	
	

Material expert validation aims to know the feasibility of the material used in learning media. The results of material validation are shown in the following Table V.

TABLE VI Material Experts Validation Results

No	Aspects	Tsev	Tsh	Percentage	Criteria
1	Content Quality	31	35	88,57 %	Very Good
2	Learning and Goal Alignment	18	20	90,00 %	Very Good
3	Feedback and Adaptation	14	15	93,33 %	Very Good
4	Motivation	9	10	90,00 %	Very Good
5	Presentation Design	13	15	86,67 %	Very Good
	Total	**85**	**95**	**89,47**	**Very Good**

StackDCode has very feasible criteria based on the material expert validation results. The results of the material expert validation carried out get a percentage value of 89.47% and are included in the criteria as very feasible. In the material expert validation stage, the Content Quality aspect received a score with a percentage of 88.75%, the Learning and Goal Alignment aspect received a score with a percentage of 90.00%, the Feedback and Adaptation aspect received a score with a percentage of 93.33%, the Motivation aspect received a score with a percentage of 90.00% and the Presentation Design aspect received a score with a percentage of 86.67%.

This study conducted product trials to measure grade X students' learning interest in Basic Software Programming and Games with Structured Programming elements. StackDCode learning media was tested on X RPL class students taking Basic Software Programming and Games.

The product trial was conducted at VHS Telkom Malang City. The subjects of the StackDCode learning media product trial were 2 X RPL classes, namely X RPL 7 class with as many as 33 respondents and X RPL 8 class with as many as 34 respondents, so the total respondents obtained were 67 respondents. The assessment will direct respondents to access StackDCode learning media through the itch.io hosting website. Then, respondents are directed to start exploring learning media from the help menu for guidance on how to use StackDCode learning media to select levels and projects that have been developed.

TABLE VII Data on the level of interest in learning X RPL 7

No	Aspects	m	M	Percentage	Criteria
1	Feeling happy	703	825	85,21 %	Very Good
2	Study Interest	764	990	77,17 %	Good
3	Student Engagement	907	1155	78,53 %	Good
4	Students Attention	958	1155	82,94 %	Very Good
	Total	**3332**	**4125**	**80,78 %**	**Good**

TABLE VIII Data on the level of interest in learning X RPL 8

No	Aspects	m	M	Percentage	Criteria
1	Feeling happy	743	850	87,41 %	Very Good
2	Study Interest	809	1020	79,31 %	Good
3	Student Engagement	920	1190	77,31 %	Good

No	Aspects	m	M	Percentage	Criteria
4	Students Attention	950	1190	79,83 %	Good
	Total	**3422**	**4250**	**80,52 %**	**Good**

After the data from the results of two respondents, namely class X RPL 7 and X RPL 8, which have been processed as a whole aspect, based on the two tables above, the following is a description of the aspects of each class. The Feelings of Pleasure aspect gets a value with a percentage of 85.21% for class X RPL 7 and 87.41% for class X RPL 8. Both classes are included in the high criteria for the level of interest in learning. The feeling of pleasure aspect includes indicators of enthusiasm and desire to learn, which affect student motivation. [16].

The Learning Interest aspect gets a score with a percentage of 77.17% for class X RPL 7 and 79.31% for class X RPL 8. Both classes are included in the High criteria for the level of interest in learning. Based on previous studies, learning interest influenced student motivation. [17]. The Learning Interest aspect includes indicators of material depth, enthusiasm, and student behavior toward the material.

The Student Attention aspect scores 78.53% for class X RPL 7 and 77.31% for class X RPL 8. Both classes are included in the High criteria for the level of interest in learning. The Student Attention aspect includes indicators of learning focus, concentration, and observing problems in the material. [18].

The Student Motivation aspect gets a score with a percentage of 82.94% for class X RPL 7 and 79.83% for class X RPL 8. The two classes have different criteria; for class X, RPL 7 is high, while for class X, RPL 8 is High. Aspects of Student Motivation include how to solve problems, persevere in tasks, and be tenacious in facing difficulties.

Based on the results of two respondents' data after using the StackDCode learning media that has been developed, both classes, namely class X RPL 7, have a total value of 80.78% learning interest level, while class X RPL 8 has a total value of 80.52% learning interest level. So, it can be concluded that class X RPL 7 and class X RPL 8 are highly interested in learning after using StackDCode learning media. This is supported by previous studies, which state that interactive technology can increase student learning interest. [19], [20], [21].

IV. Conclusion

Based on the research and development that has been carried out, it can be concluded that StackDCode learning media can be used to measure student interest in learning the subject of Basic Software Programming and Games.

Research and development that has been carried out produce a product in the form of StackDCode educational game learning media that can be used to learn the Basics of Software Programming and Games with Level, Achievement, Score, and Health Bar features. Learning media can be accessed through the itch.io website using various devices such as smartphones, laptops, and other devices so students can learn anywhere and anytime. It aligns with the first research objective, Developing Construct-Based Educational Games on Learning the Basics of Software Development and Games.

The results of the media expert validation assessment on StackDCode obtained a percentage of 90.71%, which was included in the criteria, which was very feasible by adding a zoom feature to clarify the code used. Then, the material expert validation assessment on StackDCode obtained a result of 89.47% with feasible criteria. So, it can be concluded that StackDCode is very feasible to use, and this is in line with the second research objective, namely Measuring the validation level of Construct-Based Educational Game learning media in Learning the Basics of Software Development and Games.

The process of assessing the level of learning interest in StackDCode was conducted in 2 classes, namely class X RPL 7 and X RPL 8, with 67 respondents obtaining a percentage result of 80.78% for class X RPL 7 and a percentage result of 80.52% for class X RPL 8. With the values obtained from the two classes, it can be said that they have a level of learning interest with high criteria. This aligns with the third research objective: Measuring the level of Learning Interest from the development of Construct-Based Educational Games in Learning the Basics of Software Development and Games.

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