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Gamification based mobile application as learning media innovation for basic programming lessons

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Abstract. Basic Programming is a productive subject in the study of ICT Vocational High School programs that require students to develop information systems in accordance with the times. Lack of applicative material in basic programming subjects is a problem that is often encountered so that the level of critical thinking of students is less than optimal. In addition, the level of student interest in these subjects is less than optimal because of the monotonous implementation of learning. The solutions offered through this study aim to produce gamification-based mobile applications as innovative and communicative learning media. The development method used is the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation). The result shows the total usability level is in 81.75%. Material validation shows the results in 88.89% and validation from media experts is 80.83%. Test results on the small group trial subjects shows 84.4% valid and the large group 85.22% valid. Based on the results of product usability testing and field trials, it can be concluded that the product is suitable for use as a medium in the learning process. The concept of gamification in this media also increases the attractiveness and motivation of users in order to obtain maximum testing results.

1. Introduction

Some aspects of life are have been influenced along with the development of technology, starting from the field of economy, politics, culture, art, and education. Especially in education, the advancement of ICT has changed the functioning of conventional books, teachers, and teaching systems [1]. ICT dimanfaatkan untuk menunjang pembelajaran menjadi efektif, salah satunya adalah dengan penggunaan mobile learning.

Impleentation of m-learning is an effort in utilizing mobile devices to support student learning process. M-learning dipilih akrena penggunaan perangkatnya yang portable, which means it can be easily used and access tge learning cotents while on moving and has the ability to connect to the internet which allowing users to have the latest and relevant learning contents [2].

Basic Programming is a C2 subject in a Computer Engineering and Information Technology expertise program that is appropriate for students to publish how to communicate with humans and computers to the fullest extent.

Lies Pebruanti [3] in her research stated that in the implementation there were a lot of obstacles which then made students lack the motivation to complete a program. Mustamin in Lies Pebruanti [3] mentioned that one of the obstacles was the limited learning resources received by students.

From the problems above, the researchers plan to develop a mobile application that can be used as a learning media for basic programming to meet the needs of student learning resources and minimize

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adverse effects on smartphone users by presenting valid and effective learning media on smartphones owned by students.

Applications will be develop inserting the concept of gamification. It is hoped that the developed application can attract the attention of students as targets and improve student behavior to use gamification-based mobile applications as a learning media for basic programming.

2. Literatures review

2.1. Gamification in education

ICT has been widely used in a variety of learning applications and gives positive results [4]. Utilization of ICT must also be followed by the implementation of creative and innovative learning models.

Gamification is the use of game design elements in non-game settings to engage participants and encourage desired behaviors. The dynamic of games has an influence on the popularity of gamification in the effort to enrich students' experiences in their learning journey, especially in a classroom [5]. gamification is not a product in the way that a (serious) game is; gamification in the context of learning is a design process of adding game elements in order to change existing learning processes [6]. However, as the popularity of gamification has increased. The present meta-analysis supports the claim that gamification of learning works because we found significant, positive effects of gamification on cognitive, motivational, and behavioral learning outcomes [6].

2.2. Rationale of mobile technology

Taking pictures, sharing them on social media, and finding the latest information are some things that humans do by utilizing ICT as part of their daily lives. So it is natural that gadgets and ICTs are also used in learning [7]. Over the past decade, increased connectivity has caused cellular technology to become very intertwined in students' daily lives. Dahlstrom and Bichsel, wrote that 99% of undergraduate students have devices that support mobile Internet, including 86% who have smartphones and 47% who have tablets [8]. This increased ownership of mobile devices exposes teaching staff in higher education to unique opportunities to explore the potential and positive use of these devices for educational use. This is supported by Bowen and Pistilli [9], who have determined that 83% of students use their smartphones for educational purposes, 49% of whom prefer to use mobile applications related to education.

Understanding students' preferences and embracing technology can allow pedagogical practises to develop in new and innovative ways. This can translate into positive uses within education as this understanding can also influence the creation of new mobile services that can help students be more successful [10].

2.3. Rationale of mobile game

Many studies have reported the efficiency of using educational games to teach a particular subject [11]. While the device that is currently the most widely used is a mobile device (smartphone) [12]. Within the past decade, a growing number of educational scientists have started to recognize the multifaceted potential that mobile learning games have as a tool for learning and teaching [13]. Game-based learning has been widely applied as a solution of learning media innovation. One of them is the implementation of Game-based learning and gamification approaches in learning process, giving the result that the games enhance student motivation and this means improvement also in knowledge acquisition. It could be a promising solution, since there is much experimental evidence that it proves their effect [14].

In other studies, innovative teaching methods including games and simulations are also used. Two researchers collaborate to apply a qualitative method, coding and synthesizing the results using multiple criteria. The main objective is to study the impact of games and simulations with regard to achieving specific learning objectives. On balance, results indicate that games and / or simulations have a positive impact on learning goals [15].

3. Methods

This research development uses the RnD (Research and Development) method with a quantitative descriptive approach. The research method used refers to the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) method. The research instrument was a questionnaire with a Likert scale. Product effectiveness is measured using 3 research variables namely material aspects, media aspects, and usability aspects.

The population of this study were students majoring in software engineering at SMK Negeri 10 Malang. The subject of the research was class X students who were taking basic programming subjects of 30 students.

The first stage in this study is the analysis phase, at this stage the analysis is carried out to determine the needs of students including the needs of students who are targeted by the application. Then competency and instructional analysis is also carried out covering core competencies and basic competencies as material to be contained in the developed application. System analysis is carried out to define the description of a complete information system into its component parts including functional and non-functional requirements.

The second stage is the design stage, based on the results of the analysis, the next stage is the design phase or product design which includes stages, namely: (a) making media design (storyboard), (b) determining the material, (c) preparing questions and answers, (d) review the suitability of subjects with the curriculum, and (e) the collection and manufacture of background images.

The material presented in this mobile application refers to the basic competencies listed in the Decree of the Director General of Primary and Secondary Education Number 330/D.D5/KEP/KR/2017 concerning core competencies and basic competencies of software engineering skills in basic programming subjects.

The third stage is application development. At this stage of development, researchers do several things, namely: (a) the manufacture of mobile application products in accordance with the concepts that have been designed by researchers, (b) validation of media experts, material experts, and usability tests using a questionnaire. Making mobile application products using React Native. While product validation in the form of media validation and material validation is done by 1 material expert and 1 media expert by filling out the product validation questionnaire. To see the level of usability of a product, product usability testing is done by admin users and teachers. The results of this product validation produce qualitative data in the form of criticisms and suggestions as well as quantitative data in the form of statistical calculations. The validation aims to measure the validity or feasibility of the learning media before being tested in the field using an instrument in the form of a questionnaire.

The following is the formula for calculating the validity of an instrument based on Sa'dun Akbar [16]:

$$\mathrm{Va} = \frac{\mathrm{TSe}}{\mathrm{TSh}} \times 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where is :
Va : Validity of experts
Tse : Totalskor empirical
Tsh : Maximum Total Score

$$\mathrm{Vp} = \frac{\mathrm{TSe}}{\mathrm{TSh}} \times 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where is :
Vp : Validity of the user
Tse : Total empirical score
Tsh : Maximum Total Score

The fourth stage is the implementation phase. The implementation phase of this product was tested in 1 class consisting of 32 students. The trial was conducted with an Android smartphone that is owned by each student. Then testing is done through a questionnaire to measure and find out the opinions or responses of students regarding the gamification-based mobile application as a learning medium for Basic Programming being developed.

The fifth or final stage in this study is the evaluation stage. In this study, the evaluation stage was not carried out, because the study only focused on developing and testing the feasibility of the application.

4. Result and discussions

The developed mobile learning media consists of a splashscreen page, the first page that appears when the user opens the application on a smartphone, and the main menu page, the starting page that appears after the splashscreen, which is also the core page for learning media, because from this page the user can access all menu served. On this page the user can choose the profile menu, about us, my course, or challenge.

The application of gamification is seen on the my course page where on this page sub-chapters of learning materials are sorted by level of difficulty. Then the material sub-chapters must be accessed sequentially, on learning media a session system is applied that will detect whether the previous sub-chapters have been studied by the user are marked by the completion of the quiz at the end of the sub-chapter. If the quiz at the end of the sub-chapter has been completed, the button for the next sub-chapter will automatically be active, but if it has not been completed, the next sub-chapter button will be in disabled mode.

In addition to the course page, the concept of gamification is also applied to the Challenge page. The Challenge page will be displayed when the user selects the challenge button on the main menu. On this page the user can choose several types of challenges or problems that can be solved by the user. For each challenge successfully completed, the user will get one reward or badge that will appear on each user's profile.

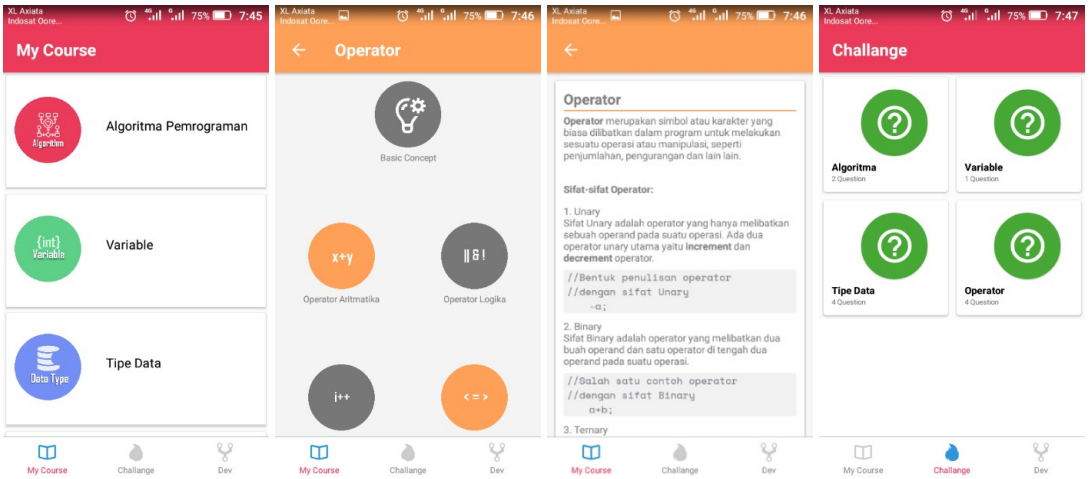

Figure 1. Interface of the developed mobile application product.

Trials have been conducted on material experts producing quantitative data including aspects of material suitability, material linguistic aspects, and supporting aspects of the presentation. In Table 1 is the validation results per aspect of the material expert.

Table 1. Validation results per expert aspect.

No	Assessment Aspects	T_{se}	T_{sh}	V%
1	Aspects of material suitability	33	36	91.67%
2	Material aspects of language	22	24	91.67%
3	Supporting aspects of the presentation	10	12	83.33%
	Total	65	72	
	On the average			**88.89%**

Based on the assessment guidelines according to Akbar [18], the percentage of the average value is classified as valid and feasible to use.

The second trial was carried out on media experts where in the test there was input in the form of selecting icons for each material presented and choosing colors for the material fonts, so it was necessary to make some revisions in that section. The results can be seen in Table 2 below.

Table 2. Validation results per medical aspect.

No	Assessment Aspects	T_{se}	T_{sh}	V%
1	Aspects of the suitability of the developed media	33	44	75%
2	Completeness aspect	33	40	82.5%
3	Communicative and interactive aspects	17	20	85%
	Total	83	104	
	On the average			**80.83%**

Based on the assessment guidelines according to Akbar [16], the percentage of the average value is classified as valid and feasible to use.

The next stage was an analysis of data from the results of a 10-student SMK Software Engineering expertise competence. Quantitative data was collected, including aspects of conformity, completeness, linguistic aspects, communicative and interactive aspects, supporting aspects of the presentation. The results of trials in small groups can be seen in Table 3.

Table 3. Test results for a small group.

No	Assessment Aspects	T_{se}	T_{sh}	V%
1	Appropriate media developed	339	396	85.61%
2	Completeness	344	396	86.87%
3	Linguistic	88	108	81.84%
4	Interactive and communicative	122	144	84.72%
5	Supporting Presentation	90	108	83.33%
	Total	983	1152	
	On the average			**84.4%**

Based on the results the user validity value is 84.4% and has been suitable for use.

The next step was to analyze the data from the results of the testing of 32 vocational high school students in the Software Engineering competence. Quantitative data was collected, including aspects of conformity, completeness, linguistic aspects, communicative and interactive aspects, supporting aspects of the presentation. The results of trials in small groups can be seen in Table 4.

Table 4. Test results for a big group.

No	Assessment Aspects	T_{se}	T_{sh}	V%
1	Appropriate media developed	1209	1408	85.87%
2	Completeness	1187	1408	84.3%
3	Linguistic	328	384	85.42%
4	Interactive and communicative	437	512	85.35%
5	Supporting Presentation	327	384	85.16%
	Total	3488	4096	
	On the average			**85.22%**

Based on the results the value of user validity is 85.22% and has been suitable for use.

The last step is user usability test by admin and teacher. In general there are five requirements or characteristics that must be met so that the application reaches an ideal level of usability, namely: learnability, efficiency, memorability, errors and satisfaction [17]. Data is collected from one admin and two subject teachers. The results of the usability test can be seen in Table 5.

Table 5. Distribution of materials based on competence.

No	Assessment Aspects	T_{se}	T_{sh}	V%
1	Learnability	237	240	98.8%
2	Efficiency	1050	1200	87.5%
3	Memorability	286	400	71.4%
4	Errors	338	400	84.5%
5	Satisfaction	636	960	66.3%
	Total			
	On the average			**81.75%**

5. Conclusion

The developed of mobile application can be used as a learning medium for basic programming. with this application the needs of student learning resources can be met and provide positive content on student smartphones. From the validation and reusability tests conducted, the gamification-based mobile application product as a learning medium has outputs that can be said to be valid and deserve to be used as a medium for learning. The developed media has also been declared suitable for use after going through the process of testing small groups and large groups.

References

[1] Elmunsyah H, Hidayat WN and Asfani K 2019 interactive learning media innovation: utilization of augmented reality and pop-up book to improve user's learning autonomy *J. Phys.: Conf. Ser.* **1193** 012031
[2] Asfani K, Suswanto H and Hidayat WN 2018 design of mobile application to improve the quality of vocational education *APTEKINDO* **4** 49.
[3] Pebruanti L and Munadi S 2015 improving motivation and learning outcomes in basic programming using modules in smkn 2 Sumbawa *Jurnal Pendidikan Vokasi* **5** 365.
[4] Deodhar OR and Mathur J 2019 *BMC Med Educ* **19** 38.
[5] Rahman RA, Ahmad S and Rabaah UH 2018 the effectiveness of gamification technique for higher education students engagement in polytechnic muadzam shah pahang, Malaysia *International Journal of Educational Technology in Higher Education* **15** 41.
[6] Sailer M and Homner L 2019 The Gamification of Learning: a Meta-analysis *Educ. Psychol. Rev.*
[7] Lameu P 2019 the case of the 'nasty trolley' or how mobile learning and tablets are influencing emotions and affects and shaping the constitution of the identity of teachers and students *Tech Know Learn*.
[8] Dahlstrom E and Bichsel J 2014 ECAR study of undergraduate students and information technology (Louisville: Research Report).
[9] Bowen K and Pistilli MD 2012 student preferences for mobile app usage *Educ. Cent. Appl. Res.*
[10] Dobbins C and Denton P 2017 MyWallMate: an investigation into the use of mobile technology in enhancing student engagement *TechTrends* **61** 541.
[11] Tlili A, Essalmi F and Jemni M 2016 improving learning computer architecture through an educational mobile game *Smart Learn. Environ.* **3** 7.
[12] APJII 2018 penetration & profile of Indonesian internet user behavior *APJII*.
[13] Schmitz B, Klemke R and Specht M 2012 effects of mobile gaming patterns on learning outcomes: a literature review *Int. J. Technol. Enhanc. Learn.* **4** 345.
[14] Pesare E, Roselli T, Corriero N and Rossano V 2016 game-based learning and gamification to promote engagement and motivation in medical learning contexts *Smart Learn. Environ.* **3** 5.
[15] Vlachopoulos D and Makri A 2017 the effect of games and simulations on higher education: a systematic literature review *International Journal of Educational Technology in Higher Education* **14** 22.

[16] Akbar S 2013 *learning instruments* (Bandung: PT Remaja Rosdakarya).
[17] Nielsen J 1993 *usability engineering*. (Boston: MA: AP Professional).