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The Construction of Isomorphic Physics (FORFIS) as Gamification-Based Application to Support Online Learning

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ABSTRACT
The learning process during the Covid-19 pandemic becomes monotonous and make students tired. Therefore, there is needed for a learning media based on gamification that can support online learning. This research was conducted to develop an android application that can be used in physics learning, especially in momentum and impulse materials. This program is an application based on gamification and more attractive for students. The developed application is called Physics Isomorphic (FORFIS). This research uses the ADDIE model (Analysis, Design, Develop, Implementation, and Evaluation) as development phases. The research data were obtained from a questionnaire containing 27 statements and analyzed using the ideal standard deviation score. The mean score result by expert judgement is 132.29, which is in the "excellent" category. The Application of Isomorphic Physics (FORFIS) is declared feasible to be used as a medium of physics learning.

INTRODUCTION

The development of education is currently influenced by the industrial revolution of 4.0, known as Education 4.0. This era affects learning activities that are required to utilize technology in its implementation. In this era, students study in the classroom, but they can also learn without limitation of space or time [1] [2]. Regarding the importance of technology-based learning, the world has recently been hit by covid-19 transmission very quickly. This situation causes typically classed learning to be diverted into online learning and utilizing technology [3]. Online learning should consider an effective learning process [4]. The problems faced during online learning are meagre participation of learners in online education and tasks completed to provide unsatisfactory results. This problem not only arises in Indonesia but becomes a global problem. The cause of this problem is the high level of saturation of learners due to monotonous learning. Therefore, educational technologists must provide learning facilities [5]. One of the methods is to provide technology-based learning resources. Learning resources are all around the environment that can help optimize learning outcomes [6]. Concerning technology, the learning resources offered can be developed as a learning medium by

utilizing the facilities around students. The availability of learning resources should also be considered so as not to increase the saturation of learners. Therefore, learning resources also need to be developed using a gamification base. This medium can stimulate thinking power and increase the concentration of learners in online learning.

In the era of industrial revolution 4.0, physics learning had to involve technology [7]. This method follows Regulation of Minister of Culture and Education No. 22 of 2016, which demands that the 2013 curriculum utilize technology in its implementation. Physics subjects are an essential field for students to learn. Students can study various natural phenomena and their interactions through physics subjects, both microscopic and macroscopic [8]. It can be studied interactions between atoms in the infinitesimal area, while in the macroscopic area, it can be studied interactions in the universe. Physics learning should be able to facilitate students to observe directly the phenomena that occur. One of the physical materials that can be observed is momentum and impulse [9]. Educators must be creative in learning to convey the material well , and the action causes saturation in learning because it cannot be observed directly through the illustrations provided.

The development of technology has a relation with physics [10]. Then, physics learning must also involve technology to make it easier for students to learn [11]. The most frequently used technology products that can be used as learning tools is smartphones. A survey conducted by the Association of Internet Service Providers in 2018 showed that 93.9% of respondents used a smartphone every day [12]. This phenomenon means that smartphones can not be separated from the community's activities, especially in Indonesia. Smartphone users referred to in the survey results consist of various circles, including students. Under the influences of the ministry of communication and informatics' ICT usage survey in 2017, 40.87% of primary school students already have smartphones, 59.89% of junior high school students, 79.56% of high school students, 93.02% diploma level, and 100% of bachelor, magister, and doctoral levels [13]. It shows that smartphones do not become foreign objects from different levels of education and have become part of student activities in their daily lives.

This situation becomes a tendency to develop a learning medium that can be operated using a smartphone. Related to the type of smartphone used by the Indonesian public, the results of the Internet Service Providers Association survey in 2018 provide information that Android-based smartphone users reach 96% while ios-based smartphone users only 3.1% [5]. It means that supporting learning media for self-learning students is those operated using android-based smartphones. Through android-based learning media, students can learn in any circumstances and anywhere.

Today's students are excited to explore the virtual world using a smartphone. It leads to the preferred learning model today being self-learning [14]. Students can search for learning materials in school independently with the help of smartphones and make use of internet facilities. Therefore, for students not to obtain inappropriate learning materials, education technology must be provided by developing technology products. Technology-based learning media can be e-books, electronic modules [15], learning applications, learning videos, learning animations, learning audio, and other media [16].

One of the physics learning media that can be utilized in industrial revolution 4.0 is teaching apps. The apps can be operated using a computer, PC, or smartphone. Android-based learning apps can easily reach learners [17]. It is because students today are already very dependent on smartphones in their daily life. By taking advantage of these students' tendencies, android-based learning apps can be developed to help students learn without limited space and time. Previous studies have revealed that the use of android-based learning apps can improve learning motivation [18], cognitive achievement [19], learning independence, and academic performance of students [20]. Research on physics-specific variables reveals that android-based learning applications can improve mathematical representation, interpretation of electrical circuits [21], understanding the concepts of physics [22], divergent thinking abilities, and also high order thinking skills [23].

It is necessary to develop an android-based physics learning medium. The product of this research is a high school physics learning apps named Isomorphic Physics (FORFIS). This app is a medium of

physics learning in questions, question exercises, and quizzes on momentum and impulse materials. The questions in this application are isomorphic so that it can make it easier for students to learn.

Isomorphic questions are a pair of questions that contain different problems but have something in common. The differences in this type of problem lie in the shape of the problem, difficulty degree, and problem's complexity [24]. In comparison, the similarity lies in the background of the problem [25] and the method to solve the problem [26] [27]. Isomorphic questions will give each other instructions to make it easier for students to practice using the application that will be developed. Thus, the purpose of the development of this application is to provide decent learning media and can be used by students to learn independently. The content in this study has been analyzed before and has been declared feasible for use in learning.

METHOD

The development model used in this study is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The total respondents are seven experts and ten students. The instrument collecting data are a questionnaire. The review questionnaire used contains 27 statement items, and the results are analyzed using the ideal score standard deviation with the following conditions. At the analysis stage, the identification of problems is carried out through observation activities and literature studies. The product of this stage is a guide in the creation of FORFIS apps. The design stage is the stage to construct FORFIS apps design according to students' needs.

Furthermore, the development stage is the stage to create FORFIS apps using Construct2 and PhoneGap software. The implementation phase is carried out to determine the feasibility of FORFIS apps. Its feasibility is obtained through the average calculation of the results of the expert judgement study. The next stage of development is the creation of apps with software using Construct2 and PhoneGap. Once the FORFIS prototype is created, it needs to be determined its validity through expert judgement using an expert validation sheet. The study questionnaire used 27 statement items, and the results were analyzed using the ideal score standard deviation with the following points. The validation sheet aspects are shown in Table 1.

Table 1. Validation Questionnaire Aspects

No	Aspek	Indikator
1	Appearances	Completeness of identity Suitability of menu appearances Suitability of quis Appearances
2	Software engineer	Instalation program Application platform Creativity and inovation

In the evaluation stage, the FORFIS was revised following the input of learning media experts so that products are ready to be disseminated. The research data was obtained by questionnaire with Likert's five scales. Then, the Ideal Standard Deviation was implemented as a data analysis technique. Its result was interpreted based on the product quality criterion in Table 2.

Table 2. Product Quality Criterion

Mean Score	Criteria
$\bar{X} \geq X_i + 1.8\ SB_i$	Outstanding
$X_i + 0.6\ SB_i \leq \bar{X} \leq X_i + 1.8\ SB_i$	Good
$X_i - 0.6\ SB_i \leq \bar{X} \leq X_i + 0.6\ SB_i$	Adequate
$X_i - 1.8\ SB_i \leq \bar{X} \leq X_i + 0.6\ SB_i$	Bad
$\bar{X} \geq X_i - 1.8\ SB_i$	Poor

RESULTS AND DISCUSSIONS

Observations made at several schools in the Province of Special Region of Yogyakarta and East Nusa Tenggara obtained information that students still have difficulty in problem-solving skills. In classroom learning, students are not very active when given questions related to problem-solving. The tendency is that students wait for the teacher to answer directly. Also, based on the results of the exercise questions, the problem-solving skills of students are still low. Based on literature studies, information is obtained to train students' problem-solving skills can be given exercises in the form of isomorphic questions. This problem type is a question that has concept similarities and method to solve the problems, but it differs in terms of the shape of the problem and the level of difficulty.

The observations also showed that students nowadays are accustomed to using smartphones based on android; even almost all students have personal smartphones. Besides, the school also does not prohibit students from carrying smartphones in school activities. Learning in the classroom also usually uses a smartphone to search for learning resources or information related to the material taught by the teacher. Therefore, there needs to be a learning medium in the form of the android application that can help students in self-learning activities.

The application developed is named Isomorphic Physics (FORFIS) which has meant the content of this application is in the form of isomorphic questions that have been declared feasible to be used to assess the analogy transferability of students [28] [29] [30]. The gamification aspect becomes a novelty of this program if compared to others application. This program has a quiz form to help students to review the physics concept in an acceptable method. It can relieve stress from the students.

The background view and the app icon are designed using Adobe Photoshop CS3, while the application system subscribes to construct2 software. The plan that has loaded the content and its appearance are then built into the form of apps to be operated using android smartphones used PhoneGap software available online. The main menu of the event sheet view of the FORFIS created using construct2 software is presented in Figure 1. The system used is causal logic. Each menu button comes with audio and a 0.5 second time to open the menu.

Fig 1. *Evensheet Menu on FORFIS*

Next, in Figure 2, the event sheet is presented on the quiz. The event sheet is created single, which contains common commands in the quiz. In the examination, the view appears the time and also the points set on this system. Additionally, incorrect and correct determinations are also made on this

event sheet. The quiz creation is easy because the question is collected to a notepad, and it is just inserted into the event sheet.

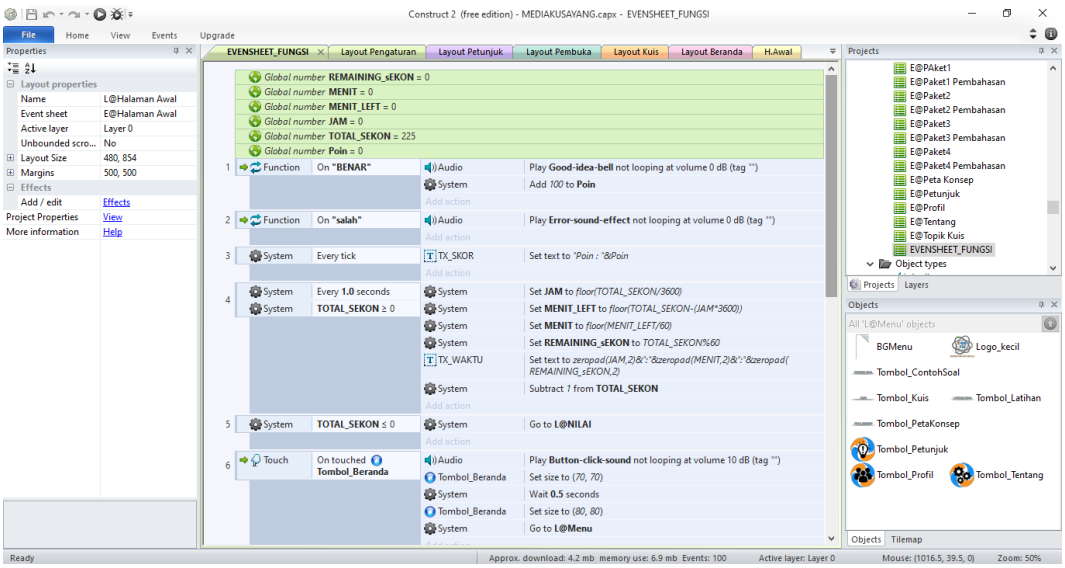

Fig 2. *The quiz system on Forfis apps*

The initial view of the developed FORFIS apps is presented in Figure 3. The initial background was created in a bright blend of East Nusa Tenggara (NTT) weaving motif with black colour for colour balance. The selection of NTT motives in the application's background is because the application was first used in one of the high schools in the NTT area. The menu view in the FORFIS app contains a 'select topic' button to make it easier to learn about existing sub-topics, a 'hint' button to make it easier to use the app. This button contains instructions for using the application. Next, the 'about' button contains the FORFIS application specification, the 'our profile' button contains the FORFIS app developer profile, and the last one is the exit button to exit the application.

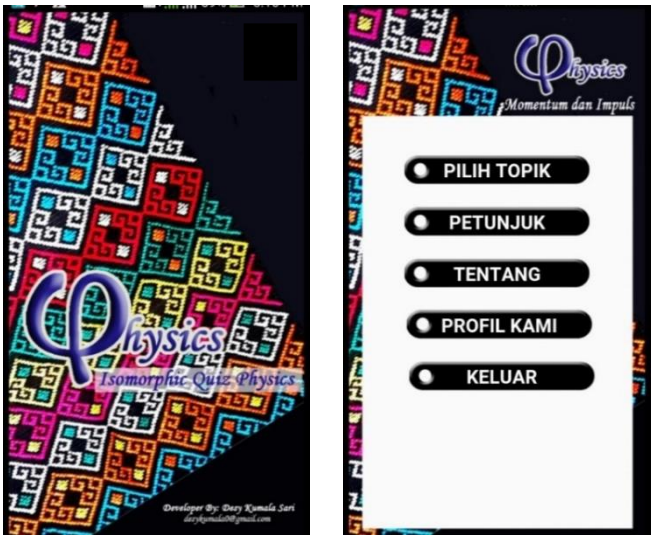

Fig 3. *The home view of Forfis apps (Scene 1 and 2)*

The FORFIS app has been developed then judged by seven experts, consisting of 1 (one) media expert, 2 (two) educational practitioners, and 4 (four) peer reviewers. The study instruments used contain statements regarding the feasibility of FORFIS apps in display and software engineering. The results then were analyzed using the ideal standard deviation. The average score of the FORFIS

application study is 132.29 according to the criteria in Table 3, so FORFIS is in the category of 'outstanding', which means that this application is worth using in physics learning in school.

Table 3. Product Quality Criterion

Mean Score	Criteria
X > 113.4	Outstanding
91.8 < X≤ 113.4	Good
72.2 < X ≤ 91.8	Adequate
48.4 < X ≤ 72.2	Bad
X ≤ 48.6	Poor

Although the FORFIS app has been declared feasible, some improvements need to be made. Experts' advice is to name applications that should use the Indonesian language, and the background should be white to be more comfortable to see for a long time, writing questions made left flat and detailed application instructions. The improvements did not change the system of the early-stage FORFIS application, but there was a change in appearance so that it looked a little different.

The home view of FORFIS can be seen in Figure 4. The name of the application, previously named Isomorphic Quiz Physics, was then replaced with Isomorphic Physics, abbreviated as FORFIS. The background colour combination is also revised to be comfortable to be viewed for a relatively long time.

Fig 4*. The revised home view of FORFIS*

The improvements to the quiz view are presented in Figure 5. The quiz view in the FORFIS app is improved to make it more interesting by adding a time and score icon. Before it, there was already a display of time and score, but to make it more attractive in icons. The answer selection button is also made more simple, as well as the view of previously centre-shaded questions is fixed using the aligned left.

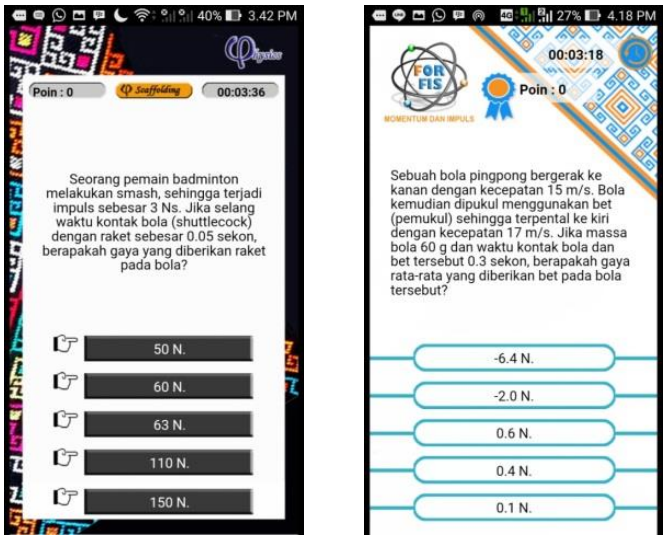

Fig 5. *The revision to quiz view of FORFIS*

The improvements to the menu view are presented in Figure 6. In the menu view, a concept map button, sample questions, and question exercises are added. The goal is to make it easier for FORFIS application users to make choices in sub-material learning. After the revision process, the About button, profile, and instructions are created in a selection icon.

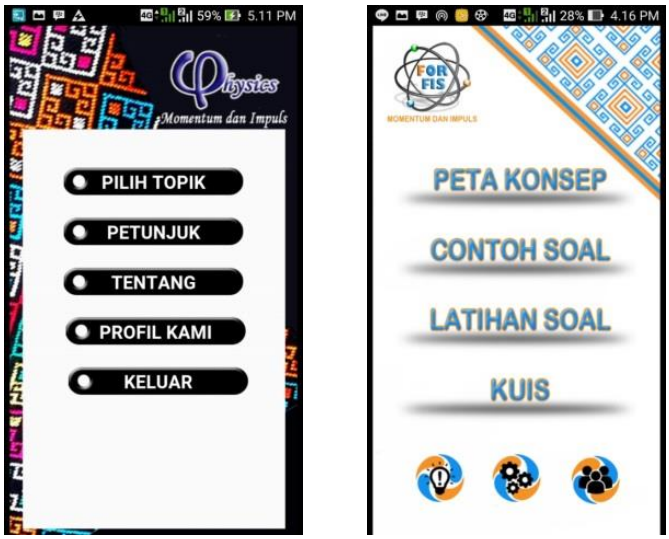

Fig 6. *The revision of the menu view of FORFIS*

The last improvement is related to the instructions for use. This improvement is presented in Figure 7. Quiz instructions previously given in general are further clarified by adding available app instructions, sample question instructions, question practice instructions, and quiz instructions. It aims to make it easier for users of FORFIS.

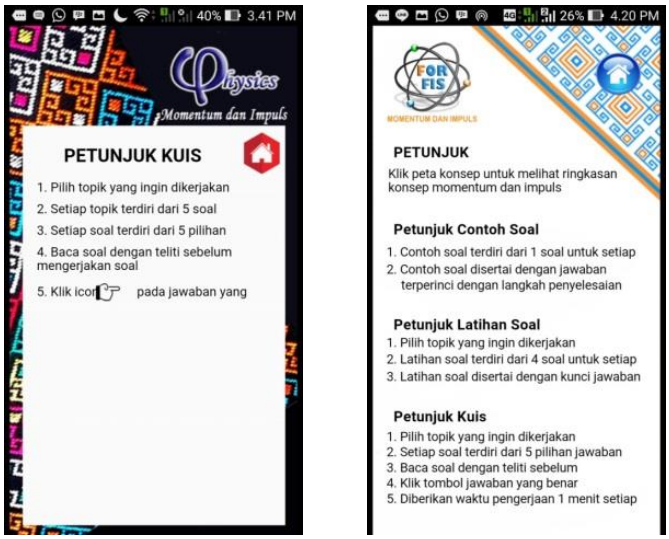

***Fig 7**. The revision of guide instruction of FORFIS*

After revision on the application based on suggestions and comments from experts judgement, the product practicality test was conducted through small-scale trials. The instrument used was a questionnaire of practicality. This questionnaire contains a statement regarding the usefulness of this application in physics learning. The results of the poll can be seen in figure 8.

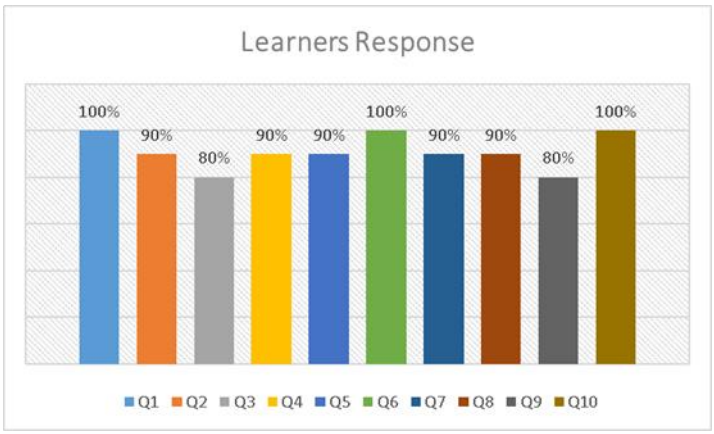

***Fig 8**. Learners Responses*

Based on the results of the practicality questionnaire, all respondents agreed that the Forfis application is helpful in learning. Students believe there is a benefit of the product developed. Furthermore, respondents agreed that the application of the forces does not restrain the learning process, which is 90%. It means that there are still students who feel uncomfortable using this app. Some students are not used to using this forfis application in learning. Then, there are 80% of students find physics learning more interesting utilizing this app. Related to the learning process, 90% of students think that forfis application can make students more excited about physics learning. These opinions arise because the application uses a gamification base not to cause saturation in learners. In addition, 90% of students feel motivated to learn to use android-based apps for self-learning. Based on the results of practical tests, the products developed are considered suitable for use in physics learning.

Nieveen [27] stated that the development of a product must fulfil existing quality standards. A product is declared good if it fulfilled 3 (three) criteria: feasibility, practicality, and effectiveness. The product is declared good if at least has achieved 2 (two) standards. The products developed in this study have met 2 (two) product quality standards that are feasible and practical. This product has met the product

feasibility criteria [22] with "excellent" measures, as well as meets the requirements of the practicality of the product by reach more than 80% [28] so that the product is declared practical to use.

After achieving feasibility and practicality criterion, FORFIS has been eligible for use in school learning. The FORFIS app can be downloaded using the QR code presented in Figure 9.

Fig 9. *QR code of FORFIS apps*

Furthermore, a guide to using the FORFIS application was created to make it easier for novice users to install or use the FORFIS application in learning. This FORFIS app user manual can be downloaded using the QR code presented in Figure 10. This FORFIS usage guide contains installation instructions and instructions for the use of FORFIS apps.

Fig 10. *QR code for usage guide of FORFIS*

CONCLUSION AND SUGGESTION

The developed application is named Physics Isomorphic (FORFIS), based on android OS. The application is built using Construct2 software and designed using Adobe Photoshop CS3. The design of the application is then made into an app using PhoneGap software. This application contains questions about the physics of momentum materials and impulses that are isomorphic. The results have shown that the average score given by expert judgement is 132.29, which is in the excellent category. This result means that the Application of Isomorphic Physics (FORFIS) is feasible to use as a medium of physics learning. Further research is expected to measure the effectiveness of the use of Isomorphic Physics (FORFIS) application in physics learning in the classroom and independently. Forfis application is developed according to the needs of self-learning media. This research is limited to momentum and impulse material for class X high school level, and also, the implementation of research only reached small-scale trials. Further research is expected to be developed to test the effectiveness of products in online learning.

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