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# "Elektrotektif": An Educational Game to Explore Electricity Concept Using Case-Based Learning

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**Abstract**

Learning physics is relevant to many cases in everyday life. Various media have been developed for physics learning, e.g., educational games. Educational games can be used as a way to motivate students who are mostly digital natives who were born and grew up in an all-digital environment. This research aims to produce a case-based educational game on electricity called Elektrotektif. This study used the research and development method with the ADDIE model. The result is an investigative game in which there are cases related to electricity in daily life, such as short circuits, electrocution, and electrostatic discharge. The quantitative evaluation results in a value of 86.5% for aspects validation of learning media, and the results from the user were 86%, with the interpretation "very good" to be used as learning companion media. Learning by using cases in a game can help students connect to real-world situations and provide solutions to physical events that excitingly occur around them.

**Keywords**: case-based learning, interactive media, educational games

## INTRODUCTION

The paradigm in learning shifts towards the constructivism paradigm, where the learners carry out the knowledge construction process by themself (Siregar & Hartini 2019). Physics is one of the fields of learning that focuses on problem-solving for problems or events that occur in students' daily lives. Physics education provides scientific information that encourages problem-solving skills (Sarjono 2017). Physics learning is composed of concrete and abstract concepts that are difficult to visualize, which causes students to have difficulty learning abstract concepts (Ismail et al. 2019). However, students must be able to use the knowledge of physics they have learned to understand physical events that directly affect their lives (Demircioğlu & Selçuk 2016). In this context, the solution is the application of Case-Based Learning in physics learning.

Case Based Learning (CBL) is a learning method that improves students' critical thinking and problem-solving (Naveed 2017). In CBL, the teacher formulates case scenarios. Students discuss cases in small groups and try to find solutions by exploring, analyzing cases, and solving problems using facts, information, and skills previously taught (Tiwale et al. 2019). Case-based learning stimulates attention, interest, and interactivity among students (Azeem et al. 2018). The electrical concept is one of the physics topics that can apply case-based learning. Students are interested in studying electricity but have difficulty understanding the material (Ramdani et al. 2021). According to the available media analysis results, many learning media related to electricity, such as electricity simulations and quizzes

related to electricity material. Opportunities for development are to provide media that can bring students' daily lives into the learning process.

The emergence of disruptive technology changes students' learning patterns (Lubis 2019). For example, students who are mostly digital natives who were born and grew up in an all-digital environment prefer interactive learning media to open books (Mensan & Anagün 2022). Interactive learning media is a learning program that combines animation, video, audio, text, and images through a computer or smartphone device to achieve learning objectives where users can interact with the program (Surjono 2017). The element of interactivity in interactive media allows users to choose and determine the information they want to learn according to their needs (Pribadi 2017). Examples of interactive multimedia commonly used in learning are games, simulations, interactive quizzes, and others (Daryanto 2016).

One of the uses of interactive media in the learning process is games. Based on research conducted by the inMobi entitled "Mobile Gaming Through the Pandemic and Beyond in Southeast Asia 2021" there is a 46% increase in online game users during the COVID-19 pandemic shown in FIGURE 1 (InMobi 2021). This data shows that the development of the game industry in Indonesia is increasing. Games that were previously only seen as entertainment can become a companion to human life, such as business, military, and formal and informal education (Byun & Joung 2017). Digital games have been developed as learning media for various subjects such as mathematics, history, engineering, health, science, and English (Hung et al. 2018).

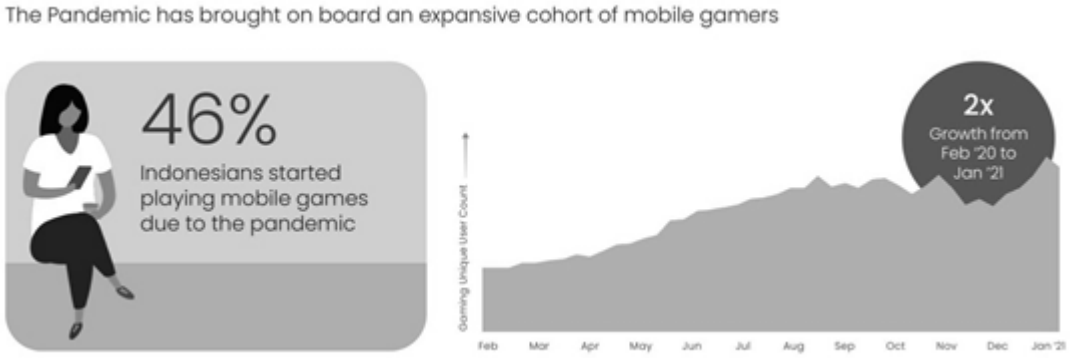



**FIGURE 1.** Graph of increase in online game users during the COVID-19 pandemic (InMobi 2021).

Educational games integrate and connect the material of each subject matter into game components (Kartika et al. 2019). Games have eight components used in learning, i.e, rules, goals and results, feedback and rewards, problem-solving, stories, players, environment, and mastery (Faiella & Ricciardi 2017). Educational games aim to stimulate students' interest in learning by playing games (Nasrudin et al. 2018). The ability of educational games to present material in a fun way can stimulate students' curiosity and imagination (Fadda et al. 2021) because students will feel happy, interested, and comfortable during the learning process (Ariawan & Pratiwi 2017). Using educational game technology as an interactive learning media is one of the right ways to improve students' problem-solving, collaboration, communication, and time management skills (auditory and verbal) (Viviers et al. 2016).

Therefore, the researcher developed a case-based educational game learning media to improve students' problem-solving abilities. Making this media using Articulate Storyline 3 software, this application does not require a programming language or script in the production process, making it easier for teachers in its development. The articulate storyline is supported by smart brainware which helps users format CDs, personal web and word processing, through offline and online designs (Syah et al. 2020).

## METHODS

This study used to research and development methods with the ADDIE model shown in FIGURE 2, which consists of Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected because the process is simple and easy to implement.

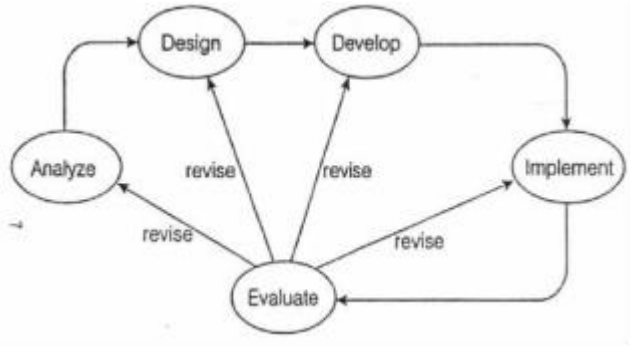



**FIGURE 2.** ADDIE Model Stage (Gagne et al. 2005)

1. The analysis phase begins with analyzing students' needs regarding learning and physics learning media in the form of a questionnaire. The questionnaire was filled in by students who studied physics at school. The needs analysis results found that students are currently interested in using learning media in the form of games because they can learn in a fun way. Then, an analysis of media availability is carried out to analyze development opportunities that can be carried out. The result is that electric learning media needs to be developed to bring real-life situations into the learning process.
2. The design stage involved making a media development plan or design based on the analysis phase results. This stage makes it easier for researchers to carry out the product development process.
3. At the development stage, all designs were realized into a case-based educational game for physics learning topics, such as electrocution, electrical overload, and electrostatic discharge. This media was created using the Articulate Storyline software, the output of which is a website. Then this media was tested by a learning media expert with an instrument in the form of a questionnaire. The validation stage will obtain the validity results. The validation instrument by experts was in the form of a questionnaire using a Likert Scale of 1-4 from very not good to very good criteria. To obtain a value for each aspect with the following formula (Arikunto 2017):

$$\%interpretation = \frac{\sum score\ obtained}{\sum total\ score} \times 100\%$$

4. At the implementation stage, the media was tested on several users before and after using the game. The test results are considered responses regarding the use of case-based educational games that have been developed.
5. The evaluation stage was carried out by analyzing the suggestions given by students if during the implementation process there were problems or deficiencies were found. The evaluation was only limited to the formative evaluation stage to improve the resulting product development.

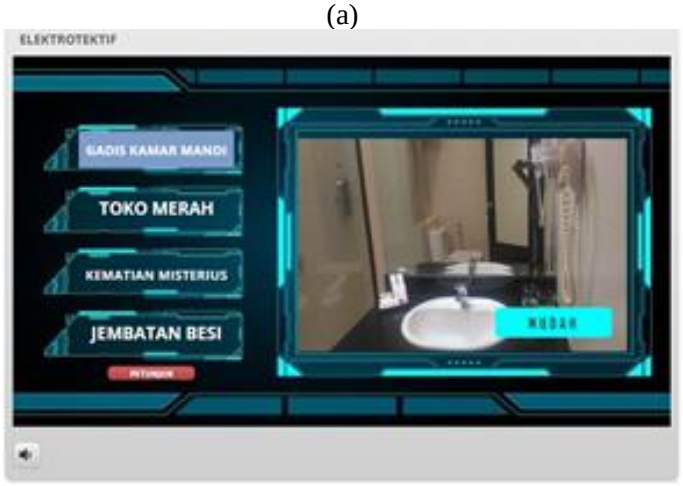
## RESULTS AND DISCUSSION

At the needs analysis stage, the results showed that 67% of students preferred interactive learning media compared to textbooks in physics learning. As many as 80% of students like to play games. The time spent playing games varies from 1 hour to 6 hours a day. There are 55.3% of the respondents have

played educational and investigative games in learning. Respondents who have played educational games think that students get a fun experience that is being able to learn while playing and can increase curiosity. According to the results of the analysis of the available media, there are many learning media related to electricity such as electrical simulations and quizzes related to electricity. There are development opportunities that can be carried out from available learning media by providing media that combines simulations, quizzes, and other elements of interactivity in a package.

The research result is a Case-Based Physics Educational Game with the name Electrotektif application. The display specifications are landscape. The display size is 16:9 or 1280 x 720 pixels. With this size, the writing and images in the application can be easily seen and function properly. Elektrotektif is made using Articulate Storyline software with HTML or website format to be used on various devices.This game loads three cases to explain electrical events. The three cases are Electrocution, Short Circuit, and Electrostatic Discharge. Elektrotektif Games can create fantasies that make users feel like they are in a detective world. Besides that, in the game, there are rules so that users can understand and follow the storyline. Users can solve cases individually or in groups and are prohibited from spreading game-related information and answers. The displays of the media are presented in FIGURE 3. In FIGURE 3(a), Users are first presented with an initial display where they can choose a menu to find out the game instructions and learning objectives. After clicking start, users can choose a mission from the easiest to the most challenging mission in FIGURE 3(b). Case resolve time will be provided in 15 minutes duration.


(a)




(b)

**FIGURE 3**. Display of Elektrotektif Educational Game (a) Initial Display; and (b) Menu Display

To explore each mission in the Electrotective Educational Game, students must answer questions about electricity materials to test their basic knowledge and to open a mission, as shown in FIGURE 4(a). The duration of each mission will start counting on this slide. If the answer is wrong, a deduction

will be made on the total mission score. After answering the quest, the user will be presented with Mission News which will start the stage of exploring cases, as shown in FIGURE 4(b). After clicking the investigation button, the user is presented with a menu for each mission, as shown in FIGURE 4(c). Users can select pages containing information such as Witness Statement 4(d), Autopsy Result 4(e), and other information. On these pages, users can collect information related to events and analyze their relationship with physics-related material. On several information pages, the user are asked to answer questions about electrical materials to test the user's basic knowledge. If the answer is correct, then the user can access the information in it.

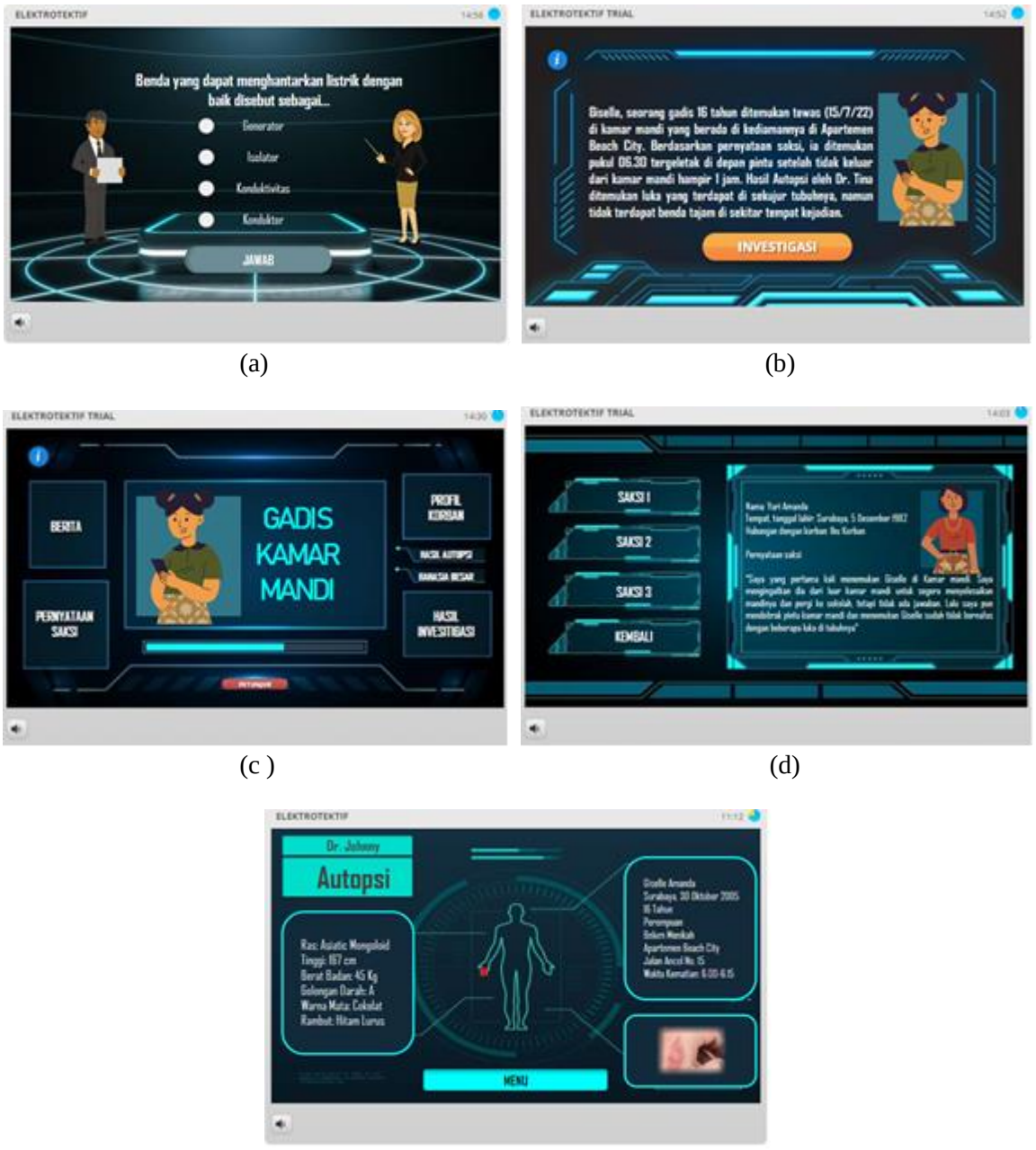
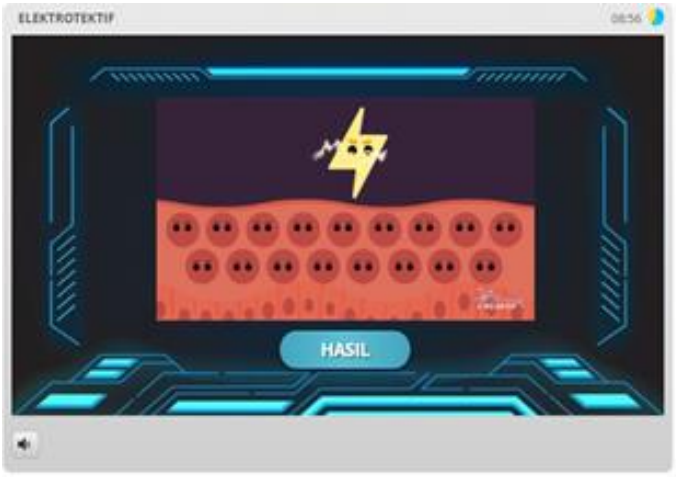



**FIGURE 4.** Display of exploring cases in Elektrotektif Educational Game (a) Quest; (b) Mission News; (c) Mission Menu; (d) Witness statement; and (e) Autopsy Result

After the user collects information on each mission, users will be directed to analyze and solve the case by answering questions shown in FIGURE 5(a). The question starts from revealing the cases and solving the electrical event in real life. For each question, a discussion will be provided in the form of

pictures, videos, narration, and mathematical calculations to avoid misconceptions shown in FIGURE 5(b). Feedback will be given to each question so that the user knows the correct or incorrect answers that have been answered.. After the user answers all the questions, the user will get a score, as shown in FIGURE 5(c). The user is considered capable of completing the mission if the score is above 75.


(a)




(b)


(c)

**FIGURE 5.** Display of analyzing and solving cases in Elektrotektif Educational Game (a)Question; (b)Discussion Video; and (c) Score

An expert validated the results of the development of these games through quantitative evaluation. The learning media expert assessment includes the learning content, display, usability, gamification, and language. The result is shown in TABLE 1. At the implementation stage, tests were also conducted on users before and after using Elektrotektif to know user perception of physics learning. The users also assessed the media with the aspect of the display of the media, language, usability, learning content, and stimulating interest. The result is shown in TABLE 2.

**TABLE 1.** The result of validation by learning media expert

| Aspect | Mean | Interpretation |
|---|---|---|
| Learning Content | 90% | Very Good |
| Display | 87.5% | Very Good |
| Usability | 95% | Very Good |
| Gamification | 90% | Very Good |
| Language | 70% | Good |
| Total | 86.5% | Very Good |

**TABLE 2.** User Assesment

| Aspect | Mean | Interpretation |
|---|---|---|
| Display of the media | 78% | Good |
| Language | 88% | Very Good |
| Usability | 94% | Very Good |
| Learning Content | 80% | Good |
| Interest | 90% | Very Good |
| Total | 86% | Very Good |

The results of the validation test by learning media experts got an average percentage of 86.5% with a “very good” interpretation. Based on the results of user perception about physics learning, there was an increase in the results before using Elektrotektif Educational Games, which was 63.4%, and increased to 85.4% after using Elektrotektif. The results from the assessment aspect were 86%, with the interpretation “very good” to be used as learning media. It means that educational games can be used to enhance student engagement and motivation in learning physics and create social skills and constructivist learning environments (Kalogiannakis & Papadakis 2019). The case-based learning method enables students to see the direct relevance of real-world situations, making them more highly motivated and more likely to remember the information (Rong & Choi 2019). Based on research by Mulyati et al under the title “Fire Phyghter” - The Development of Educational Games for Exploring Dynamic Fluids Topic, the validation result by media experts showed a value of 85%, the result of user testing obtained a value of 83,5% both the values got an interpretation very feasible for use in learning activities (Mulyati et al. 2022). So, it can be said that educational games are suitable for learning activities inside and outside the class.

The results at the evaluation stage found that the educational game media developed were limited to electrical materials. At the implementation stage, it was found that there were still many students who had difficulty accessing the media due to internet connection problems. Suggestions and recommendations obtained from the validation and implementation process are that students want more dynamic characters, and media in offline versions such as Android or iOS applications, and users expect media development with similar concepts to other learning materials.

## CONCLUSION

The results in a value of 86,5% for aspects validation of learning media, and the results from the implementation on user were 86%, with the interpretation “very good” to be used as learning companion media. It can be concluded that a case-based educational game to learn electricity with the name Elektrotektif is very good for use as a learning media. Students enjoy learning using cases in a game because it can help students connect to real-world situations and provide solutions to physical events that occur around them inside and outside the learning process. The development of this type of

media is expected by students to study material other than electricity and can be accessed on various online and offline platforms.

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