

DEVELOPMENT OF GAMES INSTRUCTION WITHIN PLANT GROWTH CONCEPT

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Abstract

Game instruction is one of the solutions to overcome problems that occur in learning activities. This study aims to develop interactive types of games instruction multimedia on the sub-concepts of plant growth and development. This study used the development research method in which research focused on front-end analysis, planning, production, and evaluation. The results of the material expert assessment obtained an average value of 91.36% which means that the material in the game is in accordance with the indicators of learning, the concepts conveyed are in accordance with the truth of the concept, and the use of the language is sufficient. Meanwhile, the results of the media experts assessment obtained an average value of 87.50% which means that navigation in the game is convenience, the programming can run well, this learning game is in accordance with the characteristics of the game and is interactive, the display of the game is interesting, as well as the elements the multimedia is fulfilled. Therefore, the game can be categorized as very good both in terms of material and media. Even more, the student response test results showed an average value of 79.35% which means that the students have an interest in the game developed, games can be used independently by students, and are able to increase learning motivation and students' learning outcomes. Hence, this learning game can be categorized as to be used by the students for their learning.

Keywords: Development, Game instruction, Plant growth concept.

1. Introduction

This type of interactive multimedia instructional game was developed based on "enjoyable learning". This pleasant atmosphere can be used as a learning strategy. Therefore, it can create an effective learning process [1-3]. In line with this opinion, many researchers argue that digital games have the potential to help students learn [4, 5]. Students can learn at the speed of their learning [2]. Thus, using game instructions is a very motivating technique because it can provide a challenging competitive environment [3-6].

Spatial ability may be one of the most important factors in multimedia learning [7]. The learning process that involves explanations using audio and visual on some biological material. This educational method must certainly be supported by ICT and must be adopted to meet the demands of 21st century students and support their meaningful learning [8]. That is because the demands of Basic Competence on the material require students to analyze the importance of the growth and development of living things. However, without guidance during exploration using multimedia, it can cause misperceptions and learning performance that is unfavorable for some students. However, for other students, this active consideration process can be more effective than passive observation [9].

So based on this description, it is necessary to develop a type of interactive multimedia game instruction on plant growth and development material. This is also supported by students' statements about the questionnaire, which states that the majority (91.67%) of students feel happy when playing games and agree to use the game as a tool in learning. Some researchers have found that student learning increases when teachers conduct debrief discussions that link gameplay with content included in the classroom [10]. From the teacher's point of view as well, this application helps them to monitor each student's reading process and progress, because this application is equipped with Sharing tools [11].

The growth process occurs because of changes in the number of cells followed by an increase in the size of cells that make up the plant itself. Plant growth is divided into two parts, primary growth which is the basic growth of plants and secondary growth which becomes continued growth where plant organs are formed. This process continues as long as the plant is still alive.

2. Method

This study used the development research method from Richey and Klein [12], in which the design of this study refers to the ASSURE research design [6]. This design was chosen because the process of analysing students' characteristics is more in-depth so that the games developed are more in line with the characteristics of the students. The steps in ASSURE research design are analysing learner characteristics, stating the objectives, selecting or modifying the media, utilizing, requiring learners' responses, and evaluating. In the first stage, learner analysis was carried out, including analysis of general characteristics, analysis of specific basic competencies, and analysis of students' learning styles.

The second stage was stating objective which serves to determine the standards and objectives to be achieved by the students. These standards and objectives were based on the concept of plant growth and development. The third stage was selecting or modifying the media which functioned to select teaching strategies, technology,

media, and materials to be used to achieve learning standards and objectives. The media developed in this study was the game “G&D puzzle”, which is a game composing of images of plant growth and development. Because puzzle games can improve students’ abilities in spatial visualization and mental rotation [13].

The fourth stage was utilizing which was divided into previewing the technology, media and material; preparing technology, media, and material; preparing the environment; preparing the learners; and providing a learning experience. At the previewing stage, expert tests were conducted on the prototypes of the media that were developed and the judgment of the implementation of the lesson plan. Next, preparations for the technology, media, and material would be carried out that would support the learning process. In this media preparation stage, media revisions were based on the results of the expert tests. The next step was to prepare the environment that will be used in the learning process. After that, preparing the learner and the last step was to provide experience for the students in using the media for learning.

The fifth stage was requiring learner responses. This stage was conducted by carrying out a limited test in the form of testing student responses to the game developed. The test of the students’ response was conducted by using students’ response questionnaires given to a limited group of students. The sampling of 28 students was based on the number of students in the class. The last stage was evaluating. At this stage, an evaluation and revision of the developed media were conducted. The evaluation was done by collecting data from expert tests and limited tests so that the results could reveal an overview of the feasibility of the media being developed, as well as its shortcomings. After evaluation, a revision of the developed media, based on data from expert testing and limited testing was carried out.

3. Results and Discussion

3.1. Results

The results of analysing learners’ characteristics revealed that the students were familiar and accustomed to playing games, most of the students felt happy when playing games and agreed with the use of games as a learning tool, and most students had a visual learning style.

Figure 1, at the planning goal stage, shows an expectation for students to have and master the standards and objectives after the teaching-learning process. The next stage was selecting or modifying the media in which the selection of learning methods and models is carried out in accordance with the use of the developed multimedia. The strategy used in learning is a student-centred strategy. This method was a discussion and assignment, as well as a learning discovery model. The elements in the game's instructions are the introduction, material description, facilities in the form of icons, prizes, and evaluations.

In Fig. 2, at the stage of the utilization, there were five factors that were done, specifically previewing the interactive multimedia type of game instruction; preparing interactive multimedia type of game instruction; preparing the environment; preparing the learners; and providing learning experiences. In this prevailing stage, expert tests on the products were conducted to obtain an assessment of the material and media aspects (See Fig. 3). The test of interactive multimedia expert tips on overall instruction in the material aspects was 91.36%

and included a significant feasible category. This value was obtained from the average value of the aspects of conformity of material with learning indicators, the truth of the concept, and language. While in the media aspect, the overall value was 87.50% which included a very decent category. The media aspect value was obtained from the average values on aspects of navigation convenience, programming, game characteristics, interactivity, display, and elements. The elements in the game's instructions are the introduction, material description, facilities in the form of icons, prizes, and evaluations.

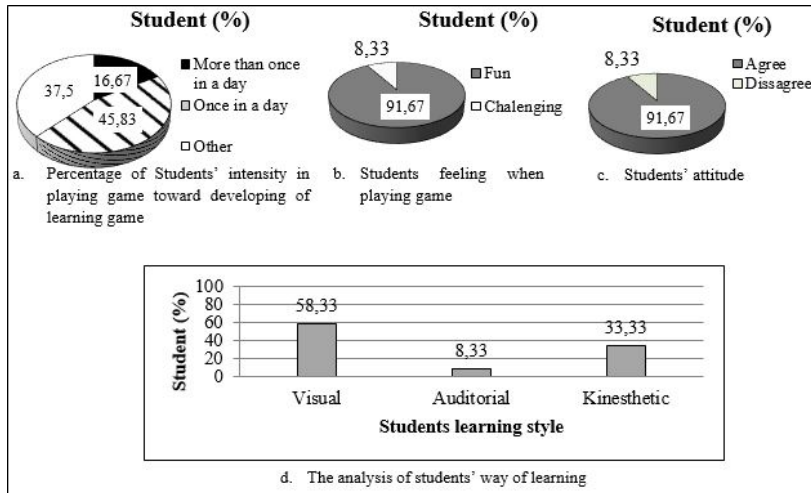


Figure 1. Students' characteristics.

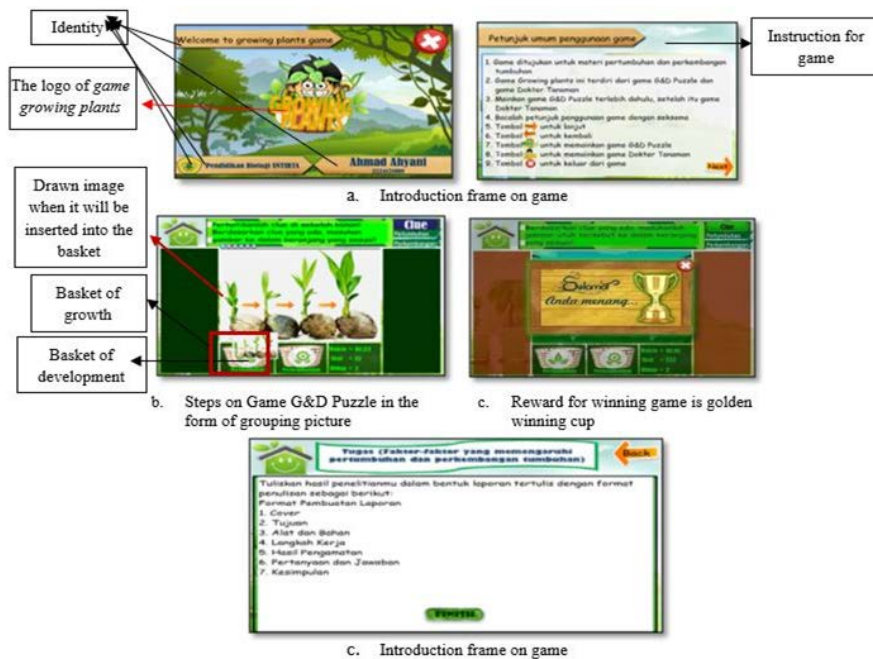


Fig. 2. Elements in game instruction.

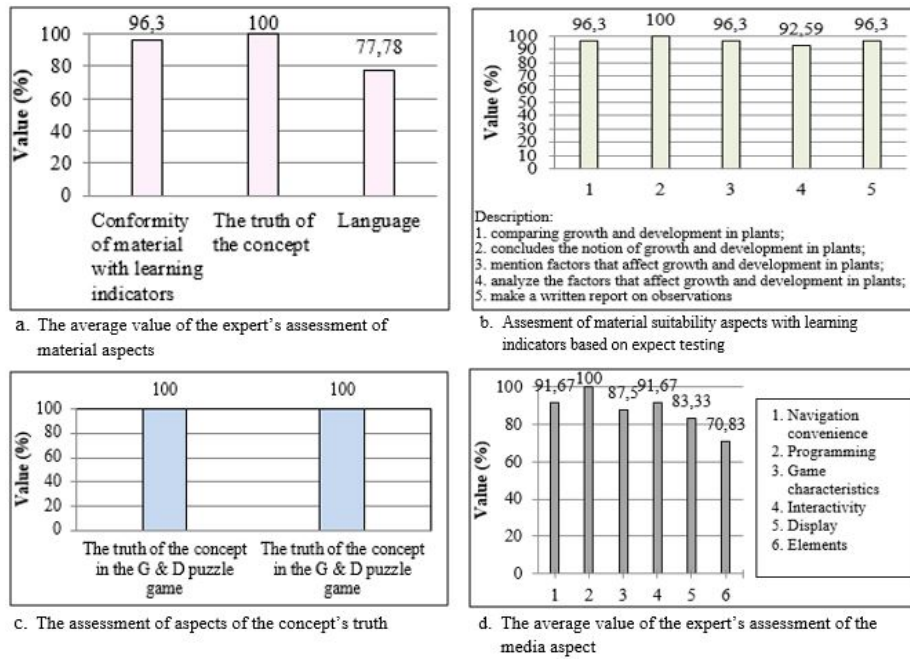


Fig. 3. The expert judgment of interactive multimedia type of game instruction.

Figure 4, based on the limited test, the average value of student responses was 79.35% and included in the good category. This value was obtained from the aspects of interest in plant growth games, autonomous learning, learning motivation, and learning outcomes.

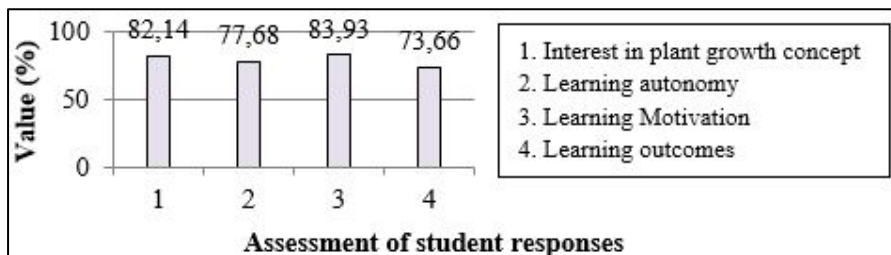


Fig. 4. The average value of student responses to interactive multimedia games instruction.

3.2. Discussion

Figure 5 explained again that the process of plant growth from seed cells that develop into plants will occur if the change in the number of cells is followed by an increase in the size of cells that make up the plant itself. The quantity of plant growth analysis obtained from the weight and leaf area of plants can be seen as follows Table 1 [14].

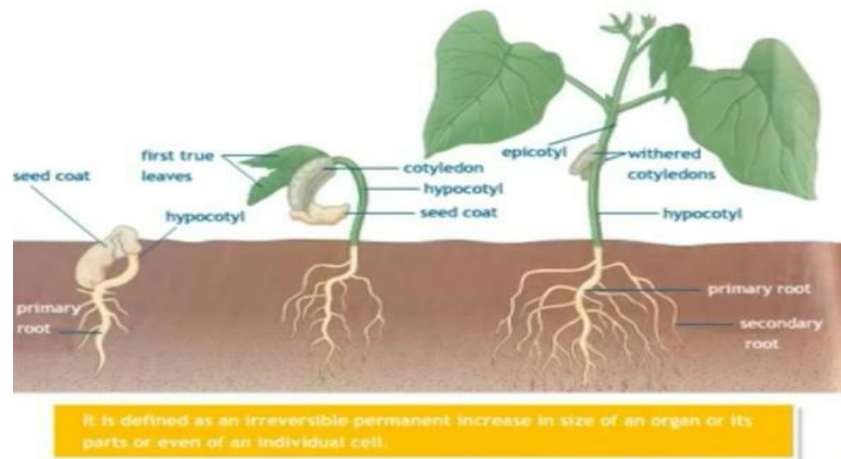


Fig. 5. Plant growth process.

Table 1. The quantity of plant growth analysis obtained from the weight and leaf area of plants.

Quantity obtained	Symbol	Formula	Unit
Relative Growth Rate	RGR	$(\ln W_2 - \ln W_1) / (T_2 - T_1)$	$W \cdot W^{-1} \cdot T^{-1}$
Leaf Area Ratio	LAR	$(L_{A2}/W_2 + L_{A1} + W_1) / 2$	$A \cdot W^{-1}$
Special Leaf Area	SLA	$(L_{A2}/W_2 + L_{A1} / W_1) / 2$	W^{-1}
Special Leaf Weight	SLW	$(L_{A2}/W_2 + L_{A1} / W_1) / 2$	$W \cdot A^{-1}$
Clean Assimilation Rate	LAI	$(L_{W2}/L_{A2}) + (L_{W1}/L_{A1}) / 2$	$W \cdot A^{-1} \cdot T^{-1}$
Leaf Area Index	LAI	$(L_{A2} + L_{A1}) / 2 \cdot (1/G_A)$	no dimension
Plant Growth Rate	CGR	$(1/G_A) \cdot (W_2 - W_1) / (T_2 - T_1)$	$W \cdot A^{-1} \cdot T^{-1}$
The duration of leaf area	LAD	$(L_{A2} + L_{A1})(T_2 - T_1) / 2$	$A \cdot T$
Lamanya Biomassa	BMD	$(W_2 + W_1) / 2 \cdot (T_2 - T_1)$	$W \cdot T$

Information: L_A = the leaf area; L_W = the leaf weights; G_A = the land area; T = the condition time; and W = the total dry weight (biological yield)

Based on the results of the above research, it can be generally stated that the age range of students in Grade VIII is between 12-14 years. The age range is included in the stage of formal operational cognitive development which is at the age of 11-15 years. This is in accordance with the opinion of Piaget, which states that cognitive development in the age range of 11-15 years is at the formal operational stage [15]. Because grade VIII students are familiar and accustomed to playing games, and most students feel happy when playing games, and agree with the use of games as a tool in learning. Therefore, these habits need to be directed to the relevant alternative educational games as a tool in learning.

Every student has a different learning style. Learning styles can be divided into 3 types, specifically visual, auditory, and kinaesthetic [1]. The students' learning style was identified through a questionnaire and found that most students had a visual learning style. This result is also in accordance with DePorter and Hernacki,

that students who have a visual learning style have the highest percentage among students [1]. Based on this, interactive multimedia of game instruction is important to be made on the material of growth and development, by delivering material content dominated in visual form, as well as students conclude their own material. So, the use of a visual learning environment can result in an increase in academic achievement that is more significant than non-use [16].

The material description was presented in the form of *G&D* puzzle games and plant doctor games. *G&D* puzzle games are presented to explain the growth and development of growth. While doctor plant games are presented to explain the factors that influence plant growth and development. The *G&D* puzzle game step is to arrange the puzzle after that group the images based on the clue that has been observed. The selection of this type of puzzle game can make students more active and increase the memory of the material. The emerging trend from computer programming teaching to younger people has led to the development of learning and game-based teaching approaches so that this is considered a promising learning platform [17].

One of the icons displayed almost in all game frames is the home icon, this icon facilitated students to go to the main view. Furthermore, the character of the student temporary character was omitted in this game. So, students themselves become leaders and game controllers, so students can focus on the description of the material presented, making it easier for students to understand learning material. Rewards in the form of gold, silver or bronze trophies will be a new motivation for students. Therefore, this reward is intended to motivate students to learn by using this game. While the evaluation element is intended to measure the success of students in learning using the game developed.

On the conformity aspect of the material with the learning indicator, the criteria to conclude that the understanding of growth and development in plants has the highest value of 100%. This is because the game is able to facilitate students to be able to deduce the material. The concluding activity in the game is in the form of a conclusion column that must be filled out by students. Meanwhile, the criteria for analysing the factors that influence growth and development in plants are rated at 92.59%, because they still cannot accommodate all the factors that influence plant growth and development.

The truth aspect of the concept gets an average value of 100% with a very decent category. Overall the truth aspects of the concept have been achieved well. In the *G&D* game, the puzzle has fulfilled the truth of the concept, including the instructions displayed, the arranged picture, and the grouping of the images. Then, in the doctor's plant game, the truth of the concept is appropriate, such as the symptoms that appear, giving treatment, and responses that occur in plants. The test of interactive multimedia experts in the type of game instruction shows that the category is very feasible in the overall aspect of the media. In the programming aspect, the value is 100% with a very decent category. This is because interactive multimedia of game instruction that is developed can be operated in accordance with the instructions, not easy to hang, can be installed on a computer easily, and can run slowly. Based on the assessment of the experts, overall interactive multimedia of instruction games is already suitable to be used as learning media in the material of growth and development of plants. In addition, this game instruction can be continued in the next stage, limited testing. Limited testing was carried out

in the context of students' responses to the game instruction. This was being done to determine the effectiveness of multimedia use by students. The students' responses test was conducted by using the student response questionnaire given to 28 students at Cilegon City YPWKS Middle School, Indonesia. The questionnaire of student responses includes four aspects, namely interest in growing plant games, learning independence, learning motivation, and learning outcomes. Based on the results of student responses to interactive multimedia games instructional type obtained an average value of 79.35% and included in the good category, this value is obtained based on the average overall aspects of the assessment.

Serious computer-based games (in this case Safe Design) provide a platform that enhances learning compared to lectures in classes and paper-based games [18]. This shows that interactive multimedia type of game instruction can make students enthusiastic in learning the material for growth and development and can make the material enjoyable. Therefore, it was found that instructional techniques strongly support analogical visual mapping, thus helping students translate game learning into science learning [19]. Visualization of multimedia game instruction will also be able to provide positive experiences in learning [20]. As explained also that learning using interactive games can also improve students' cognitive [21]. Thus, it can be concluded that interactive multimedia of game instruction in the concept of plant growth and development is very feasible and decent to be used as a learning media and can be continued to the field test stage for further refinement.

4. Conclusion

Based on the results of the study, Interactive multimedia of game instruction produced fulfils feasibility based on material and media aspects. Material aspects include the suitability of the materials with the indicators of learning, conceptual truth, and language. The media aspects include navigation convenience, programming, game characteristics, interactivity, display, and interactive multimedia elements of the game instruction. Interactive games instructions by the overall value of 89.43% in the very feasible category based on the assessment of material experts and media experts. With the details of the material experts' assessment of 91.36% and media experts at 87.50% with a very feasible category. The test results of students' responses to the interactive multimedia games instruction obtained a value of 79.35% in the good category. Based on this value, the interactive multimedia type of game instruction in the concept of growth and development of plants is very feasible.

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