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Digital puzzle: Alternative media for cell learning in middle school

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Abstract

Digital-based biology learning media is very suitable for learning in the era of globalization, especially in visualizing abstract material. Students are familiar with puzzle games; variations of digital puzzles are required for visualization cell materials. This research focuses on developing and finding learning media in the form of digital cell puzzles to use them to understand learning material that is not boring. The digital puzzle learning media developing with a 4-D development model (Define, Design, Develop and Disseminate). The developed digital puzzle learning media got value highly for using in learning cell material with assessments from material experts 81.72%, media experts 89.10%, teachers 97.82%. Student responses on the small-scale test (91.90%) and the large-scale test (93.53%) in the criteria are very good or very useful for learning. Digital-based learning such as digital puzzles can be interesting learning in the era of globalization.

Abstrak

Media pembelajaran biologi berbasis digital sangat cocok digunakan untuk pembelajaran di era globalisasi terutama dalam memvisualisasikan materi yang abstrak. Siswa akrab dengan permainan *puzzle*; variasi teka-teki digital diperlukan untuk visualisasi bahan sel. Penelitian ini berfokus pada pengembangan dan penemuan media pembelajaran berupa *digital cell puzzles* untuk digunakan dalam memahami materi pembelajaran agar tidak membosankan. Media pembelajaran puzzle digital dikembangkan dengan model pengembangan 4-D (*Define*, *Design*, *Develop*, dan *Disseminate*). Media pembelajaran *puzzle* digital yang dikembangkan mendapat nilai tinggi untuk digunakan dalam pembelajaran materi sel dengan penilaian ahli materi 81,72%, ahli media 89,10%, guru 97,82%. Respon siswa pada tes skala kecil (91,90%) dan tes skala besar (93,53%) dalam kriteria sangat baik atau sangat bermanfaat untuk pembelajaran. Pembelajaran berbasis digital seperti media *puzzle* digital ini dapat menjadi pembelajaran yang diminati di era globalisasi.

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A. Introduction

Technology has developed rapidly and has influenced various fields, especially in the field of education. Educational technology is critical to manufacturing learning media that can determine the effectiveness of learning (Suarni et al., 2021; Ula et al., 2021). Along with technological advances in education, using media for learning is one of the most critical aspects of the learning process, both at school and home.

Technological developments affect the choice of media in the learning process, so learning media also switch from conventional media to digital-based ones. The most common form of digital media used is smartphones. Fransisca (2019) states that using smartphones in learning activities can help the learning process. Various smartphone media applications include virtual classes through Google Classroom, Edmodo, and Schoology (Enriquez, 2014; Sicat, 2015; Iftakhar, 2016).

However, the facts show that learning media tend to be not widely used, especially smartphone-based media. Learning media is critical in delivering learning materials, including tools that physically contain instructional materials to motivate students to learn (Wati, 2016; Okra, 2019). One of the learning media that can make students more interested in learning is digital-based puzzles.

A puzzle is a game of compiling an image or object broken down into several parts. Puzzles are included in games that contain associative activities (connecting or stringing together). Situmorang (2012) stated that the activity of arranging pieces of puzzle pictures could motivate students to solve puzzles correctly and quickly. This puzzle learning media provides visual activities for students, where they have to arrange fun puzzles because students can learn while playing (Septiyani, 2021).

The development of digital puzzle media for junior high school level cell material does not yet exist, so it is an innovation for students, as research by Rohwati (2012) proves that the use of educational games in science learning can improve student learning outcomes and activities.

This research aims to develop, produce, and test the feasibility of learning media products in the form of puzzles for cell material for class VII SMP so they can be disseminated.

B. Material and Method

This research was designed using the research and development (R&D) of a model Four-D (4D) by (Thiagarajan et al., 1974). The 4D development model consists of 4 main stages: Define, Design, Develop, and Disseminate. This method and model were chosen because it aims to produce learning media products in the form of puzzles. The developed product was then tested for feasibility by testing the validity and testing the product to determine the feasibility of cell material puzzles learning media for class VII students.

Learning media is made according to the 4D development model based on the following stages: Define the steps, namely initial analysis, student analysis, task analysis, concept analysis, and analysis of learning objectives. The design stage includes the preparation of tests, media selection, format selection, and initial design. Develop stage Media that has been designed is subject to expert validation and product testing. Disseminate stage, disseminate the final product of learning media to other schools.

Product trial at SMP Negeri 15 Yogyakarta with research subjects of class VIII students for the 2020/2021 academic year. The data analysis technique used in this research is qualitative and quantitative data analysis techniques. Qualitative data is data about the process of developing Puzzle application learning media in the form of criticism and suggestions from media experts, material experts, teachers, and students. Quantitative data in this study were obtained from validity instruments given to media experts, material experts, teachers, and student response instruments. The data will be analyzed to determine the feasibility of the puzzle application learning media.

Data processing and assessment using techniques by describing all opinions, suggestions, and responses from the validator while in the form of numbers and student responses were analyzed by percentage using a Formula 1 by Sugiyono (2017).

$$P(\%) = \frac{\sum the\ scoring\ score\ obtained}{\sum ideal\ score} \times 100\% \text{ ..... Formula 1}$$

The results obtained from the percentage calculation are then determined by the feasibility level of the learning media products used with qualifications with the criteria that can be seen in Table 1.

Table 1 Qualifications and criteria for puzzle learning media

Percentage (%)	Eligibility Criteria
84 < score ≤ 100	Very worthy, No revision
68 < score ≤ 84	Worthy, No revision
52 < score ≤ 68	Worthy enough but needs revision
36 < score ≤ 52	deficient worthy, revision
20 < score ≤ 36	Not worthy, revision

(Source: Sugiyono, 2017)

The results of the student response analysis were categorized to see the quality of the puzzle learning media products with the criteria in Table 2.

Table 2 Quality of puzzle learning media

Percentage (%)	Criteria
84 < score ≤ 100	Very good
68 < score ≤ 84	Good
52 < score ≤ 68	Enough good
36 < score ≤ 52	Not good
20 < score ≤ 36	Not very good

(Source: Sugiyono, 2017)

C. Results and Discussion

The development of this digital cell puzzle learning media goes through various processes to obtain a product ready to be used in the learning process. This digital cell puzzle learning media has been developed using the 4D.

Define; the initial defining stage is done by interviewing science teachers at SMP Negeri 15 Yogyakarta. Based on the results of interviews conducted with science teachers at SMP Negeri 15 Yogyakarta, it was found that learning on cell material was only in the form of PPT, which only displayed writing, no exciting pictures, and designs. The problem that often occurs in learning is that teachers only use conventional methods to make learning less exciting and boring thus, learning objectives have not been achieved optimally. For learning objectives to be achieved optimally, learning must be packaged in an innovative, engaging, and fun way (Almeida & Simoes, 2019; Bayram, 2020). Researchers also conducted student analysis by looking at and observing the characteristics of students at SMP 15 Yogyakarta; most of the students prefer to learn using engaging learning media and insert games; this is in line with the opinion of Suyatno (2009) learning using games will help children reduce stress and develop his sense of humor.

According to Suhendi (2014), student analysis activities aim to determine the initial behavior of students and student characteristics which include student characteristics, abilities, and experiences. Task analysis aims to identify the main tasks to be carried out by students; concept analysis aims to determine the content of the material in the puzzled media developed, and learning objectives analysis is also carried out to achieve learning achievement indicators based on material analysis and curriculum analysis.

Design*:* The researcher begins by selecting the media to be developed by identifying learning media relevant to the material's characteristics and according to the needs of students. The media design created is the Puzzle application used on android smartphones; this application can be used offline, so it does not require an internet network. According to Ismail (2006), puzzles are included in games that contain associative activities (connecting or stringing together). Puzzles are games that users play by arranging randomized picture patterns to become a complete picture (Firdaus & Nugroho, 2016). The puzzle is one of the educational game tools. According to Adiarni (2009), Educational Game Tools (APE) are everything that can be used as a means or equipment for playing that contains an educational value and can develop all students' abilities. Ismail (2006) APE can stimulate student activities to learn a learning material, both using advanced technology and simple technology that is traditional.

Develop stage; material experts, media experts, and teachers validate the puzzle learning media. The validation results from this expert then become a reference for improving the media before the trial is carried out, then the learning media is given to the teacher, and the trial includes small-scale and large-scale trials. During the development process, the media changed both appearance and operation through a consultation process with media experts and material experts until the product had a mature concept. Expert validation (media experts, material experts, teachers) was carried out to get digital cell puzzle media that was feasible and could be used in learning. The results of expert validation are presented in Table 3. Based on Table 3, it can be seen that the digital cell puzzle is learning media in the aspect of media feasibility (very worthy) and material (worthy) used in learning as indicators of learning aspects, content, and display aspects.

Table 3 Result expert validation

Expert	Percentage (%)	Criteria
Material	81.72	Worthy
Media	89.10	Very worthy
Teacher	97.82	Very worthy

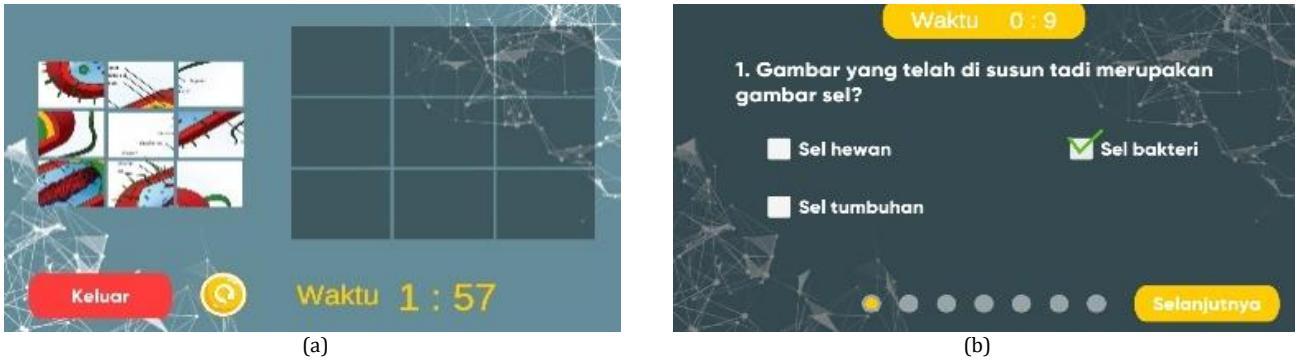
Table 4 Student response to the product

Group	Percentage (%)	Criteria
Small-scale	91.90	Very good
Large-scale	93.53	Very good

After the digital puzzle learning media product on cell material for class VII was assessed by Material Experts, Media Experts and Science Teachers, then a small-scale test was conducted on five students and a large-scale test on twenty-three (23) students in science in SMP Negeri 15 Yogyakarta. The data obtained from small-scale

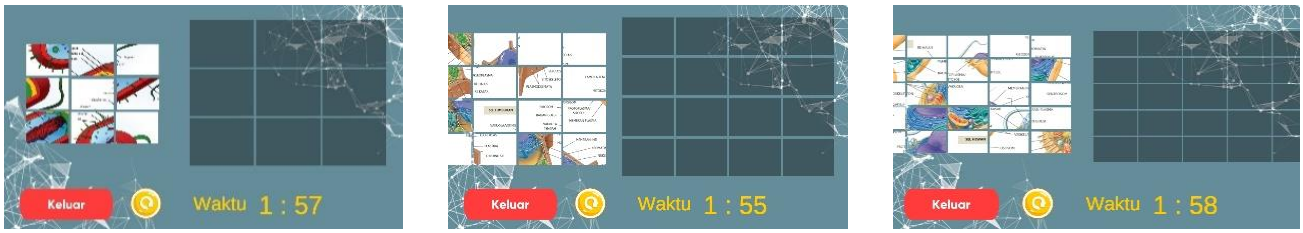
trials and large-scale tests are in the form of responses to digital puzzle learning media products on cell material. Small-scale trial data and large-scale test were analyzed and categorized by referring to Table 2. Student responses (Table 4) included aspects of ease of use and navigation, clarity of presentation, aesthetics or beauty and instructional quality.

Based on Table 4, it can be seen that the digital cell puzzle learning media in both the small group test and large group test get very good criteria for use in learning, based on the results of expert assessments and student responses, puzzles are very suitable for learning on cell material. According to Susanti (2012) states that students can be more motivated in the learning process by using the puzzle game method, this is due to the tendency of students who prefer the use of games. The advantage of the puzzle is that puzzles are a brain exercise in systemizing a form so that players will be accustomed to compiling things easily. According to Nurohmah (2009) the benefits of playing puzzles are sharpening the brain, training eye and hand coordination, practicing logic, practicing patience, expanding knowledge.



(a) (b)

Figure 1 Interface puzzle menu level 1 (a) and questions (b) in Indonesian



(a) (b) (c)

Figure 2 Puzzle level interface, level 1 (a), level 2 (b) and level 3 (c) in Indonesian

The interface display of the puzzle in Figure 1.a is a game at level 1 and Figure 1.b contains questions that are done by students after arranging the puzzle correctly, students are given 15 seconds to solve one question at a time. The digital puzzle is developed in three levels as shown in Figure 2.

The results obtained from qualitative data in the form of suggestions from material expert validators, media experts and teachers given in the process of assessing this puzzle learning media product include: improving the images presented in the learning media, adding questions in the media so that the media does not just to play, enter instructions for use to make it easier for users, fix puzzle pieces that will be arranged, enter assessments when they have completed the questions in the puzzle so that they can find out how well students understand cell material using puzzle media.

Disseminate, the purpose of this stage is to disseminate the final product of learning media to other schools. In this study, only limited dissemination was carried out, namely by disseminating and promoting the final product of puzzle media to science teachers at SMP Negeri 15 Yogyakarta, due to several reasons so that the product could not be disseminated to other schools.

D. Conclusion

Digital puzzle learning media products fall into the appropriate category (material experts) and very feasible (media experts and teachers). Student responses to this product get a very good response or are very suitable for use for learning. This shows that this digital puzzle media product is ready to be used in classroom and independent learning at home.

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