BioEdu
Berkala Ilmiah Pendidikan Biologi
Vol. 13 No. 2 Tahun 2024 Hal: 306-312
https://ejournal.unesa.ac.id/index.php/bioedu

VALIDITY OF GAMIFICATION MEDIA FOR CELL DIVISION MATERIAL TO IMPROVE STUDENTS' WORKING MEMORY

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Abstract

The application of various curricula and the development of innovative learning models are also in the spotlight in this Industrial Revolution 4.0 era, especially in using learning media. Gamification, which involves game elements in learning, was introduced to increase student motivation and involvement. Working memory is a part of short-term memory that stores and manipulates information to help the learning process. This research aims to produce valid gamification media for cell division material to improve students' working memory. The type of research used in this research is development research using the ADDIE development model. Gamification media should meet specific criteria validated by material and education experts, including presentation, visuals, language, and content. The research showed that the gamification media for cell division material was declared high validity, with an average validation score of 0.94. Research has shown that gamification effectively enhances students' working memory as a learning tool.

Keywords: *validity, gamification media, cell division, working memory, education developing*

Abstrak

Penerapan beragam kurikulum dan pengembangan model pembelajaran inovatif juga menjadi sorotan dalam era revolusi industri 4.0 ini, terutama dalam konteks penggunaan media pembelajaran. Gamifikasi, yang melibatkan unsur permainan dalam pembelajaran, diperkenalkan sebagai salah satu pendekatan yang dapat meningkatkan motivasi dan keterlibatan siswa.*Working memory* (memori kerja) merupakan bagian dari memori jangka pendek yang berfungsi untuk menyimpan dan memanipulasi informasi sehingga membantu dalam suatu proses pembelajaran. Penelitian ini bertujuan untuk menghasilkan media gamifikasi materi pembelahan sel yang valid untuk meningkatkan *working memory* siswa. Jenis penelitian yang digunakan pada penelitian ini adalah penelitian pengembangan dengan menggunakan model pengembangan ADDIE. Validitas media gamifikasi berdasarkan validator ahli materi dan ahli pendidikan dengan kriteria penyajian, visual, kebahasaan, isi dan materi media gamifikasi. Hasil penelitian menghasilkan bahwa media gamifikasi materi pembelahan sel dinyatakan memiliki kevalidan tinggi dengan skor rata-rata validasi 0,94. Media gamifikasi terbukti valid sebagai media pembelajaran yang dapat meningkatkan *working memory* siswa.

Kata Kunci: validitas, media gamifikasi, pembelahan sel, *working memory, education developing*

INTRODUCTION

The era of Industrial Revolution 4.0. currently, the education system needs new ways to improve human resources by supporting quality needs (Yamin & Syahrir, 2020). We are required to adapt science and technology to the field of education. Implementation of the curriculum to restore learning is written in the Republic of Indonesia Minister of Education and Culture Regulation No. 56/M/2022, which leads to the liberation of the implementation of the school curriculum between the 2013 curriculum, the independent curriculum or the emergency curriculum (Maghfiroh, 2023). However, technology that continues to develop has dramatically influenced various fields, including education, especially in the learning process with the emergence of various innovative and creative learning models. Modernization in teaching can make learning more effective. Therefore, it is imperative to develop and experiment by utilizing technology and integrating it into learning strategies (Ogrizovic et al., 2021).

The concept of biology is closely related to living creatures' lives (Azizah & Susantini, 2021). Biology

subjects contain complex material, one of which is cell division. The material on cell division makes it difficult for students to understand it. Using technology-based learning media can improve understanding of this material. Several mobile devices, including tablets, smartphones, and laptops, have become a solution to the problem of adapting technology and information in education as a learning medium (Ifadah & Prastiwi, 2022). Research conducted by Nurpratiwiningsih et al. (2019) shows that learning media that collaborates with technology can improve students' cognitive learning outcomes and skills. This learning media is an educational game that suits the characteristics of students. This educational game is one solution to learning.

Gamification is a product of thinking, experience, processes, and stages in design and systems, using elements in games to become a solution to overcome non-game problems. Gamification is a potential approach to foster motivation and engagement in different contexts. The application of gamification is very diverse, covering all daily human activities, such as health, education, business, and tourism (Shaliha & Fakhzikril, 2022). Gamification of education is one way to approach education with technological developments. Gamification uses game practices and elements in the learning process, arranged in unity (Palová & Vejačka, 2022). The definition of gamification, according to researchers, is an educational product with technological developments using game elements in the learning process.

Gamification has been carried out in the research of Sharifzadeh et al. (2020), demonstrating effectiveness in improving various health outcomes. The health in question is the health of the five senses and brain function, where both can work well and carefully. However, gamification does not only lie in the use of technology. Various learning environments, decisions, and rewards are the goals of gamification. One of the specific goals of gamification is to help students achieve better learning outcomes and design student activities so they can be involved in the learning process. Gamification encourages students to embrace mistakes and failure by providing opportunities to correct errors, like players correcting mistakes while playing games. Gamification aims to help students overcome obstacles like boredom, frustration, and pressure to engage in learning effectively (Yaniaja et al., 2021).

Working memory is part of short-term memory. Working memory has the function of manipulating and storing information received so that it can assist in the learning process (Ayudia, 2019). Working memory is a central cognitive system that plays a role in developing the speed of processing information. Working memory is also dynamic following human growth (Spencer, 2020). Every human being has a working memory capacity to remember information. Working memory capacity is essential in optimizing learning and developing human cognition, especially when pursuing education. Because every human has a different working memory capacity, several ways are needed to improve working memory, such as by increasing reading activities, interpreting reading, following instructions, remembering, and calculating (Putra et al., 2019). Increasing working memory can impact students' learning process. If working memory is optimized, students can easily store, process, and remember information (Trijayanti, 2019). According to Setiawan et al. (2020), improved working memory can measure students' motor and cognitive skills so that students can be more responsive in receiving and recalling information.

Gamification media for cell division material is a learning media based on game elements to study the stages of cell division. The gamification designed in this research is a card game based on a website operating system. In this game, students match cards that have the exact visualization. Players commonly refer to this game as a matching cards game where they actively need to find pairs of cards with identical images or numbers. We designed the game to motivate students using a leaderboard and points. The existence of gamification as a matching card game requires a strategy that motivates, is fun, and challenges students to participate actively. In research conducted by Hariadi (2021), the visual imagery method has several stages to help improve students' memory. The first stage is to prepare the material to be studied. The second stage is to make connections between the material so that it can be more easily remembered and developed. The next stage is to sharpen memory by visualizing objects. This method has been widely used and researched, such as by Scalise et al. (2020) in mathematics lessons and research by Dirgantara and Septanto (2021) in kindergarten to stimulate memory. This research aims to determine the validity of gamification media on cell division material to improve students' working memory.

METHOD

This research is a research effort in educational development with the main aim of improving the quality of biology learning in cell division through website technology using the card-playing method. In this

research, researchers apply the ADDIE development model using the framework proposed by Sugiyono (2015), which consists of five stages: analysis, design, development, implementation, and evaluation (evaluation).

The first stage in the ADDIE process is analysis. This analysis involves gathering in-depth information to form the basis for creating a product, which in this context is a website-based card game. This analysis includes three main aspects: understanding needs, relevant learning materials, and the learning environment. During this analysis stage, researchers also evaluated the attitudes and characteristics of students, who were the research subjects and focused on learning material about cell division. The population in this study were all class XI students at SMAN 3 Mojokerto who had yet to receive material regarding cell division. The sample in this research is XI MIA 2. The results of this analysis are used to design learning media that can effectively meet students' learning needs.

The next stage in the ADDIE model is the design stage. At this stage, the researcher detailed the data collection plan, created a flowchart, and compiled a sketch (storyboard) to guide the creation of the game application.

The third stage is the development stage. Here, researchers take concrete steps to realize the design plans that have been made. This involves creating game cards, mapping, using databases, organizing events, publishing, and expert testing.

After the development stage, the implementation stage. This stage occurs after the product has passed expert testing and meets the specified criteria. The implementation stage includes two crucial aspects: testing by teachers and testing by students in small groups and the final product. In testing by teachers, the aim is to collect responses and feedback from teachers and students, which will then be used to evaluate the quality of products under development. The results of the teacher and student trials in small groups will form the basis for revising the product. The final step is to produce the final product. The final product will be achieved if the test results show that the product has reached the desired standard and can attract student interest in the learning process. This product will be declared complete for further development and ready to be used in biology learning, especially cell division.

It is testing the validity of developing gamification on cell division material involving three experts: a lecturer who is an expert in the material, a lecturer who is an expert in creating learning resources, and a biology subject teacher at SMAN 3 Mojokerto. Testing is carried out by detailing the established criteria, which involves evaluating the game's content and relationship of constructs. Each aspect included in the validity variable is analyzed through a series of positive questions that refer to the material content, media design, media format, and use of language in the game. Validity assessment was carried out using a scale with five answer choices, namely Very Good (5), Good (4), Fairly Good (3), Not Good (2), and Not Good (1), which was adapted from the method used by Sugiyono (2015) in his research.

The score obtained is interpreted based on interpretation criteria. According to Retnawati (2014), gamification media is recognized as valid if the gamification media has an average score ≥ 0.8, which has been calculated using the Aiken formula.

RESULTS AND DISCUSSION

Gamification Media Profile

This gamification-based media development research successfully created a media to improve students' working memory in understanding cell division material. This media was designed by considering the characteristics of gamification, working memory, and cell division material. The result of this research is a game requiring players to match two types of cards, namely initial and visual cards. Its design uses several gamification characteristics, such as collecting points, achieving levels, player ranking, challenges, game aesthetics, and game strategy.

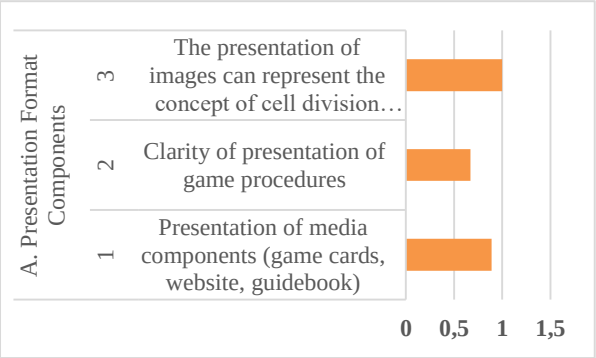
In addition, this media also considers the unique characteristics of cell division material, namely the ability to visualize distinctive features that are difficult to achieve by the human senses. Furthermore, in measuring the characteristics of working memory, this media is designed with strategies and methods to identify how students can understand, remember, and process the information provided.

The gamification media produced in this research can be accessed via a website so that students can use it via cell phones, laptops, tablets, or computers. This media is divided into two game levels, namely the mitosis and meiosis levels, allowing students to develop their understanding of these two types of cell division.

Validity of Gamification Media

Three experts carried out this validation process: two lecturers from the biology department at FMIPA UNESA and a biology teacher from SMAN 3 Mojokerto. Each validator provides an assessment, which is documented on the validation sheet. The validation implementation in this research covers various aspects, including learning tools that include gamification elements. The validation process results provided by the three validators are in the form of suggestions and input, which will serve as a guide for researchers in improving gamification-based media. The final results of this media validation series are then presented as data recapitulation, which can be found in Figure 1 below.

Figure 1. Validation Results of Presentation FormatComponents



In Figure 1, the component aspect of the presentation format with the most significant validation results is the image presentation aspect that can overcome limitations. This aspect gets a result of 1.00 with a very valid category. The aspect with the most negligible validation results is the clarity of presentation of game procedures at 0.67 in the valid category. The average validation result for the presentation format component is 0.85 in the very valid category so the gamification media developed is valid in aspects of the presentation format component.

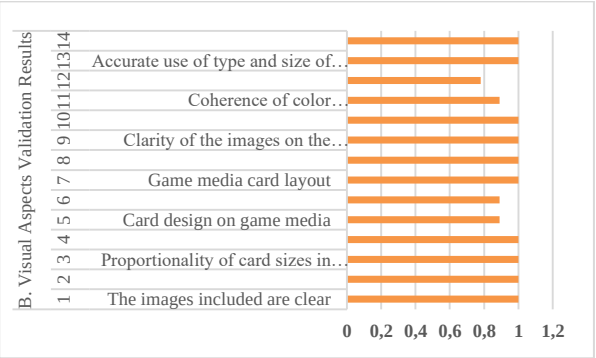


Figure 2. Visual Aspects Validation Results

The results obtained in the data above show that the visual aspect component has 14 aspects that the validator has validated. Correct use of typeface, proportionality, clarity of images, media, and website layouts have the most considerable validation results, namely 1.00 with a very valid category. The most negligible validation result for the visual aspect component was 0.78 with a valid category. The average validation result for this component is 0.96, with a very valid category.

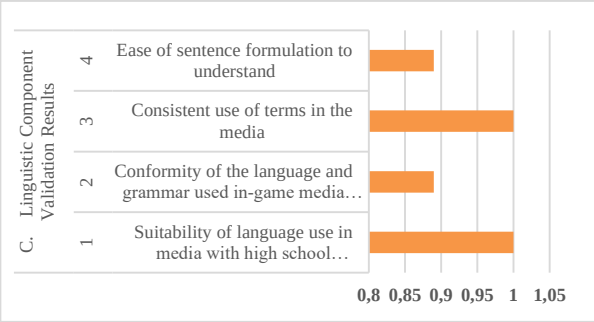


Figure 3. Linguistic Component Validation Results

Based on the data presented in the image above, the media linguistic aspect component has equivalent validation results because two aspects, namely the consistency of the use of terms in the media and the suitability of language use in the media at the high school level, have a result of 1.00 with a very valid category. Two other aspects of media language, namely the ease of formulating sentences to be understood and the suitability of the language and sentence structure used in the media, obtained a result of 0.89 in the very valid category. The average validation result for this component is 0.94, with a very valid category.

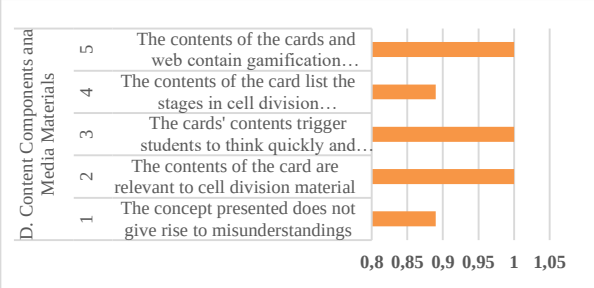


Figure 4. Validation Results of Content Components And Media Materials

The results presented in the image above show that the content and media material components have five aspects that the validator has validated. Aspects of the card and web content contain gamification elements; the card content triggers students to think quickly, and the card content is relevant to cell division material and has a validation result of 1.00 with a very valid category. The average validation result for this component is 0.94, with a very valid category.

Based on the validation results by the three validators, which were calculated using the Aiken

formula, an average score of 0.94 was obtained in the high validity category. This proves that gamification media is valid for learning and teaching activities. Validation scores are obtained based on assessment instruments, including appropriateness of presentation, visuals, language, content, and gamification media materials. This is supported by the results of relevant research conducted by Yulia and Silalahi (2019) that gamification as a learning medium can increase abilities and increase students' insight and memory.

After the validation process, the gamification media experienced improvements based on suggestions and input from the validator. This aims to create better gamification media, which will later be used in limited trials.

Regarding the feasibility of presentation, the criteria for clarity of presentation of procedures include suggestions and input from validators, namely that the presentation of game procedures is not clear enough, so it is necessary to add several points to the guide sheet. Guides and procedures that are prepared systematically make it easier for students to use learning media. Presentation clarity can also improve the quality of gamification media (Amelia et al., 2020).

Regarding visual feasibility, there are suggestions and input from validators, namely that the cells and card backgrounds are given a more striking color difference so they do not look similar. Learning media through gamification that uses visual technology is essential in conveying basic concepts effectively, efficiently, and more interestingly for students (Kembuan & Irwansyah, 2019). According to Mufidah and Amir (2021), learning with constructivist media based on visual technology will help shape abstract learning concepts into more concrete ones with striking colors. Based on the results of validity tests conducted by (Ali and Sukanto, 2021), visual biology learning media is suitable for use and very interesting for students. This was also proven by Sudana et al. (2021), who said that gamification could explain abstract things by providing a more precise and realistic picture in conveying scientific material.

One suggestion in the feasibility test was related to musical tone. The suggestion is that the sounds used in media experiences that adopt gamification have been changed to a more calming type of music to help participants complete quizzes more comfortably. Based on the suggestions obtained, the gamification media has transformed into a more relaxed musical tone to make quiz implementation easier. This is relevant to research conducted by Lisnani and Emmanuel (2020), who found that the learning process becomes more exciting, engaging, easy, and challenging because it is accompanied by music.

The linguistic component of the media received an excellent score and is worthy. This is because the language contained in gamification will influence the student's learning process to improve working memory. According to Magdalena et al. (2021), understanding the language contained in learning media is very necessary for the student learning process to develop students' intellectual, social, and character abilities. A positive and significant influence is related to reasonable and appropriate language components in the learning process to improve students' understanding (Alfirahmadita & Maarif, 2020).

The content and material components as a whole received perfect and appropriate marks. This means that the content and materials in gamification media are valid, practical, and effective. The elements contained in gamification can bring positive results for student learning and can be widely applied in the teaching and learning process (Anggraeni et al., 2022). The content and materials in gamification present interesting teaching materials to support students' reasoning, working memory, problem-solving, and communication abilities (Pangestu et al., 2019).

Gamification is a form of learning media as the primary tool for students' social development. Gamification can take students from what they do not know to what they already know. If students are only given repeatedly read material, then receiving information will be passive. Meanwhile, with gamification, the student's learning process will further stimulate memory, which causes learning to be more active and efficient. Every time a student receives information, connections are built between synapses in the brain, and memory strengthens and consolidates. When the connections between synapses in a student's brain are strong, their memory will become more attached to the brain and more accessible to remember (Munidar et al., 2022).

CLOSING

Conclusion

The gamification media for cell division material that has been developed is declared to have high validity with an average score of 0.94 based on the appropriateness of presentation, visuals, language, content, and material.

Suggestion

Based on the results of research on the development of gamification media to improve students' working

memory on cell division material, it is necessary to expand gamification media to other biology learning materials so that it can create an effective, creative, and interactive learning environment. Apart from that, further research is needed to determine the long-term impact of involving other memory systems to find out whether there is an increase in learning achievement after using gamification media.

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