

Cell-Wolf game: A teaching tool for understanding Meiosis in form four Biology

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Published: 29 December 2023

To cite this article (APA): Saidin, S., & Abdul Halim, A. A. (2023). Cell-Wolf game: A teaching tool for understanding Meiosis in form four Biology. *EDUCATUM Journal of Science, Mathematics and Technology*, 10(2), 29–37. <https://doi.org/10.37134/ejsmt.vol10.2.4.2023>

To link to this article: <https://doi.org/10.37134/ejsmt.vol10.2.4.2023>

Abstract

The complexity of meiosis, combined with a lack of knowledge about chromosomes and misconceptions, contributes to students' difficulty understanding this process. Therefore, this study aimed to develop a *Cell-Wolf Game* as a teaching tool for form four biology students learning about meiosis and to assess its usability based on teacher trainees' perceptions. This study uses a developmental research design by employing ADDIE model as the instructional design model. Two instruments were used in this study: expert validation form and the usability perception of the questionnaire. Two biology lecturers have been appointed to assess the validity of teaching aid material content and questionnaires. A total of 103 trainee teachers from the Bachelors of Education (Biology) programme were selected as respondents for the field study. The study showed the content validity index for both the teaching aid material, and the questionnaire is 1.0, meanwhile, the reliability index for questionnaire was 0.76. The study showed that the trainee teacher's perception of the teaching aid material's design, teaching aid material's content, and the usability of the teaching aids is 3.76 (SD = 0.33), 3.68 (SD = 0.42) and 3.64 (SD = 0.47), respectively. In conclusion, the *Cell-Wolf Game* was successfully developed and validated in this study. Furthermore, trainee teachers' perceptions of the game have a high mean value, indicating that it is appropriate to be implemented as a teaching aid during teaching and learning sessions to create a fun learning environment, thereby strengthening students' understanding.

Keywords: *Cell-Wolf Game*, Meiosis, Game-Based Learning, Teaching tool

INTRODUCTION

In the current era of information and communication technology advancement, 21st Century Education (PAK21) is a suitable approach that should be implemented. According to the Ministry of Education (2018), the Malaysian Education Development Plan (PPPM) 2013-2025 has set 11 Shifts to achieve the vision of improving the standard of the 21st century education system, one of which is leveraging information and communication technology (ICT) [1]. Thus, teachers are also responsible for deepening PAK21 skills to meet the PPPM 2013-2025 goals, by making learning enjoyable and simple for students to understand. Game-based learning (GBL) has been shown to increase student engagement by providing students with a more comprehensive learning experience and improving their understanding through active participation in class [2]. Furthermore, it has the potential to motivate students as well as stimulating interest and creating exciting experiences for players [3]. This learning method, according to Tangkui and Keong [4], involves combining game features with teaching content, allowing students to have learning aids that help them learn. Teachers can engage students in the teaching and learning (TnL) process while incorporating 21st century learning features by using a GBL approach.

Nowadays, TnL method used by teachers is still teacher-centered resulting in unfocused students in the classroom [3]. This problematic method of teaching among teachers has an impact on student performance. Furthermore, students have a negative perception towards Biology because it contains abstract concepts that are unintelligible [5]. Preliminary study revealed that the topic of meiosis is difficult for students to understand [5, 6, 7]. One of the reasons of this problem is students must integrate several complex concepts related to the structure and function of chromosomes in order to gain a thorough understanding of meiosis. This is supported by the findings of the Malaysian Examination Board (LPM) analysis of student answers in the Sijil Pelajaran Malaysia (SPM) examination in 2014. Biology Analysis Paper 2 demonstrates a lack of understanding in meiosis, as they have not mastered the concept of cell division and are unable to communicate their ideas using scientific terms and concepts. In addition, cell division has previously been a very difficult topic for students [5]. As a result, teachers must diversify their teaching methods, such as developing game-based teaching aids, in order to better deliver lessons to students and improve understanding of fundamental concepts. Furthermore, the incorporation of games in education is not new, and the game does not have to be in digital form [8, 9]. Hence, the goal of this study is to develop *Cell-Wolf Game* as a teaching aid for the meiosis subtopics in Form Four Biology and assess its usability based on trainee teacher perception. This game is a teaching tool designed to help students master the Form 4 Biological Meiosis subtopic. This teaching resource was inspired by the online game Werewolf. There are several games developed for teaching the concept of meiosis such as Sex Chromosome Meiosis game, the Meiosis Game, Meiosis Review Game, Genetic & Meiosis, and Mitosis, Meiosis and Fertilization Vocabulary Review Taboo Game. However, *Cell-Wolf Game* differ from the available games. It has several unique features comprising multiple teams (Each team has its own agenda and goals, which adds complexity to the game), special roles (these roles add depth to the game and give players unique abilities to help them achieve their goals), large number of players (the game can be played with 4-5 players, making it a great option for large groups), hidden identities (players must keep their identity a secret, which adds an element of mystery to the game), and focus on group dynamics (players must work together to achieve their goals, but they must also deceive and manipulate each other to succeed) make it a fun and challenging game to play.

METHODOLOGY

Research design

This study uses a development design using a quantitative study approach. The development of the *Cell-Wolf Game* in the meiosis subtopic is guided by the ADDIE model. This model is a five-step systematic design that is frequently used by researchers to produce successful development. The steps are analysis, design, development, implementation, and evaluation [10]. Figure 1 illustrates the conceptual framework for the development and evaluation of the *Cell-Wolf Game*. The game was designed to meet the content of meiosis whilst still providing a fun exercise for students to help reinforce important biological concepts and terms (Figure 2). To incorporate the Cell Wolf game into the classroom, teachers are advised to provide students with a brief introduction to mitosis and meiosis. This will enhance their understanding of the concepts and enable them to apply their knowledge during gameplay. Prior to starting the game, teachers should explain that the *Cell-Wolf Game* is an interactive learning tool that aimed at enhancing comprehension. Then, students will be divided into small groups which promotes collaborative teaching and learning, allowing students to discuss and share information with one another. Teachers should encourage students to engage in discussions while playing the game, encouraging them to share information, ask questions, and collectively determine the validity of the information presented in the game. This approach fosters critical thinking and active participation. Following the gameplay, teachers can allocate time for reflection with the students. They can discuss the concepts covered in the game and address any questions or misconceptions that may have arisen during gameplay. One notable advantage of the *Cell-Wolf Game* is its incorporation of music and sound effects, which enhances the enjoyment and engagement. These elements contribute to creating a fun and immersive learning environment.

Population studies and sampling methods

The study population was among 147 teachers of biology trainees of Universiti Pendidikan Sultan Idris (UPSI) from semester six and seven. The respondents for this study were 103 biology trainee teachers comprising 75 female trainee teachers and 28 males. The number of these respondents is based on the sample size determination table proposed by Krejcie and Morgan [11]. A simple random sampling technique was used to determine the sample size for the study.

Research instrument and analysis data

The study used two types of research instruments, namely expert validation forms and usability questionnaires. Two experts from the Department of Biology were used to examine the face and content validity of the *Cell Wolf Game* and the questionnaire, respectively. The questionnaire used was adapted from the Rahim and Lee [12] study using a four-point Likert scale to analyze data scores starting from Highly Disagree (STS), Disagree (TS), Agree (S) and Very Agree (SS) scores. The data was descriptively analyzed using SPSS software to obtain frequency, percentage, mean and standard deviation values.

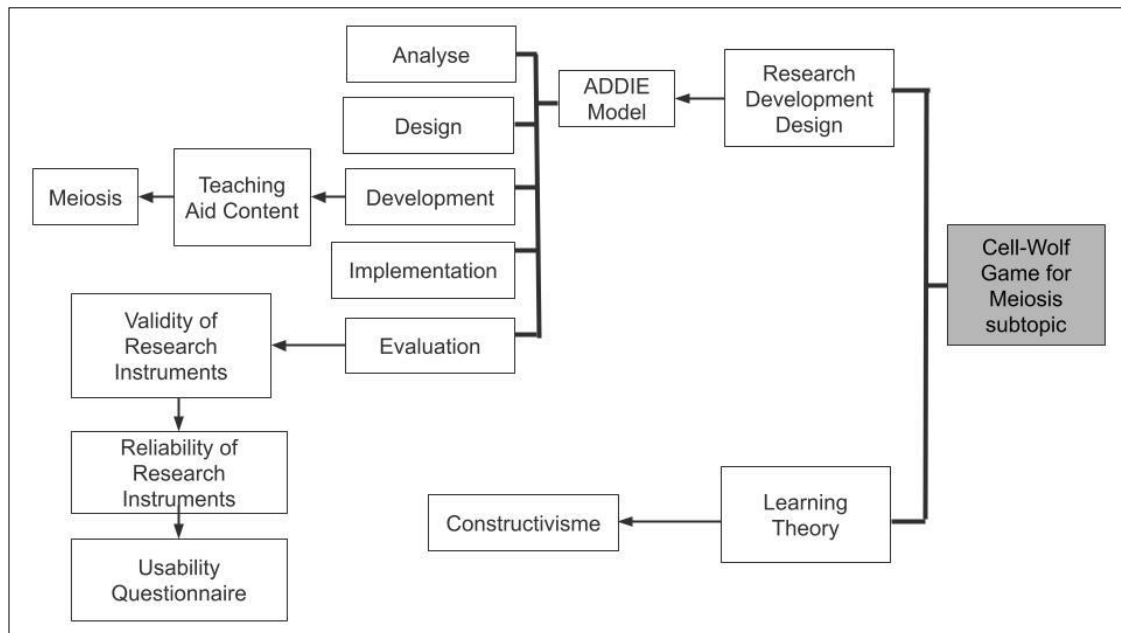


Figure 1 The conceptual framework for the development and evaluation of the *Cell-Wolf Game*



Figure 2 Meiosis questions in *Cell-Wolf Game*

RESULTS AND DISCUSSIONS

Validity and Reliability of Instruments

Two UPSI biology lecturers with expertise in genetics and biotechnology have been chosen as validity experts to provide feedback on the *Cell-Wolf Game*. There are seven items listed in the *Cell-Wolf Game* content validity form. Based on Table 1, we have managed to obtain high face validity and content values for *Cell-Wolf Game*. According to Sidek and Jamaludin [13], the validity level of a product must exceed 70% to achieve a high level of validity. In conclusion, *Cell-Wolf Game* is at an excellent level based on the percent of face and content validity.

Table 1 Validation of *Cell-Wolf Game*

Expert	Face Validity (%)	Content Validity (%)
Expert 1	100	100
Expert 2	100	100
Overall	100	100

Trainee teacher's perception on the development of *Cell-Wolf Game* for subtopic meiosis in Form 4 Biology

The perception of trainee teachers in this study focused on teaching aids design, content and usability. The actual study was conducted on 103 UPSI Biology trainee teachers who were in the sixth and seventh semesters to obtain the mean value and standard deviation on *Cell-Wolf Game* perception. Table 2 shows the summary of mean values and standard deviations of constructs in the teaching aids perception questionnaire. The findings showed that the mean value and standard deviation of all constructs in the trainee teacher's perception questionnaire of *Cell-Wolf Game* was 3.69 (SD = 0.41). This means that the construct of the content, design, usability and effectiveness are at a very high level. High validity values are important to ensure that the instrument used measures what should be measured [14, 15].

Table 2 Summary of mean values and standard deviations of constructs in the teaching aids perception questionnaire

Construct	Mean	Standard Deviation
Teaching aids design	3.76	0.33
Teaching aids content	3.68	0.42
Teaching aids usability	3.64	0.47
Overall	3.69	0.41

The perception of trainee teachers on *Cell-Wolf Game* design

The design of the teaching material includes the selection of elements and the application of content materials into the educational context [16]. According to Mahat et al. [17], the effectiveness of a teaching aids, is dependent on the user's acceptance of the design of the teaching aids presented. There are five items in this design construct such as the use of colors, text, graphics, layout and game screen display. This construct gets the highest mean value, which is 3.76 with a standard deviation value of 0.33. Trainee teachers agree that the font and font size used are appropriate and easy to read, screen displays, images and graphics and colors used are eye-catching and orderly. Overall, respondents' acceptance of teaching aid's design can help in facilitating understanding of the topics taught and being a factor in attraction, interest and motivation. Furthermore, the Power Point software used is also able to motivate students towards learning [18].

Table 3 Distribution of the scale frequency of the trainee teacher's perception on the *Cell-Wolf Game* design

No.	Item	Scale Frequency			
		1	2	3	4
1.	The font type used in <i>Cell-Wolf Game</i> is easy to read.	0 (0.00%)	1 (0.97%)	20 (19.42%)	82 (79.61%)
2.	The font size used in <i>Cell-Wolf Game</i> is appropriate.	0 (0.00%)	1 (0.97%)	22 (21.36%)	80 (77.67%)
3.	The screen display in <i>Cell-Wolf Game</i> attracts the attention of users.	0 (0.00%)	0 (0.00%)	23 (22.33%)	80 (77.67%)
4.	The image or graphics used in <i>Cell-Wolf Game</i> are interesting.	0 (0.00%)	0 (0.00%)	27 (26.21%)	76 (73.79%)
5.	Arrangement in the <i>Cell-Wolf Game</i> makes it easier for users to understand how to play.	0 (0.00%)	0 (0.00%)	29 (28.16%)	74 (71.84%)
				Mean	=3.76
				Standard Deviation	=0.33

The perception of trainee teachers on *Cell-Wolf Game* content

The *Cell-Wolf Game* content includes the materials used in the development of this teaching aid, such as characters and questions related to the meiosis subtopic. A total of five items were listed in the questionnaire to find out the trainee teacher's perception of the teaching aid's content. The overall mean value of the trainee teacher's perception of the content of this game is 3.68 and the overall standard deviation value is 0.42 which interpreted by Abdullah and Wei as the best value [19]. Trainee teachers

agree that the content of *Cell-Wolf Games* coincides with the Secondary School Standard Curriculum (KSSM) based on the Curriculum and Assessment Standard Document (DSKP). Therefore, we have developed these questions in *Cell-Wolf Game* by being guided by DSKP so that the learning objectives are implemented. Next, the content of teaching aid is also easy to understand. Therefore, the use of Power Point in teaching is very effective and easy to understand by users [20, 21]. In addition, this *Cell-Wolf Game* also has no spelling errors and the questions given are also related to the meiosis subtopic. We have included the questions found in the biology textbook for the fourth form of meiosis subtopics. According to Guat [22], textbooks are the most important teaching and learning material and are often used as a source of knowledge. We have also considered the learning objectives that students must meet for the subtopic of meiosis and have developed questions based on DSKP. Finally, the trainee teachers also agrees that this teaching aids helps in understanding and strengthening the concept of meiosis. Therefore, this teaching aids encourages discussions to be held between students. Through this discussion, students can understand and strengthen the concept of meiosis. In terms of content, *Cell-Wolf Game* has accurate content and is compatible with KSSM and helps in understanding and strengthening the concept of Meiosis during the game.

Table 4 Distribution of the scale frequency of the trainee teacher’s perception on the *Cell-Wolf Game* content

No.	Item	Scale Frequency			
		1	2	3	4
6.	The content of <i>Cell-Wolf Game</i> is coincided with the Secondary School Standard Curriculum (KSSM) based on the Curriculum and Assessment Standards Document (DSKP).	0 (0.00%)	2 (1.94%)	31 (30.10%)	70 (67.96%)
7.	The content of <i>Cell-Wolf Game</i> is easy to understand.	0 (0.00%)	2 (1.94%)	28 (27.18%)	73 (70.87%)
8.	There are no spelling errors in the content of <i>Cell-Wolf Game</i> .	0 (0.00%)	2 (1.94%)	25 (24.27%)	76 (73.79%)
9.	The questions given in the <i>Cell-Wolf Game</i> are relevant to the Meiosis subtopic.	0 (0.00%)	2 (1.94%)	27 (26.21%)	74 (71.84%)
10.	<i>Cell-Wolf Game</i> assists in the understanding and confirmation of the concept against the Meiosis subtopic.	0 (0.00%)	4 (3.88%)	32 (31.07%)	67 (65.05%)
				Mean	=3.68
				Standard Deviation	=0.42

The perception of trainee teachers on *Cell-Wolf Game* usability

The last construct is usability of the developed teaching aids. The usability of teaching aids provides an insight into the extent to which the teaching aids developed can be used by students to effectively achieve learning outcomes based on the perception of the trainee teacher. A total of four items were listed in the questionnaire to identify the trainee teacher's perception on the usability of the *Cell-Wolf Game*. The overall mean value of the trainee teacher's perception on the usability of *Cell-Wolf Game* is 3.64 and the overall standard deviation value is 0.47 which is also interpreted as outstanding by Abdullah and Wei [19]. The trainee teacher agrees that the *Cell-Wolf Game* delivery flow is easy to understand. As such, the teaching aids produced in the form of *Power Point* is easy to understand due to its not too complex design.

To aid understanding of the game, we also provided user manuals and game instructions. The class teacher serves as a facilitator and provides guidance for the implementation of this teaching aid.

Additionally, the trainee teachers concurs that the *Cell-Wolf Game* also can promote in-class learning interactions. This teaching aid requires students to discuss in their group to answer the questions given in due time. The game has set two minutes of time for the discussion to take place for each question. In this context, interaction refers to how well students cooperate within their groups and participate in group discussions. This element of interaction is important and is the main condition for the learning and teaching process to take place [23, 24]. Additionally, this *Cell-Wolf Game* is simple to play. The use of non-complex Power Point makes it easier for users to operate this teaching aids. Power Point programs help users manage the materials to be delivered easily and more effectively [20]. Finally, the trainee teacher also agrees that the link to access this *Cell-Wolf Game* is working well. This Game is placed in the *Google Drive* folder and only needs to copy the link of the folder for access.

Table 5 Distribution of the scale frequency of the trainee teacher's perception on the *Cell-Wolf Game* usability

No.	Item	Scale Frequency			
		1	2	3	4
11.	The <i>Cell-Wolf Game</i> delivery flow is easy to understand.	0 (0.00%)	3 (2.91%)	29 (28.16%)	71 (68.93%)
12.	<i>Cell-Wolf Game</i> promotes in-class learning interaction.	0 (0.00%)	2 (1.94%)	30 (29.13%)	71 (68.93%)
13.	<i>Cell-Wolf Game</i> is easy to operate.	0 (0.00%)	4 (3.88%)	36 (34.95%)	63 (61.17%)
14.	The link to access <i>Cell-Wolf Game</i> works well.	0 (0.00%)	4 (3.88%)	29 (28.16%)	70 (67.96%)
				Mean	=3.64
				Standard Deviation	=0.47

In conclusion, the *Cell-Wolf Game* is perceived as easy to use and understand in terms of usability and delivery flow. This implies that it can be readily adopted by teachers and students without significant barriers. The game's easy-to-understand delivery flow suggests that it effectively presents the concepts of meiosis. By using the game as a teaching material, students may have a better grasp of these topics, leading to improved learning outcomes. The game being used as an ICT-integrated teaching aid indicates the integration of technology in the classroom. This can enhance students' digital literacy skills and make the learning experience more engaging and enjoyable. Overall, this study suggests that this game has the potential to be a valuable teaching tool in the classroom, facilitating interactive and engaging learning experiences for students.

CONCLUSION

The *Cell-Wolf Game* teaching aids have been successfully developed by being guided by the ADDIE model. The findings showed that this teaching aids obtained a validity coefficient (CKI = 1.00, I-CVI = 1.00) and a high reliability value ($\alpha = 0.76$). The mean value for the teaching aids design is 3.76 (SD = 0.33) while the teaching aids content gets a mean value of 3.68 (SD = 0.42) and for the teaching aids usability construct is 3.64 (SD = 0.47). Thus, this *Cell-Wolf Game* can be used by teachers to deliver more effective and fun teaching and learning session in the classroom.

ACKNOWLEDGEMENT

We would like to thank the Department of Biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, as well as all participants in the study, particularly trainee teachers from the Bachelor of Education (Biology) programme.

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