Implementation of Game-Based Learning in Biology Learning to Improve the Ability of High School Students: A Narrative Literature Review

Nida Zahra Al Banna [1,*], **Agung Wijaya Subiantoro** [2]

Department of Biology Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta-Indonesia

[1] nidazahra.2023@student.uny.ac.id; [2] agung_wijaya@uny.ac.id
* Corresponding author: nidazahra.2023@student.uny.ac.id

ABSTRACT

Game-based learning is a widely implemented model in biology education. This study aimed to know (1) the contribution of improving the ability of high school students after the implementation of Game-Based Learning in biology learning; (2) the types of Game-Based Learning implementation used in biology learning to improve the ability of high school students. This study used a narrative literature review to synthesize findings flexibly across diverse game-based learning models. Sixteen articles were selected from those published in the last 10 years (2014-2024). The research articles were obtained from Google Scholar, Scopus, and Garba Rujukan Digital (Garuda) databases. The analysis and narrative review results showed that implementing game-based learning in biology learning positively contributed to improving high school students' ability in terms of critical thinking, activeness, independence, concept understanding, and cognitive learning outcomes. The form of implementing game-based learning in biology learning is highly varied, including web-based games (*Kahoot*, *Quizziz*, and *Wordwall*), android-based games, and traditional games (crossword and Snakes and Ladders). The findings provide actionable recommendations for biology educators to adopt game-based models tailored to student needs.

Keywords: Game-Based Learning, Educational Games, Biology Learning

Introduction

The Merdeka Curriculum demands a more student-centered learning process, so the learning process must actively involve students in understanding the material being studied. One of the learning models that can be applied to foster student-centered learning is game-based learning (GBL). Game-based learning is a learning model that involves games in the learning process that can create a fun learning atmosphere, encourage curiosity, and improve various learner abilities, such as critical thinking, concept understanding, cognitive learning outcomes, activeness, and self-reliance (Hung et al., 2019). On the other hand, GBL is an attractive model for students and can be used to achieve learning objectives. However, the teachers also experience difficulties when practicing GBL, including time limitations and technical problems such as unstable internet connection and inadequate equipment (Siburian & Mahmud, 2022).

Most teachers use this model as a strategy to improve students' abilities. The game-based learning model has the following learning syntax: 1) Choosing a game according to the topic; 2) Explaining the concept of the game; 3) Explaining the rules of the game; 4) Playing the game according to the duration of the game; and 5) Summarizing knowledge and experience after playing the game (Ngurah & Made, 2023). As time passes, especially in digital technology in the 21st century, many forms of web-based games can be used in game-based learning models such as *Kahoot*, *Quizziz*, and *Wordwall*. There are also Android-based and traditional games, such as crossword puzzles and *Snakes and Ladders*.

Web-based games, such as *Wordwall*, as stated in Sadiyah et al. (2023), improve students' critical thinking skills on ecosystem material. Furthermore, research by Ngurah & Made (2023) also stated that the implementation of game-based learning in traditional types, such as crossword, improves the activeness of students in the class on the teaching of the excretory system from 52.17% to 84.78% in the final cycle. This is similar to the research of Nurfahsyai et al. (2023), which also states that implementing game-based learning, such as *Snakes and Ladders*, can improve students' activeness during learning.

Based on the various studies above, researchers are interested in narrating the literature review to find answers to the research questions that have been posed. The research question was created so that researchers can focus on the literature review and facilitate researchers in finding related data for optimal results (Yovita et al., 2022). The research questions of this study are: 1) How is the contribution of improving the ability of high school students after the implementation of game-based learning in biology learning? and 2) What types of game-based learning implementation are used in biology learning to improve the ability of high school students? Therefore, the article is entitled: "Implementation of Game-Based Learning in Biology Learning to Improve the Ability of High School Students".

Methods

This research uses a type of literature review method: Narrative Literature Review. The narrative literature review method was chosen for its flexibility in synthesizing diverse research findings and offering a descriptive overview of the selected studies, as opposed to systematic reviews that require strict inclusion criteria. This research is based on analyzing various literature sourced from scientific articles that align with the topic of study. Literature review research with this method aims to arrange a summary or review that comes from the results of research that has been done before, then repackaged in narrative form. So, no statistics are involved; there is only a description of the research results found in narrative form to provide a better overview of the studied topic (Nahyidin, 2023).

The scientific articles used in this study are scientific research articles collected from databases such as Google Scholar, Scopus, and Garba Rujukan Digital (Garuda) from 2014-

2024. Scopus and Google Scholar were chosen for their comprehensive coverage of high-impact studies, while Garuda was included to incorporate locally relevant research in the Indonesian educational context. Publish or Perish (PoP) software also assisted in article collection because PoP provides the option to do an article search. The relevant research literature was searched using the keywords: "Game-Based Learning", "Game Education", and "Biology Learning". Articles can be written in English or the Indonesian language. This article search was held in April 2024. Then, 16 articles were collected that matched the research aims and criteria.

Results and Discussion

The analysis of 16 articles revealed that implementing game-based learning in biology significantly improved high school students' abilities. The data is presented in Table 1, which contains the journal's identity, research information regarding the ability of students who have improved, and the materials used.

Table 1. The contribution of game-based learning to the students' abilities

Article Code	Year of Article	Author	Students' Ability	Learning Topics
B01	2024	(Nurlatifah et al., 2024)	Cognitive Learning Outcomes	Biotechnology
B02	2023	(Misliyanti et al., 2023)	Activeness and Cognitive Learning Outcomes	Virus
B03	2023	(Nurfahsyai et al., 2023)	Cognitive Learning Outcomes	Biodiversity
B04	2023	(Nur et al., 2023)	Activeness	Biodiversity
B05	2023	(Ngurah & Made, 2023)	Activeness	Excretory System
B06	2023	(Rahmah & Risnani, 2023)	Concept Understanding	Ecosystem
B07	2023	(Sadiyah et al., 2023)	Critical Thinking	Ecosystem
B08	2023	(Wulan et al., 2023)	Cognitive Learning Outcomes	Virus
B09	2023	(Juniarthi et al., 2023)	Cognitive Learning Outcomes	Virus
B10	2022	(Johny, 2022)	Cognitive Learning Outcomes	Biodiversity
B11	2021	(Kurniawan & Risnani, 2021)	Concept Understanding	Plantae
B12	2021	(Bahari & Yuliani, 2021)	Critical Thinking	Growth and Development
B13	2021	(Prenawa et al., 2021)	Self-Reliance	Virus
B14	2020	(Noor, 2020)	Cognitive Learning Outcomes	Scope of Biology
B15	2019	(Wibowo & Ramadhan, 2019)	Concept Understanding	Genetics
B16	2015	(Nisa et al., 2015)	Cognitive Learning Outcomes	Reproductive System

The Contribution of Game-Based Learning to the Students' Abilities
Table 1 revealed that implementing game-based learning in biology significantly improved high school students' abilities. Game-based learning impacts critical thinking, activeness, self-reliance, concept understanding, and cognitive learning outcomes.

Critical Thinking

Critical thinking is the ability to analyze information comprehensively and rationally to make the right decision based on the knowledge that has been gained. Paul & Elder (Santi et al., 2018) stated that individual critical thinking can be assessed through the dimensions of reasoning. The first dimension is the elements of reasoning, including purpose, questions, assumptions, points of view, information, concepts, inferences, and implications. The second dimension is the intellectual standard of reasoning used to measure each reasoning element in the first dimension. The intellectual standards of reasoning include the following: clarity, accuracy, precision, relevance, depth, breadth, and logic. Facione (Nurfaizah et al., 2022) also stated six critical thinking indicators: interpretation, analysis, evaluation, conclusion, explanation, and self-regulation.

This ability is an important ability that every student must have. Therefore, schools should endeavor to learn to support the improvement of students' critical thinking skills. Improving critical thinking skills is measured by working on pre-test and post-test questions. The article B07 in Table 1 states that implementing the game-based learning model on complex ecosystem material has improved students' critical thinking skills. Learning with this game-based learning model helps students solve problems in the learning process. This is caused by students having to consider and find the cause-and-effect relationship of a problem in the game and how to solve the problem, so that the results of measuring the critical thinking skills of students on ecosystem material show significant results with the implementation of the game-based learning model (Sadiyah et al., 2023).

Implementing the game-based learning model has also been proven to improve critical thinking skills in other biological materials, such as those written in the article with code B12 in Table 1, which is the growth and development known for its wide scope of material. The implementation of the game trains students to achieve critical thinking aspects, such as interpretation, where students can understand the problems given by the teacher in the game. Then, there is the aspect of inference that arises when students try to assemble the knowledge they have to reach an answer or conclusion, so that the apparent use of this game encourages students to think in depth using reasoning and be able to convey their arguments or answers (Bahari & Yuliani, 2021).

The fundamental constructivist theory, developed by Jean Piaget and Lev Vygotsky, holds that knowledge created via experience is undoubtedly connected to developing students' critical thinking following instruction utilizing the game-based learning paradigm. Through inquiry and active learning through games, students in the game-based learning model can evaluate the material at their disposal, create new knowledge based on their experiences, and analyze and make well-informed judgments. With instant feedback on their game results, game-based learning also offers a rich environment for exploration and reflection, enabling students to consider their choices. Students can improve their future strategies and comprehend the repercussions of their activities with this feedback (Gunanto, 2021).

Activeness

The students' activeness can be defined by the students' ability to be involved physically, mentally, and emotionally during the learning process. As stated by Sardiman (Wibowo, 2016), student learning activity itself is a student activity that is both physical and mental in learning, where students do and think as a series that cannot be separated. Then, Sudjana (Ula, 2024) outlines indicators of learning activeness, namely participating in teaching tasks, being involved in problem-solving, asking friends or teachers, seeking information, conducting group discussions, assessing self-ability, practicing problem-solving, and applying the information obtained.

Student activeness was measured using an activeness observation sheet. Game-based

learning ensures active engagement between students, who work together to play the game and find answers to the given problems (Aini, 2018). This can be found in article code B02, wherein the virus material and games are used to increase students' activities, such as reading books, asking the teacher questions, and giving answers or comments when playing games. Then, students also take notes on the material presented during the presentation as material to answer questions in the game. So that when it is time to play the game, students are very active and enthusiastic about solving existing problems by working with their groupmates (Misliyanti et al., 2023).

Biodiversity material, which has a broad scope, often makes students lose focus and interest in understanding this material. This is evidenced in article B04, where students frequently cause additional movements during the learning process, such as leaving their seats, making noise, and disturbing peers and teachers. Then, teachers work around this by applying games to learning so that the problem of student unfocus can be minimized and create a fun learning atmosphere so that students are interested in being actively involved and playing directly while understanding the material (Nur et al., 2023). Although using games in learning is very fun, teachers still pay attention to the use of time because the application of games in learning sometimes makes students focus only on games rather than on learning materials.

Furthermore, article B05 mentioned that applying game-based learning on excretory system material positively increased student activeness during the learning process, from 52.17% in the pre-cycle to 84.78% in the second cycle. This is due to the direct involvement of students in the game. Students also work actively with their group members to gather information that will be used in the game. The information is then tested in the game, creating long-term impressions and memories because of the pleasant learning atmosphere for students (Ngurah & Made, 2023). The correlation between the increase in student activeness and the application of game-based learning is very high; where according to the theory of "Learning by Doing" by John Dewey, it is stated that students need to be involved in the learning process spontaneously or in other words, students need to be actively engaged so that their curiosity arises and this is accommodated through game-based learning (Robani *et al*., 2021).

Self-Reliance

Self-reliance is the ability of individuals to direct and control themselves in thinking and taking action. Self-reliance means the ability of students to direct and maintain themselves, to organize efficient learning sessions to improve their ability. This game-based learning model plays a concrete role in student self-reliance, especially during the COVID-19 pandemic, where long-distance learning or online learning was held, and teachers could not monitor students directly in the classroom in person. This game helps students understand the material provided in a fun way, even though they do not meet directly with the teacher (Correia & Santos, 2017). Article B13 proves that the application of this game-based learning model shows a positive contribution in the form of an increase in student learning independence by 34% in learning virus material during the COVID-19 pandemic. Students maintain an interest in learning at home. By applying games in this distance learning, students remain eager to learn the material independently and compete in challenging and fun games (Prenawa et al., 2021).

Concept Understanding

Concept understanding is one of the students' abilities, where students can build their knowledge about a concept. The easiest way for students to understand concepts is by actively involving students in learning. The game-based learning model is a learning model that actively involves students. Using this way of playing, students actively try to solve problems with concepts or knowledge about the material they already have (Tendrita, 2017). Article B06 proves that concept understanding in ecosystem material can be improved by applying game-based learning. "The Ecosystem" game has interactive features that help students visualize

complex ecological relationships and lead to deeper conceptual understanding. This learning model that uses game media can attract students' attention to learn it, impacting the ease of students' understanding a material concept (Rahmah & Risnani, 2023).

Article B11 uses games to help students understand the broad concept of plant material because learning becomes less saturated and can help student retention. The game "Adventure of Plant" has three levels, and it has been adjusted to the indicators of plant material. The three levels cover moss material (Bryophyta), ferns (Pterydophyta), and seed plants (Spermatophyta). Each level has different challenges and difficulties. Therefore, the player must be able to master the Plantae material to complete the adventure and open the evaluation questions (Kurniawan & Risnani, 2021). The increase in understanding of this concept is measured by analyzing the significant increase in students' pre-test and post-test scores, as in article B15, students are asked to answer questions at each level. Previously, students had been given material related to the questions. In the material, there are videos and summaries. The material and questions provided cover all the subchapters in the Genetic material chapter, so that they can be used as a reference for the level of understanding of Genetic material. The result is a significant increase in scores and proves an increase in student understanding after applying game-based learning in learning Genetic material by 83.8% (Wibowo & Ramadhan, 2019).

Cognitive Learning Outcomes

Cognitive learning outcomes are the ability of students to learn material concepts at school, and the results are expressed in the form of scores through tests (Naimnule et al., 2016). These cognitive learning outcomes determine the high level of learning success. One indicator of student learning success is the establishment score of the standard completeness of passing grades students must achieve. The success of learning in achieving standard completeness of passing grade scores is certainly affected by many factors. Appropriately using models and media in learning significantly affects students' learning outcomes. The implementation of game-based learning models in the learning process is capable of creating learning experiences that are fun and effective and have a significant effect on students' cognitive learning outcomes. These cognitive learning outcomes are measured by instruments such as test questions after learning with the game-based learning model (Sitorus & Santoso, 2022).

The implementation of this game-based learning model has been widely used in various materials. It affects improving cognitive learning outcomes, as in articles B02, B08, and B09, which applied game-based learning to the same material, viruses. Students consider this virus material as material that has many terms, so it is not easy to remember, and sometimes makes students less interested in learning it. According to article B02, using games to teach viruses can attract students' attention. Then, after the test, cognitive learning outcomes showed an increase in very high cognitive learning outcomes from 71% to 100%. This means all students can fully achieve the standard completeness of passing grade scores by learning games (Misliyanti *et al.*, 2023). The same material, article B08, shows that using games with templates that are not tedious and unique can attract students' interest in learning. Students were very enthusiastic about answering questions in the game, especially those related to new terms (Wulan *et al.*, 2023). Article B09 also confirmed the effect of play-based learning on improving cognitive learning outcomes due to the game characteristics that allow a sense of competition to get the highest score. To get the highest score, students must have mastered the material, answered questions quickly, and gotten a good score (Juniarthi *et al.*, 2023).

The other materials are biodiversity in articles B03 and B10. Article B03 shows improved cognitive learning outcomes using games during the learning process. This game makes students active in discussion activities with their group members, looking for and finding ideas and solutions in problem-solving. Students can more easily understand and know the problems they learn when faced with tests *(*Nurfahsyai *et al.*, 2023). Then, in article

B10, students, when they were observed, seemed to have a lack of interest in learning, which affected the learning outcomes that did not reach the standard completeness of passing grade scores. After the implementation of game-based learning, there was an increase in interest in learning, which affected cognitive learning outcomes from 68% to 82% of students who reached the standard completeness of passing grade scores (Johny, 2022).

Biology material in class X also has quite complex material, which is the scope of biology. In article B14, it is explained that this material, when tested, made many students fail to reach the standard completeness of passing grade scores because the material delivery was in the form of lectures, so students were not motivated to learn. Then, a solution was given using game-based learning to deliver the material. This changes the classroom atmosphere to be fun and indirectly increases learning motivation. Then, when this material was tested again, there was an increase in cognitive learning outcomes by 20% (Noor, 2020). In biotechnology material, which also has a wide range of materials, implementing game-based learning is known in article B01 to significantly improve cognitive learning outcomes from 68% to 84%. This shows that using games to understand the material and answer questions makes students feel more comfortable than understanding the material with the lecturing method and doing questions in a conventional form with paper (Nurlatifah et al., 2024). Class XI has much material about the structure and function of organs in the body system. Reproductive system material is included in the material that is considered more difficult than other materials. So, in article B16, it was shown that changing the lecture learning model to a game-based learning model had a significant effect on students' cognitive learning outcomes. Students actively participated in the game and conducted discussions about the material to solve the questions in the game (Nisa et al., 2015).

The Types of Game-Based Learning that are Implemented in Biology Learning

After describing the contribution of game-based learning to improving students' abilities, the discussion continues by describing the types of game-based learning implemented in biology learning. This description is presented in Table 2, which contains the journal's identity as well as research information regarding the types of game-based learning implemented and the materials used.

Table 2. The types of game-based learning in biology learning

Article Code	Year of Article	Author	Type of Game-Based Learning	Learning Material
B01	2024	(Nurlatifah *et al.,* 2024)	Web-Based Game (*Quizziz*)	Biotechnology
B02	2023	(Misliyanti *et al.,* 2023)	Web-Based Game (*Wordwall*)	Virus
B03	2023	(Nurfahsyai *et al.,* 2023)	Web-Based Game (*Wordwall*)	Biodiversity
B04	2023	(Nur *et al.,* 2023)	Traditional Game (*Snake and Ladder*)	Biodiversity
B05	2023	(Ngurah & Made, 2023)	Traditional Game (*Crossword Puzzle*)	Excretory System
B06	2023	(Rahmah & Risnani, 2023)	Android-Based Game (*The Ecosystem*)	Ecosystem
B07	2023	(Sadiyah *et al.,* 2023)	Web-Based Game (*Wordwall*)	Ecosystem
B08	2023	(Wulan *et al.,* 2023)	Web-Based Game (*Wordwall*)	Virus

Article Code	Year of Article	Author	Type of Game-Based Learning	Learning Material
B09	2023	(Juniarthi *et al.,* 2023)	Web-Based Game (*Quizziz*)	Virus
B10	2022	(Johny, 2022)	Web-Based Game (*Quizziz*)	Biodiversity
B11	2021	(Kurniawan & Risnani, 2021)	Android Based Game (*Adventure of Plant*)	Plantae
B12	2021	(Bahari & Yuliani, 2021)	Traditional Game (*Snake and Ladder*)	Growth and Development
B13	2021	(Prenawa *et al.,* 2021)	Web Based Game (*Kahoot*)	Virus
B14	2020	(Noor, 2020)	Web Based Game (*Quizziz*)	Scope of Biology
B15	2019	(Wibowo & Ramadhan, 2019)	Android Based Game (*Cali-Cali*)	Genetics
B16	2015	(Nisa *et al.,* 2015)	Traditional Game (*Snake and Ladder*)	Reproductive System

Web-Based Games

A web-based game is a digital game that can be accessed and played through a web browser without downloading an application. Players only need to open a web domain address and play according to the instructions. The game results from the interaction of players and game objects can be seen directly (Sujalwo & Sukirman, 2017). These web-based games, such as *Kahoot*, *Quizziz*, and *Wordwall*, are known in the analyzed articles.

Kahoot

Kahoot is a web-based game widely used in the learning process. *Kahoot* can be accessed by opening the web domain address "https://kahoot.com/" in a browser. Kahoot has many features. The most used feature in learning is a quiz. *Kahoot*'s quiz feature allows students to answer questions directly through devices such as smartphones after opening the web domain and entering the class code (Ilmiyah & Sumbawati, 2019). Article B13 states that *Kahoot* is a medium for game-based learning models. *Kahoot* can combine learning experiences through interactive games and is equipped with an assessment system that makes it easier for teachers (Prenawa et al., 2021). The advantage of the *Kahoot* web is that the questions presented in the application have a limited time allocation, so students are trained to think quickly and precisely to solve problems. Moreover, many features in *Kahoot* can be accessed for free, so teachers can explore various types of games for learning (Bunyamin et al., 2020).

Quizziz

Quizziz is a web-based game that is frequently used as a learning medium. *Quizziz* has a web address: https://quizziz.com. This web contains many types of games with interactive forms and can be accessed for free. The main features are various themes, leaderboards, and music playback as you want. Easy access and the availability of multiple types of games allow teachers to create games that will be applied in class freely. *Quizziz* can make the class atmosphere more exciting without losing the importance of the material. Students use the class code to start the game using this *Quizziz* game (Rahman et al., 2020).

Web *Quizziz* used in biology learning can be shown in articles B01, B09, B10, and B14. *Quizziz*, as used in these articles, can provide a more effective stimulus to students than conventional learning. This *Quizziz* offers an atmosphere of competition to motivate students to achieve better results (Nurlatifah *et al.,* 2024). The number of players that can include many

people allows students to create groups and discuss the game. Teachers and students can also easily see the game's results, which will be evaluated together (Juniarthi *et al.*, 2023). *Quizziz* is known as a narrative and flexible game. Many *Quizziz* features emphasize creativity, thinking, and time management (Johny, 2022). This can help students master the material and increase their learning self-reliance. Students' retention improves as they play (Noor, 2020).

Wordwall

Wordwall is a website containing various types of games that can be used for learning. *Wordwall* can be used by accessing its web address, https://wordwall.net/ in a browser. *Wordwall* can include images, audio, animation, and various interactive games that can be accessed for free. The advantage of *Wordwall* is that if you have problems with the internet network, *Wordwall* can be printed in PDF form as a solution (Sari *et al.*, 2021). Another advantage is that there are many types of interactive games. Teachers can create questions on *Wordwall* creatively by using the 18 game templates available. Game templates such as quiz templates, puzzles, and many more. Then, when using it, the teacher shares the link for students to access without downloading the application (Wafiqni & Putri, 2021).

The utilization of web *Wordwall* in biology learning can be shown in articles B02, B03, B07, and B08. The *Wordwall* used in these articles can encourage students to be active in learning activities, such as discussion with group members to solve problems or questions in the game (Nurfahsyai *et al.*, 2023). For example, the word match game is one of the game types in the *Wordwall*. This type of word match game is very appropriate to help students understand unfamiliar terms and their explanations without feeling overwhelmed. With this game, students find ways to understand unfamiliar terms in a fun and enthusiastic atmosphere with group members (Wulan *et al.*, 2023).

Android Based Games

Android-based games are specifically used on smartphones that run on the Android operating system. Most students have smartphones that are using the Android operating system. This Android system is open-source, which means it is free to use and develop (Ramansyah, 2016). Because of that, many people use Android-based games to learn. The implementation of game-based learning that uses Android-based games is getting a lot. Android-based games, played through a smartphone, make it easy for students to restudy the material anywhere and anytime. Students can download the Android-based game application from the Play Store or share via data transfer, such as Bluetooth (Putra & Nugroho, 2016). From article B6, this Android-based game called "The Ecosystem" was created using Adobe Illustrator CS6 and Unity applications for ecosystem material. After that, the game is formatted into Android format (.apk), making it easy to use on smartphones (Rahmah & Risnani, 2023).

In article B11, this android-based game called "Adventure of Plant" was created using the Adobe Illustrator CS6 application and the Unity 2D Version 2019.4.lfl application. Then, the game is converted into an Android format (.apk) to be played. This "Adventure of Plant" game is an android-based game for Plantae material with an attractive appearance in terms of design, graphics, characters, and challenges for game users (Kurniawan & Risnani, 2021). This is similar to article B15, where a game called "*Cali-Cali*" was also created using the Adobe Illustrator CS6 application and the Unity 2D Version 2019.4.lfl application. This "Cali-Cali" game is a game about genetic material. This game has an adventure plot with the main character, who goes on an adventure in the form of curiosity about genetic material. During the journey, the main character will meet many obstacles in the form of questions that must be answered based on clues and explanations of the material at each level (Wibowo & Ramadhan, 2019).

Traditional Games

Traditional games have existed for a long time and are played by children. Popular traditional

games include hide and seek, snakes and ladders, jump rope, crossword puzzles, and marbles. These traditional games can be used in learning because they have educational values that are not less good than web-based games or Android-based games (Khomsin & Rahimmatussalisa, 2021). The analyzed articles show that the traditional games used are *Crossword Puzzles* and *Snakes and Ladders*.

Crossword Puzzle

Crossword puzzle is a traditional game that has existed for a long time and is known as a game that uses the mind or brain power. Using crossword puzzles in learning can improve students' thinking power (Ade et al., 2021). In article B05, it is explained that crossword puzzle games are played in groups. So that each group must compete to answer as many crossword questions as possible; this game can increase students' learning motivation to be more concentrated during learning and more active in finding information related to learning materials. In this way, students become more active in asking questions, discussing with groups, communicating perceptions, paying attention to explanations, and taking notes to prepare themselves and groups when playing games (Ngurah & Made, 2023).

Snakes and Ladders

Snakes and Ladders is a traditional game that has existed since the old days and is still often played today. *Snakes and Ladders* is a board game with a game board that contains images of snakes, ladders, and dividers in boxes that usually contain numbers 1-100, and is played using dice (Wati, 2021). The *Snakes and Ladders* game in this learning can actively involve students physically and emotionally to create a joyful learning atmosphere. The article B04 explains that implementing game-based learning in learning uses a *Snakes and Ladders* game printed as a banner. So that students can play directly and actively participate on the banner that contains a *Snakes and Ladders* board. Students are enthusiastic about playing this game and feel that this can relieve learning pressure (Nur et al., 2023). Research conducted by Nisa et al. (2015) in article B16 also shows that the *Snakes and Ladders* game makes students more active in learning. Students become active in discussions and actively ask questions if there are questions in *Snakes and Ladders* that need to be clarified. In article B12, it is mentioned that the *Snakes and Ladders* game in the learning process provides many benefits for students, such as gaining insight, developing problem-solving skills, emphasizing concentration, activeness, and communication skills.

Conclusion

Based on the analysis and narrative review of the 16 articles above, implementing game-based learning in biology education positively improves high school students' abilities in terms of critical thinking, activity, independence, concept understanding, and cognitive learning outcomes. Game-based learning implementations in biology education vary, such as web-based games (*Kahoot*, *Quizizz*, and *Wordwall*), Android-based, and traditional games (*Crossword Puzzles* and *Snakes and Ladders*). Based on its effectiveness in learning, the application of web-based games currently dominates and has proven effective in enhancing various student abilities in different biology topics. The varied implementation allows flexibility in its application to accommodate different learning styles and classroom conditions. Future research could explore the long-term impact of game-based learning on biology learning outcomes and compare its effectiveness across various educational institutions.

References

Ade, M. Y. N., Bare, Y., & Mago, O. Y. T. (2021). Development of crossword learning media (TTS) on the material of the motion system for class XI high school. *Jurnal Pendidikan MIPA*, *11*(2), Article 2. https://doi.org/10.37630/jpm.v11i2.485

Aini, F. N. (2018). The effect of game-based learning on interest and learning outcomes in economics subjects of XI IPS class students. *Jurnal Pendidikan Ekonomi (JUPE)*, 6(3). https://doi.org/10.26740/jupe.v6n3.p%p

Bahari, F. V., & Yuliani, Y. (2021). Development of the snakes and ladders game on growth and development materials to train critical thinking skills of class XII high school students. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 10(3), 617–626. https://doi.org/10.26740/bioedu.v10n3.p617-626

Bunyamin, A. C., Juita, D. R., & Syalsiah, N. (2020). Using Kahoot as a game-based learning media as a form of learning variation. *Gunahumas*, 3(1), Article 1. https://doi.org/10.17509/ghm.v3i1.28388

Correia, M., & Santos, R. (2017). *Game-based learning: The use of Kahoot in teacher education*. 1–4. https://doi.org/10.1109/SIIE.2017.8259670

Gunanto, S. G. (2021). Game-based learning: A constructive media for self-directed learning for students. *Rekam: Jurnal Fotografi, Televisi, Animasi*, 17(1), Article 1. https://doi.org/10.24821/rekam.v17i1.4951

Hung, C. Y., Sun, J. C. Y., & Liu, J. Y. (2019). Effects of flipped classrooms integrated with MOOCs and game-based learning on the learning motivation and outcomes of students from different backgrounds. *Interactive Learning Environments*, 27(8), 1028–1046. https://doi.org/10.1080/10494820.2018.1481103

Ilmiyah, N. H., & Sumbawati, M. S. (2019). The effect of Kahoot media and learning motivation on student learning outcomes. *JIEET (Journal of Information Engineering and Educational Technology)*, 3(1), 46–50. https://doi.org/10.26740/jieet.v3n1.p46-50

Johny, M. M. (2022). The use of Quizziz learning media in improving biology learning outcomes. *TEACHER: Jurnal Inovasi Karya Ilmiah Guru*, 2(2), Article 2. https://doi.org/10.51878/teacher.v2i2.1332

Juniarthi, D., Timang, R., & B, N. (2023). Improving learning outcomes using Quizizz learning media on biology subjects of class X MIPA I students of SMA Negeri 3 Toraja Utara. *JP-3: Jurnal Pemikiran dan Pengembangan Pembelajaran*, 5(2), Article 2. https://doi.org/10.31970/pendidikan.v5i2.737

Khomsin, K., & Rahimmatussalisa, R. (2021). Effectiveness of Snakes and Ladders game media to improve English vocabulary recognition skills in early childhood. *Jurnal Pendidikan Anak*, 10(1), Article 1. https://doi.org/10.21831/jpa.v10i1.37872

Kurniawan, M. R., & Risnani, L. Y. (2021). Development of digital educational games and implementation in learning biology plantae material for high school students in grade X. *BIOEDUKASI: Jurnal Pendidikan Biologi*, 12(1), Article 1. https://doi.org/10.24127/bioedukasi.v12i1.3759

Misliyanti, W., Adnan, A., & Hajar, A. (2023). Efforts to improve activeness and learning outcomes through the application of Wordwall learning media in biology learning. *JP-3: Jurnal Pemikiran dan Pengembangan Pembelajaran*, 5(3), 449–456. https://doi.org/10.31970/pendidikan.v5i3.822

Nahyidin, N. A. (2023). Librarian performance research in libraries through google scholar database: Narrative literature review. *BIBLIOTIKA: Jurnal Kajian Perpustakaan dan Informasi*, 7(2), 227–239. http://dx.doi.org/10.17977/um008v7i22023p227-239

Naimnule, L., Oetpah, V., & Sila, V. U. R. (2016). Improving students' cognitive learning activities and outcomes through the implementation of think talk write (TTW) learning model at SMUK. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(10), Article 10. https://doi.org/10.17977/jp.v1i10.7622

Ngurah, T. J. I. G. A., & Made, R. P. P. N. (2023). Implementation of game-based learning in biology learning to increase student activity in class XI MIPA SMA Negeri 1 Kuta Utara. *Emasains: Jurnal Edukasi Matematika dan Sains*, 12(1), Article 1. https://doi.org/10.5281/zenodo.7900617

Nisa, A., Djamahar, R., & Evriyani, D. (2015). Effect of application of ular tangga game media on cognitive learning result of human reproductive system. *Biosfer: Jurnal Pendidikan Biologi*, 8(2), Article 2. https://doi.org/10.21009/biosferjpb.8-2.4

Noor, S. (2020). The use of Quizizz in learning assessment on biology scope material to improve student learning outcomes of class X.6 SMAN 7 Banjarmasin. *Jurnal Pendidikan Hayati*, 6(1), 1–7. https://doi.org/10.33654/jph.v1i1.927

Nur, K., Muis, A., & Mulianti, M. (2023). Efforts to increase the activeness of learners following the learning process through game-based learning (GBL) at UPT SMA Negeri 1 Bone. *Jurnal Pemikiran dan Pengembangan Pembelajaran*, 5(3), Article 3. https://doi.org/10.31970/pendidikan.v5i3.910

Nurfahsyai, Bahri, A., & Delviany. (2023). Joyful learning method approach based on Wordwall to improve biology learning outcomes of biology class X students at SMA Negeri 5 Makassar. *Jurnal Pemikiran dan Pengembangan Pembelajaran*, 5(3), Article 3. https://doi.org/10.31970/pendidikan.v5i3.971

Nurfaizah, N., Putro, K. Z., & Tejaningrum, D. (2022). Students' critical thinking skills in the learning strategy course. *Jurnal Penelitian Ilmu Pendidikan*, 15(1), Article 1. https://doi.org/10.21831/jpipfip.v15i1.41689

Nurlatifah, A., Usman, A., & Hidayati, N. (2024). Application of Quizziz as a learning evaluation media in improving students' cognitive learning outcomes in biology subjects at SMA Negeri 1 Bondowoso. *Jurnal Biologi*, 1(4), 1–6. https://doi.org/10.47134/biology.v1i4.1989

Prenawa, W. N., Setiawati, N., & Centauri, B. (2021). The effect of Kahoot implementation as a digital game-based learning media on learning independence of students of SMAN 1 Basarang Kapuas regency 2020/2021 academic year. *Jurnal Teknologi Pendidikan*, 1(2), Article 2. https://doi.org/10.37304/jtekpend.v1i2.3017

Putra, D. R., & Nugroho, M. A. (2016). Development of android-based educational games as accounting learning media on service company adjusting journal material. *Jurnal Pendidikan Akuntansi Indonesia*, 14(1), Article 1. https://doi.org/10.21831/jpai.v14i1.11364

Rahmah, S., & Risnani, L. Y. (2023). Development of educational game-based learning media to improve mastery of ecosystem material in high school students. *Practice of the Science of Teaching Journal: Jurnal Praktisi Pendidikan*, 2(2), 84–98. https://doi.org/10.58362/hafecspost.v2i2.42

Rahman, R., Kondoy, E., & Hasrin, A. (2020). Development of Quizziz application as a quiz giving media in improving student learning motivation. *JISIP (Jurnal Ilmu Sosial dan Pendidikan)*, 4(3), Article 3. https://doi.org/10.58258/jisip.v4i3.1161

Ramansyah, W. (2016). *Development of Android-based Education Game (EDUGAME) on English Subjects for Elementary School Learners*. https://doi.org/10.21107/edutic.v2i1.1560

Robani, M. E., Rachim, F. A., Febriani, A., & A, E. R. F. (2021). Learning by doing method in optimizing the quality of learning of junior high school students. *Jurnal Ilmiah Edukasia*, 1(1), Article 1. https://doi.org/10.26877/jie.v1i1.7961

Sadiyah, S., Maspupah, M., & Yuliawati, A. (2023). Critical thinking ability of students using game-based learning (GBL) model assisted by Wordwall on ecosystem material. *Jurnal Bioedutech*, 2(2). https://doi.org/10.572349/biedutech.v2i1.1353

Santi, N., Soendjoto, M. A., & Winarti, A. (2018). Critical thinking skills of biology education students through environmental problem solving. *Bioedukasi: Jurnal Pendidikan Biologi*, 11(1), Article 1. https://doi.org/10.20961/bioedukasi-uns.v11i1.19738

Sari, R. N., Nazmi, R., & Zulfa, Z. (2021). The effect of Wordwall game on learning outcomes of history class X MIPA SMA 2 Lubuk Basung. *Puteri Hijau: Jurnal Pendidikan Sejarah*, 6(2), Article 2. https://doi.org/10.24114/ph.v6i2.28828

Siburian, S. N. R., & Mahmud, Y. S. (2022). Primary school teacher's perception of game-based learning in online learning: The advantages and challenges. *IJECA (International Journal of Education and Curriculum Application)*, 5(2), 116–132. https://doi.org/10.31764/ijeca.v5i2.8694

Sitorus, D. S., & Santoso, T. N. B. (2022). Utilization of Quizizz as a game-based learning media during the covid-19 pandemic. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, 12(2), Article 2. https://doi.org/10.24246/j.js.2022.v12.i2.p81-88

Sujalwo, S., & Sukirman, S. (2017). Web-based game as interactive physics learning media for junior high school students. *Progressive and Fun Education (Profunedu) International Conference Proceeding*. Seminar Nasional Kedua Pendidikan Berkemajuan dan Menggembirakan. http://publikasiilmiah.ums.ac.id/handle/11617/9603

Tendrita, M. (2017). Improving learning activities and understanding of biology concepts with survey, question, read, recite, review (SQ3R) strategy for students of class XI IPA SMA Negeri 5 Kendari. *Jurnal VARIDIKA*, 28(2), Article 2. https://doi.org/10.23917/varidika.v28i2.2867

Wafiqni, N., & Putri, F. M. (2021). The effectiveness of using Wordwall application in online learning of mathematics on the material of numbers in grade 1 at MIN 2 South Tangerang City. *Elementar: Jurnal Pendidikan Dasar*, 1(1), Article 1. https://doi.org/10.15408/elementar.v1i1.20375

Wati, A. (2021). Development of Snakes and Ladders game media to improve learning outcomes of elementary school students. *Mahaguru: Jurnal Pendidikan Guru Sekolah Dasar*, 2(1), Article 1. https://doi.org/10.33487/mgr.v2i1.1728

Wibowo, F. M., & Ramadhan, M. A. (2019). Designing biology educational games to improve understanding of genetics material. *Jurnal Resti: Rekayasa Sistem dan Teknologi Informasi*, 3(3), 349–356. https://doi.org/10.29207/resti.v3i3.1058

Wibowo, N. (2016). Efforts to increase student activeness through learning based on learning styles at SMK Negeri 1 Saptosari. *Elinvo (Electronics, Informatics, and Vocational Education)*, 1(2), Article 2. https://doi.org/10.21831/elinvo.v1i2.10621

Wulan, W., Palennari, M., & Sundariati, S. (2023). Implementation of differentiated learning by using Wordwall media in biology learning class X. *Jurnal Pemikiran dan Pengembangan Pembelajaran*, 5(3), Article 3. https://doi.org/10.31970/pendidikan.v5i3.929

Yovita, Y., Qomariah, W. F., & Syafaren, A. (2022). Effectiveness of using educational games in elementary schools: A Systematic Literature Review. *Milenial: Journal for Teachers and Learning*, 3(1), Article 1. https://doi.org/10.55748/mjtl.v3i1.126