



The application of gamification to learning outcomes and motivation of biology students: A literature review

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Abstract. Scientific concepts in high school biology are abstract and complex, so they require a deep understanding from students. However, in reality, many schools still use conventional learning methods that are less interactive, such as lectures, causing low learning outcomes and student motivation. The solution provided is the application of gamification learning methods. This study aims to examine the relationship between the application of gamification as a whole to student learning outcomes and motivation in learning Biology. The research method used was systematic literature review by collecting data from various relevant articles, proceedings, and research reports published in 2020-2024 through the Google Scholar database. Data collection was carried out during the research period, which took place from July 26-July 29, 2025 then the data was analyzed descriptively using content analysis techniques. The results showed that the trend of gamification research in Biology learning increased significantly in 2020-2024, with a peak of publications in 2024. From the 10 selected articles, gamification was proven effective in improving learning outcomes, motivation, and student engagement, thus having a positive impact on the cognitive, affective, and participatory aspects of Biology learning. The application of gamification, both as a media and learning method, not only improves cognitive achievement, but also increases students' active involvement and participation in the Biology learning process.

Abstrak. Konsep-konsep ilmiah dalam Biologi SMA bersifat abstrak dan kompleks, sehingga membutuhkan pemahaman yang mendalam dari peserta didik. Namun, kenyataannya banyak sekolah masih menggunakan metode pembelajaran konvensional yang kurang interaktif, seperti ceramah, sehingga menyebabkan rendahnya hasil belajar dan motivasi siswa. Solusi yang diberikan adalah penerapan metode pembelajaran gamifikasi. Penelitian ini bertujuan untuk mengkaji keterkaitan penerapan gamifikasi secara menyeluruh terhadap hasil dan motivasi belajar siswa dalam pembelajaran Biologi. Metode penelitian yang digunakan systematic literature review dengan mengumpulkan data dari berbagai artikel, prosiding, dan laporan penelitian yang relevan yang diterbitkan pada tahun 2020-2024 melalui database Google Scholar. Pengumpulan data dilakukan selama periode penelitian, yang berlangsung mulai 26 Juli-29 Juli 2025 kemudian data dianalisis secara analisis deskriptif dengan menggunakan teknik content analysis. Hasil menunjukkan tren penelitian gamifikasi dalam pembelajaran Biologi meningkat signifikan pada 2020-2024, dengan puncak publikasi pada 2024. Dari 10 artikel terpilih, gamifikasi terbukti efektif meningkatkan hasil belajar, motivasi, dan keterlibatan siswa, sehingga berdampak positif pada aspek kognitif, afektif, dan partisipatif pembelajaran Biologi. Penerapan gamifikasi, baik sebagai media maupun metode pembelajaran tidak hanya meningkatkan capaian kognitif, tetapi juga meningkatkan keterlibatan dan partisipasi aktif siswa dalam proses pembelajaran Biologi.

Received date: 31/07/2025
Accepted date: 17/08/2025
Published date: 13/10/2025

Keyword: gamification; learning outcomes; learning motivation

Introduction

Technological developments and educational innovations encourage the emergence of various learning strategies that are more interactive and interesting for students, including Biology in high school. Biology is a subject at the high school level that requires a deep understanding of abstract and complex scientific concepts, such as ecosystems, genetics, and human physiology (Anggraini & Syamsurizal, 2025). Biology as a branch of natural science is closely related to everyday life, so it demands an interactive, relevant (Punandari, 2024), and fun learning approach so that students not only understand the concepts, but are also motivated to learn more deeply (Amalia & Marta, 2024). In this context, learning motivation requires a comprehensive approach, one of which is through innovative learning methods such as gamification, which not only encourages increased motivation and learning outcomes, but also helps students understand Biology concepts more deeply (Chans & Portuguese, 2021; Zebua et al., 2024). However, the reality in the field shows that the application of learning methods is still traditional and lecture, which results in reduced student motivation in learning Biology. The results of research conducted by Nissa & Triyanto (2024) stated that the lecture method in learning biology has weaknesses in increasing students' active participation and awareness, so that the low response and awareness of learning indicate that this method is less than optimal in creating meaningful learning. The results of observations by Irsalina et al. (2025) stated that students tend to be less interested when learning is done using the lecture method and giving independent assignments.

The application of learning models that are less varied will cause a lack of student learning motivation in the teacher does not provide opportunities for students to participate actively and creatively in the teaching and learning process (Aritonang & Zubir, 2022). In this case, innovative, interesting and contextual learning approaches are needed. One of the innovative approaches in education is gamification. The term comes from the word "game" and the suffix "-ification", which refers to the application of game elements into non-game contexts, such as education (Artini, 2025). According to Wangi et al. (2022)) gamification is a learning strategy that applies game elements to non-game applications with the aim of increasing learner enthusiasm and learning outcomes. The basic concept of gamification is to incorporate game elements in online learning media. Gamification has four basic game components, namely gamification rules, feedback (leaderboards), prizes, medals, goals, and challenges.

With innovation in learning, students' learning process can be more dynamic, interesting, and in accordance with the needs of the material being taught. Innovative learning also provides opportunities for students to be more actively involved, either through discussions, experiments, or the use of technology that supports in-depth understanding. However, in reality, many schools are still fixated on using one learning method for all materials without considering the characteristics and difficulty level of each topic (Kasmayanti et al., 2023). As a result, some concepts are difficult to convey optimally, and students have difficulty in connecting theory with practice. This shows the importance of teacher flexibility in choosing methods that are in accordance with learning objectives, student characteristics, and material demands so that the learning process is truly effective and meaningful.

Most studies on gamification in education only focus on general implementation in learning without a specific focus on the subject of Biology. In addition, many studies are still limited to the aspect of learning outcomes without thoroughly linking it with students' learning motivation. The novelty of this literature study lies in its approach that systematically examines the relationship between gamification learning methods and two important aspects at once, namely learning outcomes and motivation in the context of Biology learning. Thus, this study provides a more specific and comprehensive contribution in understanding the effectiveness of gamification as a learning strategy in science that demands deep conceptual understanding. According to Zuleni & Marfilinda (2022) motivation and concept understanding are fundamental abilities that students must have and develop. Because to develop the ability to understand concepts, requires student learning motivation. Motivation is the driving force from within students to learn and understand subject matter. This is clarified by Amalia et al. (2024) who state that gamification functions as a reinforcer of student learning motivation related to learning satisfaction. In addition, Putranadi et al. (2021) said that the addition of gamification elements to learning evaluations in the form of small games that can increase students' cognitive stimulation is very effective, especially on long-term memory and understanding of more abstract biological concepts.

This research is important because there are still many teachers who use traditional learning methods, whereas today's students need learning that is more interesting and in accordance with technological developments. Gamification is one of the new ways that can make learning Biology more fun and increase students' enthusiasm for learning. However, many previous studies have only discussed gamification in general and have not looked deeply into the relationship between motivation and learning outcomes, especially in Biology. Therefore, this study aims to find out how gamification can affect these two things at once, as well as to see the direction and development of research on gamification in general towards student learning outcomes and motivation in learning Biology.

This study was designed to answer three main questions, namely:

- 1) What are the research trends related to the application of gamification methods in Biology learning from year to year.
- 2) What are the findings generated from the ten selected articles regarding the application of gamification learning methods.
- 3) What is the scientific impact of the application of gamification learning methods on Biology education. These three questions are expected to provide a more comprehensive understanding of the effectiveness and relevance of gamification methods in the context of Biology learning.

Research Methods

This research method uses a systematic literature review to analyze the application of gamification learning methods to the learning outcomes of biological material obtained from various sources of scientific papers and current literature. According to Afsari et al. (2021) stated that systematic literature review is a method used to analyze, review and explain existing research to answer the formulation of the problem to be studied. Another opinion by Snyder (2019) and Azzam et al. (2025) literature review is an excellent way to synthesize research findings to show evidence at the meta-level and to uncover areas that require further research, which is an important component in creating theoretical frameworks and building conceptual models. Data were searched from July 26-July 29, 2025 with the keywords "Learning outcomes and motivation for applying gamification methods in biology learning" based on these keywords 1080 articles were found and then the 10 most relevant ones were selected, the determination of article selection was determined based on the inclusion and exclusion criteria in Table 1 adapted from Fajeriadi et al. (2024). This literature study involves collecting and analyzing data from relevant journal articles, proceedings, and research reports searched through the *Google Scholar* database in the 2020-2024 time period with the procedure can be seen in Figure 1.

Table 1 Inclusion and Exclusion Criteria

No.	Inclusion criteria	Exclusion criteria
1.	Articles published between 2020 and 2024.	Articles published other than in the inclusion time span
2.	Articles that discuss the implementation of the use of gamification in relevant biology learning.	Articles that are not relevant to the implementation of gamification in biology learning.
3.	Research that specifically discusses the implementation of gamification use in biology learning	Research that does not specifically discuss the implementation of the use of gamification in learning biology
4.	Articles in Indonesian language	Articles that use languages other than Indonesian.
5.	Type of article " <i>Research Articles</i> "	Article types other than " <i>Research Articles</i> "
6.	Articles published "Open Access & Open Archive"	Published articles are not " <i>Open Access & Open Archive</i> "
7.	Field of science "Social Science"	Fields of science other than " <i>Social Science</i> "

The data collection technique was carried out by collecting key information from each article based on the research findings. Furthermore, the data analysis technique used is descriptive analysis using content analysis techniques. According to Saefullah (2024), *content* analysis is a technique used to find patterns, themes, and meanings contained in the literature used as data sources. Through this method, researchers can categorize keywords and main topics so that they can be examined more deeply. This process helps reveal the implied messages in various texts, whether in the form of holy books, books, articles, media, or other sources.

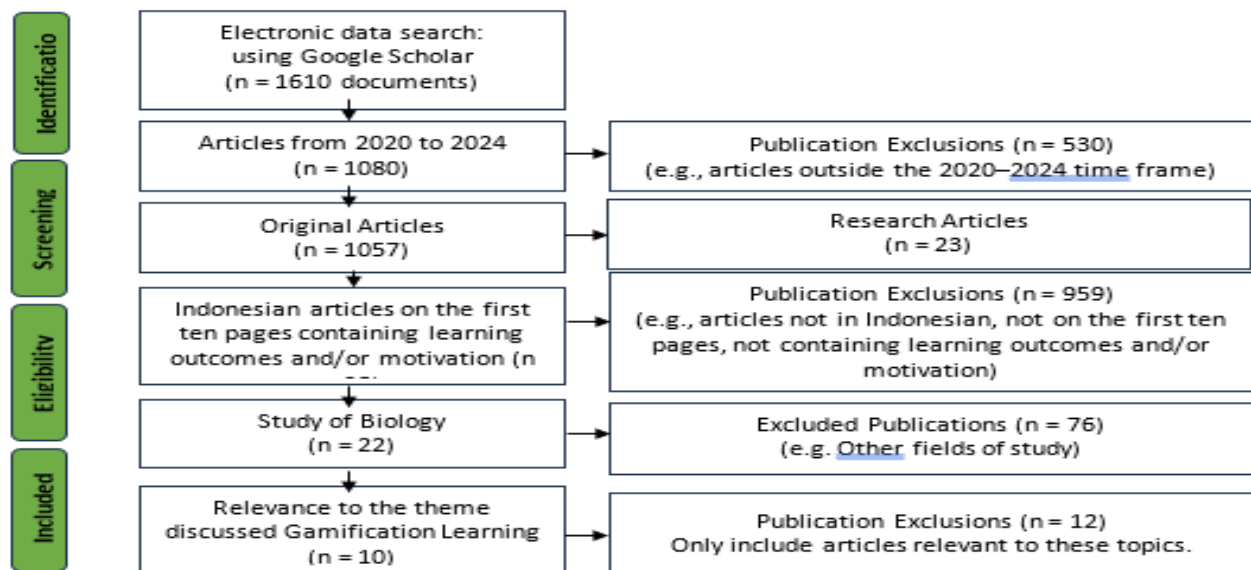


Figure 1 Systematic chart of literature review

Results and Discussion

Based on the analysis of various literatures that have been conducted, the application of gamification learning methods shows a positive impact on improving learning outcomes and student motivation in learning Biology. This method integrates game elements such as points, levels, challenges, and rewards into the learning process, thus creating a more interesting, fun, and appropriate learning atmosphere with the characteristics of today's digital generation (Purba et al., 2024). Conventional formative assessment often fails to sustain student engagement. Therefore, educators are beginning to explore innovative methods such as gamification to make the assessment process more interactive and motivating (Akrom & Taufik, 2025).

The increase in the number of publications from year to year not only shows the high level of research activity, but also reflects the growing academic attention to innovative approaches in education, especially gamification. This shows that the study of gamification is increasingly being researched because it is considered relevant in the world of education, especially in responding to the challenges of 21st century learning that demands interactive and contextual methods. This trend shows a higher awareness of the importance of disseminating knowledge in an open and structured manner. Therefore, analyzing the number of documents published each year can provide insight into the dynamics of scientific literature development and the potential for future collaboration and knowledge integration. To illustrate this phenomenon, Figure 3 presents the trend in the research with the keyword "Learning outcomes and motivation of applying gamification method in biology learning" number of documents from 2020 to 2024 which shows significant growth in the last five years.

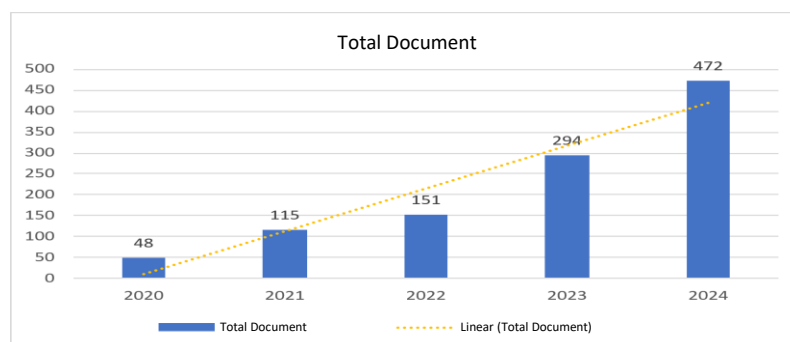


Figure 2 Graph of total documents

Research trends regarding the application of gamification in Biology learning have increased significantly from year to year. The data presented in Figure 3 from a google scholar search with the keywords "Learning outcomes and motivation for the application of gamification methods in biology learning" shows that the peak of the trend occurred

in 2024, characterized by a much higher spike in the number of publications compared to previous years. From a total of 1,080 articles found in the time span of 2020 to 2024, a strict screening process was carried out using inclusion and exclusion criteria. The selection results resulted in 10 scientific articles, as shown in Table 2, which were considered the most relevant and eligible for further analysis and contained information covering the problems studied, the research methods used, and the main findings obtained, which can be seen in Table 3.

The surge in the number of publications in this period reflects the increasing attention of researchers to learning innovations, especially as a solution to the challenge of low student motivation and learning achievement in Biology. The ten articles reviewed used various methods such as quasi-experiments, classroom action research, and media development, but not all of them clearly explained the validity of the instruments or sample selection, which could potentially bias the results. All articles were from open-access national journals in the field of Biology education to make them relevant to the Indonesian learning context. Gamification is effective in improving learning outcomes and motivation, especially when combined with cooperative strategies and interactive media. Its effectiveness is influenced by learning design and student engagement.

Table 2 List of Sample Articles

Code	Article Title (Researcher)	Data available	
		Learning Outcomes	Learning Motivation
A1	Validity of gamification learning media for waste material (MEGALI) to improve learning outcomes of X grade high school students (Widianto & Prastiwi, 2024)	√	-
A2	The effect of using kahoot on learning outcomes of biology scope material at SMA Negeri 1 Muncar (Darmawan, 2020)	√	-
A3	Implementation of gamification-based assessment media on biology learning motivation of MAN Kotawaringin Timur students (Febryana & Zubaidah, 2022)	-	√
A4	The application of the teams games tournament (TGT) type cooperative learning model to improve student learning outcomes on biology concepts (Hafizah et al., 2024)	√	-
A5	Analysis of differences in student responses to biology learning using kahoot interactive media on ecosystem material (Azizah & Syafaruddin, 2024)	-	√
A6	Application of word wall game quiz combined with classroom to increase motivation and achievement in learning biology (Arimbawa, 2021)	√	√
A7	The effect of game-based learning model assisted by baamboozle media on motivation and learning outcomes of biology class X SMA 2 Tenggara Sebrang (Nugraha et al., 2024)	√	√
A8	Improving learning outcomes through the application of discovery learning assisted by wordwall-based media in biology learning (Kusumawati et al., 2024)	√	-
A9	Development of ultavirbio learning media gamification in action on classification material (Mardhiyah, 2023)	√	-
A10	The application of the TGT (team games tournament) cooperative method as an effort to improve the learning outcomes of biology of circulatory system material in class XI students of Banat State Senior High School in the 2022/2023 academic year (Lakapu, 2023)	√	√

The application of gamification in education has shown significant potential in increasing students' motivation to learn. Learning motivation itself is one of the main determinants of academic success, where highly motivated students tend to show perseverance, active engagement, and better academic achievement. Through the integration of game elements, gamification creates a more interesting and challenging learning atmosphere, thus encouraging students to learn with higher enthusiasm (Mahmubi & Homaidi, 2025). The main goal of this approach is to provide a positive and motivating learning experience through the application of game principles that have been proven to stimulate active and consistent behavior in the long term (Jia et al., 2022). By bringing game dynamics to the learning process, gamification is designed to increase student participation, extend engagement time in learning activities, and support improved overall academic performance (Van Gaalen et al., 2021). In detail, the application of Gamification in biology learning on learning outcomes and learning motivation is presented in Table 3.

Table 3 Research Results of Gamification Learning Method Implementation

Code	Researcher (Year)	Problem	Method	Findings
A1	Widianto & Prastiwi (2024)	Student learning outcomes on environmental change material are still low and many do not reach the KKM. The learning process tends to be monotonous due to the dominance of the lecture method and the lack of innovative learning media that attracts students.	Development research (R&D) using the ADDIE model, with media developed through Articulate Storyline 3. Validation was conducted by two lecturers (material and media experts) and one biology teacher, covering eight components using a Likert scale.	MEGALI learning media was declared highly valid with a score of 95.98% and effective in improving learning outcomes through gamification elements that are attractive, interactive, easy to use, and supported by relevant language, graphics, and features.
A2	Darmawan (2020)	Low student learning outcomes on the scope of biology material due to the lack of use of interactive learning media in accordance with the characteristics of the digital generation.	Quasi-experimental research with pre-test and post-test design on two groups: experimental class (using Kahoot) and control class (without Kahoot). The sample consisted of two X MIPA classes at SMA Negeri 1 Muncar. Data were analyzed using parametric statistical tests (normality test, paired t-test, and independent t-test) with the help of SPSS.	The use of Kahoot significantly improved student learning outcomes, with an average post-test of 85.21 for the experimental class and 76.72 for the control class, a difference of 8.49 points. Kahoot also proved to be engaging, motivating and increased student engagement.
A3	Febryana & Zubaidah (2022)	The low motivation of students in Biology class XI IPS at MAN Kotawaringin Timur, which is only 55% (low category), is a challenge in realizing meaningful learning.	Quantitative research with pre-experimental methods and One Group Pretest-Posttest design. The sample was 120 students of class XI IPS. The instrument is a learning motivation questionnaire with 3 main indicators. Data analysis using t-test with Microsoft Office 365.	The implementation of gamification-based assessment media (Quizizz, Kahoot, Wordwall) significantly increased student learning motivation from 55% (low) to 74.32% (good).
A4	Hafizah et al. (2024)	Low student learning outcomes and lack of independence and active participation in learning Biology, especially in biodiversity material, are caused by conventional learning that is less interesting and has not been able to motivate students optimally.	The study used two methods: True Experimental Design (Posttest-Only-Control Design) and Classroom Action Research (PTK) in two cycles. Data collection techniques were posttest test, observation, and documentation.	The TGT model improved learning outcomes, activities, and student engagement, with an average experimental posttest of 84.90 and control of 82.35. PTK results rose from 70.35 (cycle I) to 82.50 (cycle II) with 75% completeness.
A5	Azizah & Syafaruddin (2024)	Biology learning on ecosystem material in class X Madrasah Aliyah Kanaeng is still less interesting because the teacher has not used interactive methods such as Kahoot, so that student response and involvement are low.	Quantitative research with pseudo-experimental method using two classes, namely experimental class (with Kahoot) and control class (without Kahoot), with questionnaire instrument and data analysis through descriptive statistics and independent sample t-test.	The experimental class with Kahoot obtained an average of 74.37, higher than the control class of 70.69. The t-test showed sig. 0.00, indicating Kahoot has a positive effect on student responses.

Code	Researcher (Year)	Problem	Method	Findings
A6	Arimbawa (2021)	The motivation and achievement of Biology students in class XI MIPA 1 SMA N 1 Petang are low due to monotonous learning, lack of innovation, and lack of student involvement, especially in the material of Addictive and Psychotropic Substances.	PTK was conducted in two cycles through the stages of planning, implementation, observation, and reflection, with data from motivation questionnaires and learning achievement tests based on Word Wall Game Quis.	In cycle I, motivation reached 80.15 (high) and achievement 21.43 (very poor), then increased in cycle II to 85.85 (very high) and 84.00 (very good).
A7	Nugraha et al.,(2024)	Low student motivation and learning outcomes in biology learning due to unattractive learning models and media.	Quasi experiment with pretest-posttest non-equivalent control group design. Instruments in the form of motivation questionnaires and pretest and posttest essay questions. Learning media using Baamboozle in the Game Based Learning (GBL) model.	The Game Based Learning model assisted by Baamboozle improved learning outcomes (posttest 79.69 vs 66.03) and learning motivation (82.69 vs 73.86) compared to the conventional model.
A8	Kusumawati et al, (2024)	The low learning outcomes of biology class XI students at SMA Negeri 2 Makassar on enzyme material, caused by the lecture method and the lack of use of interactive media.	Classroom action research (PTK) with Kemmis and Taggart model, conducted in 2 cycles. The research subjects were 36 students of class XI Biology 4. The instrument was a cognitive test in each cycle.	The application of the Discovery Learning model assisted by Wordwall media effectively improves learning outcomes, from 13% complete in the pre-cycle to 61% in cycle I and 94% in cycle II.
A9	Mardhiyah (2023)	The utilization of digital classrooms is not optimal, and the material of classification of living things is considered complicated and boring by students. Interesting, communicative, and technology-based learning media are needed to improve motivation and learning outcomes.	Research and Development (R&D) with ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Instruments in the form of validation sheets, student and observer response questionnaires, and essay test questions.	UITaVirBio BeraKsi media is very valid (3.66), very practical (4.35), and effective (91% of students completed).
A10	Lakapu (2023)	The low learning outcomes of biology students in class XI of SMA Negeri Banat, especially on the material of the circulatory system, and the lack of enthusiasm for learning.	Classroom Action Research (PTK) was conducted over three cycles with the Kurt Lewin model (planning, implementation, observation, reflection). Data were collected through observation, tests, and documentation.	TGT cooperative learning model improved learning outcomes: learning completeness increased from 60.71% (cycle I) to 75.00% (cycle II) and 89.29% (cycle III). This model also increases motivation and cooperation among students.

Based on Table 3, it can be seen that most studies highlight two main issues in learning Biology, namely low student learning outcomes and decreased learning motivation. These issues are addressed through the application of various forms of gamification-based learning media and strategies. This approach includes the development of innovative app-based media such as MEGALI and UITaVirBio BeraKsi, the utilization of interactive quiz platforms such as Kahoot!, Wordwall, and Quizizz, and the use of cooperative and game-based learning models with gamification elements such as points, levels, challenges, and rewards. The results of the literature study show that the application of gamification learning methods has a significant impact on improving student learning outcomes and motivation in learning Biology. The following is the integration of the gamification approach through media and learning methods, as

well as the effect on improving student learning outcomes and motivation from Table 3, which is displayed in schematic form in Figure 3.

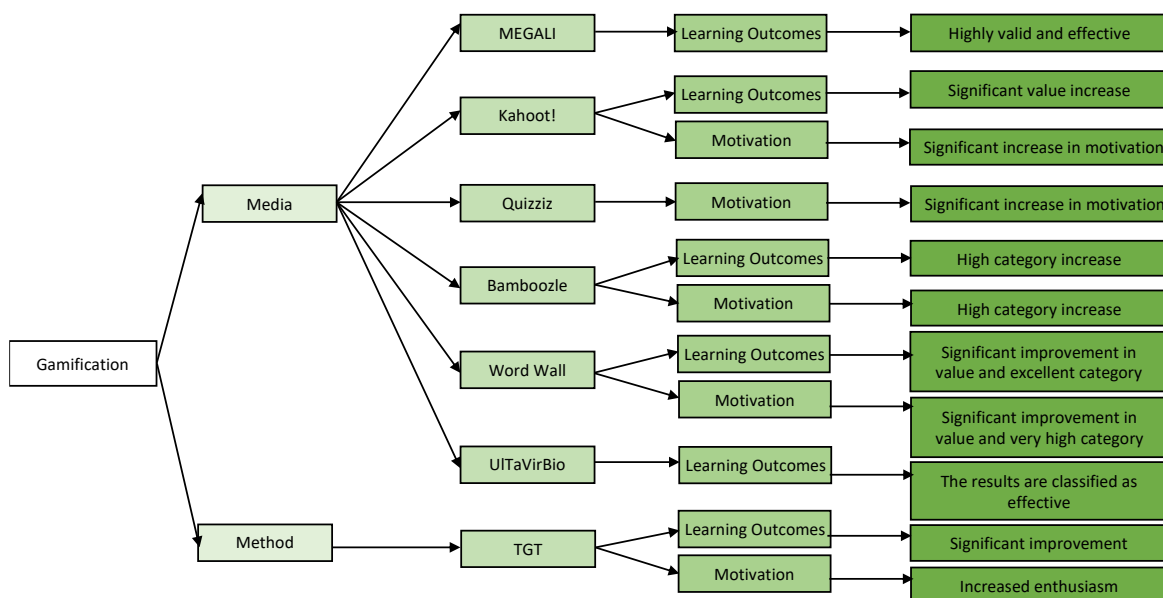


Figure 3 Schematic of gamification learning and its effects

Based on Figure 3, it can be seen that the application of gamification in Biology learning is proven to have a positive impact on student learning outcomes and motivation. Media such as MEGALI, Kahoot!, Word Wall, and ULTaVirBio showed a significant increase in learning outcomes, with effectiveness categories ranging from very good to very high. Meanwhile, Quizziz, Bamboozle, and Kahoot! also managed to significantly increase learning motivation, showing that the elements of competition and games can encourage active student engagement. In addition to the media, gamification methods such as TGT also contributed to improving learning outcomes and overall student enthusiasm.

Based on Table 3. shows the results of Widiyanto & Prastiwi's research (2024) developing MEGALI interactive media that contains game elements such as ecoenzyme games, levels, and quizzes, and shows very high validity (95.98%) in improving student learning outcomes. Meanwhile, Darmawan (2020) proved that the use of Kahoot significantly improved learning outcomes in Biology scope material, with an average increase in scores of 8.49 points compared to the control class. The aspect of learning motivation in Febryana & Zubaidah's research (2022) noted an increase from the low category (55%) to the good category (74.32%) through the integration of platforms such as Quizziz, Kahoot, and Wordwall. Research by Hafizah et al. (2024) also stated that the TGT game-based cooperative learning model improved learning outcomes and student engagement, with higher post- test scores than the control group. Similar results were shown by Azizah & Syafaruddin (2024), who noted a significant increase in student response and engagement through the use of Kahoot.

In addition, Arimbawa (2021) reported that Wordwall Game Quiz was able to increase student motivation and learning achievement from very poor to very good. Nugraha et al. (2024) applied the Game-Based Learning model assisted by Baamboozle, which succeeded in increasing motivation to 82.69 and learning outcomes with an average post-test score of 79.69. Similar findings were obtained by Kusumawati et al. (2024) through the application of Discovery Learning assisted by Wordwall which increased learning completeness from 13% to 94%. Mardhiyah (2023) developed ULTaVirBio BeraKsi media which proved valid and effective, and succeeded in making 91% of students complete learning.

According to Lakapu (2023), the TGT cooperative learning model improved learning outcomes from 60.71% to 89.29% and also improved student cooperation and motivation. In general, all articles show that the application of gamification through digital media approaches and educational games can significantly improve learning outcomes (cognitive aspects), motivate students (affective aspects), and encourage active involvement in the learning process (participatory aspects). The application of gamification in Biology education provides a significant scientific impact in three main aspects: cognitive, affective, and participatory. In the cognitive aspect, it can be stated that the use of interactive media such as MEGALI, Kahoot, Wordwall, and Baamboozle proved effective in improving student learning outcomes, characterized by an increase in post-test scores and a high percentage of learning completeness. From the

affective side, gamification is able to increase student learning motivation, which was originally in the low category to high, creating a more interesting and fun learning experience. From the participatory aspect, the application of educational games and cooperative learning models such as TGT encourages students' active involvement in the learning process, strengthening social interaction and cooperation in the classroom. Overall, these findings show that gamification is not only an innovative approach, but also has a strong scientific basis in supporting the achievement of Biology learning objectives in a comprehensive and meaningful way.

This is in line with research by Zeybek & Saygi (2023) in Purba et al. (2024) who mentioned gamification or game adaptation in learning is an approach in which game concepts and mechanisms are used to improve learner engagement, motivation, and learning outcomes. In addition, Chans & Castro (2021) also support that the application of game-based learning is proven to be significant in improving students' academic achievement in biology subjects. Local research such as that conducted by (Zebua et al., 2024) also shows that gamification supports increased student understanding and enthusiasm for learning, especially in Biology subjects. The impact of Gamification on Biology learning can be said to be positive, both in the aspects of learning outcomes (Cognitive) and learning motivation (Affective) so that follow-up is needed for researchers and Indonesian educational institutions to develop more Gamification learning either media or methods, to be tested and disseminated as an interactive learning tool.

Conclusion

Based on the results of the literature search, the application of gamification learning methods has a significant positive impact on student learning outcomes and motivation in learning Biology. The integration of game elements such as points, levels, challenges and rewards can create a learning atmosphere that is more fun, interesting and relevant to the characteristics of today's digital generation. Research trends in recent years also show increasing scientific interest in gamification as an innovative approach in science education. Scientifically, the application of gamification supports the achievement of three important aspects in education - the cognitive aspect (improved learning outcomes) and the affective aspect (improved learning motivation). In the context of Biology education, this approach is proven to be able to help students understand abstract concepts more effectively, so it has the potential to become an adaptive and transformative future learning strategy. It is hoped that there will be follow-up for researchers and educational institutions in developing, testing and disseminating Gamification learning in biology or other studies.

Acknowledgement

The author would like to thank Lambung Mangkurat University, especially the Department of Biology Education, which has provided support in the implementation of this research. Gratitude is also extended to the course lecturers who have given permission to access data and relevant reference sources in the preparation of this literature study.

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