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Feedback System in Educational Games: A Systematic Literature Review

Aditya Sudyana[1], Atina Putri[2], Yusep Rosmansyah[3]
School of Electrical Engineering and Informatics, Bandung Institute of Technology, Bandung, Indonesia[1,2,3]
Email: 23222063@mahasiswa.itb.ac.id*

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ABSTRACT

Feedback system is critical for educational game engagement. This system promotes educational game participation and motivation. The feedback system also helps players learn by expanding their knowledge. However, there is a scarcity of comprehensive research on feedback systems in educational games, making it difficult to develop a dependable feedback system capable of better achieving educational game objectives. Educational games often scatter feedback systems, making it challenging to identify which games utilize them. This study improves comprehension of educational game feedback systems while also filling a gap in the literature. This study conducts a comprehensive and systematic review of the educational game feedback system literature. A total of 36 relevant journal articles spanning from 2019 to 2023 were reviewed. This study investigates trends in educational game feedback systems, including the technologies used to build them, the educational domains studied, the products developed, feedback system design methods, and various feedback and algorithm implementations. This study also discusses selecting feedback components for player feedback and how feedback systems in educational games impact players. This study greatly contributes to the progress of learning conducted through educational games.

INTRODUCTION

The various aspects that lead to a player's addiction to educational games are complex, encompassing components of game design, instructional material delivery, and player engagement tactics. Firstly, the inclusion of innovative methods for rewarding players and incorporating features of serious games, together with chances for user participation and social interaction, are crucial in increasing player engagement and creating a dynamic learning environment (Powers, 2014). These qualities are essential for ensuring that educational games are both informative and interesting, effectively engaging the player. Furthermore, the examination of popular games and the determination of characteristics that contribute to addiction in mobile games have revealed that factors such as engagement, commitment, likeability, and usage have a

big role. By comprehending these factors, educational games can be developed to bypass typical barriers and exploit the fundamental principles of addiction to enhance the effectiveness of learning (Berkling et al., 2018).

Feedback plays a critical role in this ecosystem. It performs as an enlightening tool, providing students with an immediate understanding of their performance, which is crucial for cultivating interest and motivation (Makhija et al., 2022). There exist two distinct categories of feedback mechanisms: immediate feedback and delayed feedback. Immediate feedback refers to instantaneous responses given to students while they are engaged in the learning process (Coggins et al., 2022). The feedback is obtained immediately throughout the instructional activity, enabling fast evaluation of understanding and performance (Doyle et al., 2022). Meanwhile, delayed feedback occurs when feedback on a student's performance is not supplied immediately (Chu et al., 2021). Integrating game features into educational games is in line with the idea of delayed feedback, as these elements offer continuous feedback on performance and progress, enhancing the interactivity and effectiveness of the learning experience (Heintz & Lai-Chong Law, 2012). Hence, the inclusion of game components such as points, badges, and leaderboards may effectively integrate the concept of delayed feedback into educational games.

The impact of feedback system in educational game is multifaceted; although it can improve performance and learning, excessive or untimely feedback may result in decreased performance by promoting less effective problem-solving approaches (Prasad et al., 2020). Hence, the development of educational games necessitates meticulous consideration of the specific kind and timing of feedback in order to maximize learning outcomes and enhance user involvement. Personalizing feedback in educational games is also a significant challenge, particularly due to the diverse cognitive capacities and capabilities of students. Customizing feedback for individual learners has the potential to greatly improve interaction and learning processes (Shin, 2010). Furthermore, it is crucial to give careful thought to the design of feedback in educational games in order to promote curiosity, motivation, and enhanced engagement. This emphasizes the importance of developing a feedback framework that is in line with psychological theories, with the aim of empowering learners (Chaudy & Connolly, 2018).

To create a feedback system that is effective in educational games, it is necessary to have a thorough comprehension of various types of feedback, techniques to engage learners, and the educational goals of the game. Through the integration of these components, educators and game designers have the ability to develop immersive and stimulating learning experiences that effectively improve learning results. Studies by Hassan et al. (2019) show that feedback implementation significantly improves student performance in e-learning. Simmilar studies Hocine (2022), Mao et al. (2024), and He & Loewen (2022) also show that feedback system gave positif impact in serius game, game-based learning, and gamification.

We conducted a systematic literature review on feedback systems in educational games as part of our research. We chose the feedback method for multiple reasons. Based on multiple studies Tang et al. (2020), Rajendran et al. (2019), and Pan et al. (2019), it is believed that incorporating feedback into educational games might enhance motivation and engagement, leading to more effective learning compared to traditional techniques and resulting in improved learning outcomes. Furthermore, we believe that the deployment of feedback might have either a positive or negative impact on users' performance (Prasad et al., 2020). Furthermore, there is a lack of systematic literature reviews on the topic of feedback systems for educational games that systematically examine and identify the findings of past studies to draw definitive conclusions or provide recommendations for future research based on scientific literature.

RESEARCH METHOD

This research incorporates an approach to systematic literature review that is based on the suggestions of Kitchenham (Kitchenham & Brereton, 2013).

Research Question

RQ1: What are the current trends in feedback system in educational games?
RQ2: What are the techniques that have been used to implement feedback system in educational games?
RQ3: How the feedback system in educational games impacts the learner?

Research Strategy

Searching involves choosing a digital library, selecting keywords, conducting an initial search, refining search terms, and obtaining a preliminary list of relevant primary studies. Examined digital databases are listed here.

- Scopus (*scopus.com*)
- ACM Digital Library (*portal.acm.com*)
- Emerald (*emerald.com*)
- IEEE Digital Library (*ieeexplore.ieee.org*)
- Taylor and Francis Online (*tandfonline.com*)
- Science Direct (*sciencedirect.com*)

Abbreviations, synonyms, and alternative spellings must be inventoried after database identification. This procedure simplifies keyword selection. These are the keywords that are utilized in the research: ("educational game" OR ("education" AND "game") OR "edutainment game" OR gamification OR gamifying OR gamify OR "gameful design" OR gamefulness OR funware OR "serious games" OR game OR gamified OR "game-based learning") AND (adaptation OR adaptive OR adaptability OR adaptivity OR customization OR customizing) AND feedback. The search parameters were tailored to each database. The database search included the article title, keywords, summary, and publication type, such as journal. Only English-language articles were searched.

Study Selection Criteria

The selected papers for the examination were chosen based on the specific criteria outlined in Table 1. We found 1149 scientific papers in the search. After removing duplicates, we had 1103 articles for further review. After reviewing titles and abstracts and applying inclusion criteria, 65 articles were selected for quality assessment. After excluding multiple articles that did not meet quality assessment criteria, 36 were selected.

Table 1
Inclusion and Exclusion Criteria

Criteria Type	Included	Excluded
Period	2019 – 2023	Before 2019 and after 2023
Language	English	Non-English
Type of Article	Articles from journal	Articles from conferences, books, literature review, and other types of non-conventional publications
Accessibility	Available in full text	Only abstract available
Relevance to research questions	Relevant to educational games	Not relevant to educational games

RESULT AND DISCUSSION

Description of Studies

A total of 36 scientific articles were retrieved as shown in table 2.

Table 2
Count of Studies Derived from Sources

No	Digital Source	Qty
1	Scopus	26
2	Science Direct	3
3	IEEE	2
4	ACM	0
5	Taylor and Francis	2
6	Emerald	3

The search results from the six journal databases showed limited research in the field of feedback systems. Through careful examination of the study selection process, it was found that a significant amount of research focused on educational games. Eventually, only a limited number of studies specifically addressed the implementation and effectiveness of feedback systems in educational games. Figure 1 shows journal distribution by year of publication.

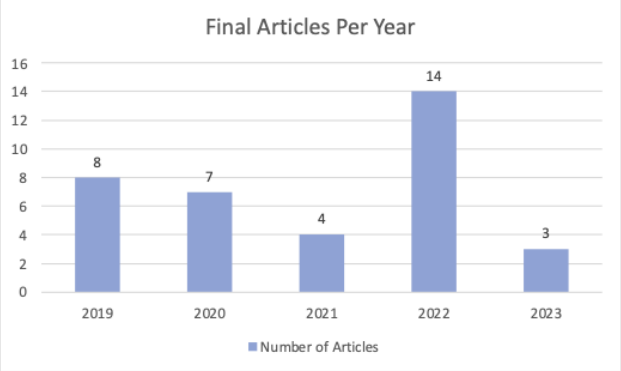

Figure 1
Publication Year of the selected Study (January 2019 to November 2023)

RQ-1: What are the Trends of Feedback System?

Effective learning design requires feedback to improve student performance and learning. Feedback in various forms, content, formats, and frequencies achieves this (Freitas et al., 2023). It also lets developers and educators keep up with technological and pedagogical advances to add effective feedback mechanisms to their games. Pattern recognition helps stakeholders predict industry advancements and adjust strategies and resource allocation. Table 3 shows the domains that have been studied regarding the integration of feedback in educational games.

Table 3
Domain of Educational to Implement Feedback System

No	Domain	Qty	Paper
1	Academic	13	(Arner et al., 2021; Awais Hassan et al., 2019; Biswas et al., 2020; Bräuer & Mazarakis, 2022; He & Loewen, 2022; Karavidas et al., 2022; Leonardou et al., 2020; Mao et al., 2024; Mendoza et al., 2019; Sayed et al., 2023; Sharma et al., 2022; Tang et al., 2020; Tärning & Silvervarg, 2019)
2	Mental Health	7	(Amat et al., 2021; Bermúdez i Badia et al., 2019; Derks, Willemen, Wouda, Meekel, & Sterkenburg, 2022; Dietvorst et al., 2022; Moldoveanu et al., 2023; Rajendran et al., 2019; Schroeder et al., 2021)
3	Physical Health	5	(Amiri et al., 2022; Ben Itzhak et al., 2022; Pan et al., 2019; Škola et al., 2019; Tuti et al., 2020)
4	Sports	2	(Oagaz, Schoun, & Choi, 2022; Schättin et al., 2022)
5	Manufacturing Industry	3	(Passalacqua et al., 2020; Ulmer et al., 2022, 2023)
6	Construction	1	(Jeelani, Han, & Albert, 2020)
7	Social	3	(Othlinghaus-Wulhorst & Hoppe, 2020; Stefanidis et al., 2019; Zarglayoun et al., 2022)
8	Bussiness	1	(Hocine, 2022)

According to the data, researchers primarily use the academic domain to develop feedback systems in educational games. This discovery is not surprising, considering the inherent compatibility of educational games with educational institutions such as schools

and universities, where they are used as a component of teaching methods. The feedback approach is commonly used in schools and universities to enhance students' learning outcomes and encourage them to participate more actively in their studies (Arner et al., 2021; Leonardou et al., 2020; Mendoza et al., 2019; Sayed et al., 2023; Tang et al., 2020; Welbers et al., 2019).

Within the area of mental health, the incorporation of feedback has made the emotion maze game more adaptable by modifying the graphical user interface in response to the player's emotions (Bermúdez i Badia et al., 2019). A study conducted by Moldoveanu et al. (2023) suggests that incorporating feedback from sensors, such as heart rate and electrodermal activity, into a game can assist patients with acrophobia and claustrophobia in overcoming their fears during therapy. Moreover, the utilization of feedback in educational games has proven to be efficacious in delivering therapy to individuals diagnosed with autism spectrum disorder (Amat et al., 2021). The domain of physical health, similar to the domain of mental health, also shares identical goals. Research conducted by Amiri et al. (2022) designed an educational exergame specifically for scoliosis patients. The game incorporated motivational sentences as feedback during gameplay and made adjustments to the difficulty level as the game progressed. The implementation of a feedback system in health-related educational games has proven to be successful in enhancing the engagement of stroke patients in therapy (Pan et al., 2019). Furthermore, feedback in educational games is also utilized in various fields other than health and academia, including sports (Oagaz et al., 2022; Schättin et al., 2022), manufacturing industry (Passalacqua et al., 2020; Ulmer et al., 2022, 2023), construction (Jeelani et al., 2020), social sciences (Othlinghaus-Wulhorst & Hoppe, 2020; Stefanidis et al., 2019; Zarglayoun et al., 2022), and business (Hocine, 2022).

Table 4 shows the outcomes of classifying the technologies employed for constructing feedback systems in educational games. Analysis of the data reveals that desktop application technology is the most prevalent, representing 33.3% of researchers' usage in the development of educational games with feedback systems. In the study conducted by Karavidas et al. (2022), the use of desktop applications was found to be beneficial for developers in creating educational games that incorporate sensors. The implementation of feedback in the studies by Ben Itzhak et al. (2022), Biswas et al. (2020), Hocine (2022), Zarglayoun et al. (2022), and Othlinghaus-Wulhorst & Hoppe (2020) involves the use of sophisticated methods or algorithms, including the application of multiple artificial intelligence algorithms and interfaces, which necessitate powerful computational resources. Moreover, the use of desktop applications for educational games is widespread in school settings, as demonstrated in studies by Mao et al. (2024), Rajendran et al. (2019), and Tärning & Silvervarg (2019). This practice helps educators deliver education in a centralized location and reduces students' dependence on their own devices.

Table 4
Technology Used for Educational Games

No	Technology	Qty	Paper
1	Virtual Reality	6	(Amat et al., 2021; Bermúdez i Badia et al., 2019; Moldoveanu et al., 2023; Oagaz et al., 2022; Škola et al., 2019; Ulmer et al., 2022)
2	Augmented Reality	2	(Amiri et al., 2022; Ulmer et al., 2023)
3	Mobile Application	7	(Bräuer & Mazarakis, 2022; Dietvorst et al., 2022; He & Loewen, 2022; Passalacqua et al., 2020; Tang et al., 2020; Tuti et al., 2020; Welbers et al., 2019)
4	Web Application	6	(Arner et al., 2021; Awais Hassan et al., 2019; Leonardou et al., 2020; Mendoza et al., 2019; Sayed et al., 2023; Schroeder et al., 2021)
5	Desktop Application	12	(Ben Itzhak et al., 2022; Biswas et al., 2020; Derks et al., 2022; Hocine, 2022; Jeelani et al., 2020; Karavidas et al., 2022; Mao et al., 2024; Othlinghaus-Wulhorst & Hoppe, 2020; Rajendran et al., 2019; Stefanidis et al., 2019; Tärning & Silvervarg, 2019; Zarglayoun et al., 2022)
6	Others	3	(Pan et al., 2019; Schättin et al., 2022; Sharma et al., 2022)

In addition, some researchers utilize mobile application, virtual reality (VR), and web application technologies, with proportions of 19.4%, 16.7%, and 16.7%, respectively. Using mobile applications for educational games enables learners to conveniently access learning content from any location and at any moment (Fan, Liu, Wang, & Yu, 2023). In addition, according to studies by Bräuer & Mazarakis (2022), Dietvorst et al. (2022), He & Loewen (2022), and Welbers et al. (2019), the feedback used in their educational games includes gamification elements such as points, badges, and leaderboards.

Researchers also employ web technology to create feedback systems in educational games. Web-based educational games offer a platform for students to share and review knowledge, similar to mobile technology. However, they do not require system upgrades or extra downloads. It is important to note that these games have limitations regarding internet connectivity and data restrictions (Dwianika et al., 2022; Godtsfriedt & Cardoso, 2022). When implementing feedback systems that involve complex computation in the backend, it is important to consider the choice of web technology.

Furthermore, VR technology is utilized in the creation of educational games. VR is a cutting-edge technology that creates lifelike environments, allowing users to engage with and control them (Zheng et al., 1998). VR technology comprises electronic devices like head-mounted displays and handheld controllers that deliver sensory stimuli, including visual, auditory, and tactile signals. This combination creates an immersive experience that feels natural to users (Novotny & Joo (Grace) Ahn, 2022). Virtual reality enhances the immersion of games by incorporating feedback adaptation, virtual reality enhances game immersion.

We discovered a limited number of articles that employed augmented reality (AR) as a means to integrate feedback systems into educational games. AR enables interactive learning experiences by superimposing digital elements onto the real world, thereby enhancing students' comprehension and engagement (Kshirsagar et al., 2023). The low use of AR in educational games is due to the difficulties of integrating AR with feedback systems. Scalability is hindered by the need for separate software development kits and technical specifications for each augmented reality hardware set (Olim & Nisi, 2020). Moreover, the dependence on intricate vision-based algorithms in AR systems presents a substantial obstacle to their implementation (Abdelrazeq et al., 2020). The majority of other technologies used in this feedback system are motion-based. Studies by Pan et al. (2019), Schättin et al. (2022), and Sharma et al. (2022) employ specific sensors capable of capturing players' movements in order to provide feedback within the game.

To better understand feedback system patterns in educational games, we categorized the identified research studies by type of game. Table 5 shows educational game classifications.

Table 5
Types of Educational Games

No	Types of Educational Games	Qty	Paper
1	Serious Games	20	(Amat et al., 2021; Amiri et al., 2022; Ben Itzhak et al., 2022; Bermúdez i Badia et al., 2019; Biswas et al., 2020; Derks et al., 2022; Dietvorst et al., 2022; Hocine, 2022; Jeelani et al., 2020; Karavidas et al., 2022; Moldoveanu et al., 2023; Oagaz et al., 2022; Othlinghaus-Wulhorst & Hoppe, 2020; Pan et al., 2019; Schättin et al., 2022; Schroeder et al., 2021; Škola et al., 2019; Tang et al., 2020; Tuti et al., 2020; Zarglayoun et al., 2022)
2	Game-Based Learning	6	(Bräuer & Mazarakis, 2022; He & Loewen, 2022; Passalacqua et al., 2020; Ulmer et al., 2022, 2023; Welbers et al., 2019)
3	Gamification	6	(Bräuer & Mazarakis, 2022; Garbaya, Romano, & Hattar, 2019; He & Loewen, 2022; Passalacqua et al., 2020; Ulmer et al., 2023; Welbers et al., 2019)
4	E-Learning	3	(Awais Hassan et al., 2019; Rajendran et al., 2019; Sayed et al., 2023)

Serious game, game-based learning, and gamification are distinct concepts despite their apparent similarity. Serious games are designed to improve health, wellness, education, and culture knowledge, skills, and attitudes. It does this by providing practical training in a simulated environment (Din et al., 2023). Game-based learning uses effective game design and learning goals to engage students and meet their basic needs for competence, autonomy, and relatedness (Triantafyllou & Sapounidis, 2023). Gamification, on the other hand, uses game elements in non-game situations to motivate and engage people. It shows a societal shift toward game-like features in various areas (AlSaad & Durugbo, 2021). However, e-learning uses digital platforms and web-based applications to make educational content available at any time and place. The statement

describes a shift from traditional classrooms to online areas where people can study and earn professional degrees (Jayanthi et al., 2023).

Analyzing feedback system trends in educational games shows that academia is the focus. Desktop applications are mostly used to create feedback systems. Educational game researchers prefer serious games. These three factors make it compelling to increase feedback in educational games, making them more useful and appealing to users. This does not mean that feedback systems in educational games are inappropriate for other domains of education, technologies, or games. Due to the lack of research, there may be other ways to improve feedback systems in educational games.

RQ-2: What Techniques are Required for Feedback System?

Educational games can incorporate feedback in several ways. Research conducted by Radulović (2021) demonstrates that educational games enhance educational effectiveness and student involvement, indicating a beneficial impact on motivation and engagement. Nevertheless, the efficacy of feedback in educational games is not consistently favorable. A study conducted by O'Rourke et al. (2014) revealed that feedback in educational games occasionally had an adverse effect on performances.

We divide educational game feedback into immediate and delayed types. Table 6 displays the categorization results for the different types of feedback.

Table 6
Types of Feedback System

No	Types of Feedback	Qty	Paper
1	Instant/Immediate Feedback	13	(Amat et al., 2021; Bermúdez i Badia et al., 2019; Karavidas et al., 2022; Mao et al., 2024; Mendoza et al., 2019; Oagaz et al., 2022; Othlinghaus-Wulhorst & Hoppe, 2020; Pan et al., 2019; Passalacqua et al., 2020; Rajendran et al., 2019; Sharma et al., 2022; Stefanidis et al., 2019; Tuti et al., 2020)
2	Delayed Feedback	15	(Awais Hassan et al., 2019; Ben Itzhak et al., 2022; Biswas et al., 2020; Bräuer & Mazarakis, 2022; Dietvorst et al., 2022; He & Loewen, 2022; Hocine, 2022; Jeelani et al., 2020; Leonardou et al., 2020; Schroeder et al., 2021; Tang et al., 2020; Tärning & Silvervarg, 2019; Ulmer et al., 2022, 2023; Welbers et al., 2019)
3	Combination	8	(Amiri et al., 2022; Arner et al., 2021; Derks et al., 2022; Moldoveanu et al., 2023; Sayed et al., 2023; Schättin et al., 2022; Škola et al., 2019; Zarglayoun et al., 2022)

According to the data, delayed feedback is the most common type of feedback in educational games. The second most common form of feedback is immediate feedback, used in 13 of 35 articles. Research conducted by Ben Itzhak et al. (2022), Bräuer & Mazarakis (2022), Dietvorst et al. (2022), He & Loewen (2022), Schroeder et al. (2021), Ulmer et al. (2022, 2023), Welbers et al. (2019), and Leonardou et al. (2020) has shown that incorporating feedback with gamification elements has been effective in improving the results of educational games, including motivation and learning outcomes. This

demonstrates that by utilizing delayed feedback mechanisms in gamification format, educational games are still able to achieve favorable outcomes in terms of their main objectives. Nevertheless, not all forms of delayed feedback incorporate gamification components. An instance of this is the application of artificial intelligence in the research conducted by Hocine (2022).

Eventually, gamification elements are best for delayed feedback systems due to the way they work. Leaderboards and rewards appear after the game. Sometimes artificial intelligence is used as a more flexible feedback system because it is better for complex computational processes. In certain cases, rule-based systems also employ delayed feedback systems because of the intricate nature of their rule settings (Awais Hassan et al., 2019; Biswas et al., 2020; Jeelani et al., 2020; Tärning & Silvervarg, 2019). We have classified them into three categories: artificial intelligence, rule-based, and gamification.

Table 7
Methods of Feedback System

No	Types of Feedback	Qty	Paper
1	Artificial Intelligence	4	(Hocine, 2022; Karavidas et al., 2022; Tang et al., 2020; Zarglayoun et al., 2022)
2	Rule-Based	19	(Amat et al., 2021; Awais Hassan et al., 2019; Bermúdez i Badia et al., 2019; Biswas et al., 2020; Derks et al., 2022; Jeelani et al., 2020; Mao et al., 2024; Mendoza et al., 2019; Moldoveanu et al., 2023; Oagaz et al., 2022; Othlinghaus-Wulhorst & Hoppe, 2020; Pan et al., 2019; Rajendran et al., 2019; Sayed et al., 2023; Schättin et al., 2022; Sharma et al., 2022; Stefanidis et al., 2019; Tärning & Silvervarg, 2019; Tuti et al., 2020)
3	Gamification	13	(Amiri et al., 2022; Arner et al., 2021; Ben Itzhak et al., 2022; Bräuer & Mazarakis, 2022; Dietvorst et al., 2022; He & Loewen, 2022; Leonardou et al., 2020; Passalacqua et al., 2020; Schroeder et al., 2021; Škola et al., 2019; Ulmer et al., 2022, 2023; Welbers et al., 2019)

However, most articles that use immediate feedback use rule-based feedback systems. Rules-based systems make decisions based on uncertain variables using if-then rules (Hocine, 2022). These rules were created to comply with feedback implementation goals. Most articles indicate that rule-based methods do not explain their calculation algorithms. There are few rule-based system computation formula articles (Awais Hassan et al., 2019; Rajendran et al., 2019; Sayed et al., 2023; Tuti et al., 2020). In 19 articles, rule-based techniques are used in case studies with different rule definitions. There is no universal feedback system formula. Gamification features like points, badges, leaderboards, challenges, levels, and rewards can be integrated with rule-based and AI techniques in many feedback system case studies. However, few studies have used AI in educational game feedback systems.

Players receive feedback from three main components, as shown in Table 8. The text component gives players only text feedback. Gamification research usually gives players text feedback (Ben Itzhak et al., 2022; Bräuer & Mazarakis, 2022; Dietvorst et al., 2022; He & Loewen, 2022; Leonardou et al., 2020; Schroeder et al., 2021; Ulmer et al., 2022, 2023; Welbers et al., 2019). Several other studies utilize the text component to provide feedback to players in the form of motivating sentences, regardless of whether the feedback is correct or incorrect. The purpose of this feedback is to encourage players to continue playing the game (Amiri et al., 2022; Arner et al., 2021; Mendoza et al., 2019; Rajendran et al., 2019; Sayed et al., 2023; Stefanidis et al., 2019; Tärning & Silvervarg, 2019).

Table 8
Components of Feedback System

No	Types of Components	Qty	Paper
1	Text	16	(Arner et al., 2021; Awais Hassan et al., 2019; Derks et al., 2022; Dietvorst et al., 2022; He & Loewen, 2022; Hocine, 2022; Mao et al., 2024; Othlinghaus-Wulhorst & Hoppe, 2020; Passalacqua et al., 2020; Rajendran et al., 2019; Sayed et al., 2023; Sharma et al., 2022; Tärning & Silvervarg, 2019; Tuti et al., 2020; Ulmer et al., 2023; Welbers et al., 2019)
2	Audio	0	-
3	Visual	8	(Amat et al., 2021; Biswas et al., 2020; Jeelani et al., 2020; Moldoveanu et al., 2023; Škola et al., 2019; Tang et al., 2020; Ulmer et al., 2022; Zarglayoun et al., 2022)
4	Text + Audio	2	(Ben Itzhak et al., 2022; Bräuer & Mazarakis, 2022)
5	Text + Visual	6	(Karavidas et al., 2022; Leonardou et al., 2020; Mendoza et al., 2019; Oagaz et al., 2022; Pan et al., 2019; Schroeder et al., 2021)
6	Audio + Visual	2	(Bermúdez i Badia et al., 2019; Schättin et al., 2022)
7	Text + Audio + Visual	2	(Amiri et al., 2022; Hocine, 2022)

Table 8 shows that the text component is used most often to give players feedback. Over half of the articles give players text feedback. This supports the widespread adoption of text-based feedback systems, such as motivational sentences, rewards, leaderboards, hints, and chatbot integration. Due to its easy integration in educational games, text is widely used. Text can also be seamlessly integrated with audio and visual elements. It is widely agreed that visual feedback is the second most common medium for players.

RQ-3: How the feedback system impacts the learner?

After careful examination, it can be determined that the implementation of feedback systems has at least six impacts. Table 9 shows the impacts of utilizing feedback system.

Table 9
Impacts of Feedback System in Educational Games

No	Impacts	Qty	Paper
1	Self-Improvement	8	(Bermúdez i Badia et al., 2019; Biswas et al., 2020; Dietvorst et al., 2022; Leonardou et al., 2020; Moldoveanu et al., 2023; Oagaz et al., 2022; Othlinghaus-Wulhorst & Hoppe, 2020; Tärning & Silvervarg, 2019)
2	Increase Motivation	24	(Amat et al., 2021; Amiri et al., 2022; Arner et al., 2021; Awais Hassan et al., 2019; Ben Itzhak et al., 2022; Bermúdez i Badia et al., 2019; Bräuer & Mazarakis, 2022; Derks et al., 2022; Dietvorst et al., 2022; He & Loewen, 2022; Jeelani et al., 2020; Othlinghaus-Wulhorst & Hoppe, 2020; Pan et al., 2019; Passalacqua et al., 2020; Rajendran et al., 2019; Schättin et al., 2022; Schroeder et al., 2021; Sharma et al., 2022; Škola et al., 2019; Stefanidis et al., 2019; Tärning & Silvervarg, 2019; Ulmer et al., 2022, 2023; Zarglayoun et al., 2022)
3	Increase Learning Outcomes	18	(Amat et al., 2021; Arner et al., 2021; Awais Hassan et al., 2019; Ben Itzhak et al., 2022; Biswas et al., 2020; Bräuer & Mazarakis, 2022; Derks et al., 2022; He & Loewen, 2022; Jeelani et al., 2020; Leonardou et al., 2020; Mao et al., 2024; Othlinghaus-Wulhorst & Hoppe, 2020; Škola et al., 2019; Stefanidis et al., 2019; Tang et al., 2020; Tuti et al., 2020; Ulmer et al., 2022; Welbers et al., 2019)
4	Increase Engagement	21	(Amiri et al., 2022; Arner et al., 2021; Awais Hassan et al., 2019; Ben Itzhak et al., 2022; Biswas et al., 2020; Bräuer & Mazarakis, 2022; Derks et al., 2022; He & Loewen, 2022; Leonardou et al., 2020; Mao et al., 2024; Mendoza et al., 2019; Othlinghaus-Wulhorst & Hoppe, 2020; Passalacqua et al., 2020; Schättin et al., 2022; Schroeder et al., 2021; Sharma et al., 2022; Škola et al., 2019; Stefanidis et al., 2019; Ulmer et al., 2023; Welbers et al., 2019; Zarglayoun et al., 2022)
5	Personalization	9	(Bermúdez i Badia et al., 2019; Mendoza et al., 2019; Moldoveanu et al., 2023; Pan et al., 2019; Stefanidis et al., 2019; Tang et al., 2020; Ulmer et al., 2023; Welbers et al., 2019; Zarglayoun et al., 2022)
6	Dynamic Difficulty Adjustment	9	(Amat et al., 2021; Amiri et al., 2022; Arner et al., 2021; Hocine, 2022; Karavidas et al., 2022; Mao et al., 2024; Pan et al., 2019; Sayed et al., 2023; Sharma et al., 2022)

Self-improvement in educational games involves the enhancement of skills and knowledge through interactive learning experiences (Leonardou et al., 2020). By utilizing visual feedback through a feedback board incorporated into virtual reality in the table tennis training game, players receive precise information regarding their posture and body movements, allowing them to rectify any mistakes in their performance (Oagaz et al., 2022). As a result, the confidence and ability of the players increased by 34%. The feedback system method employed by Dietvorst et al. (2022) utilized gamification, incorporating points and leaderboards presented in a dashboard format. VR phobia

therapy games adjust visual feedback based on player fear. These findings motivate players to stay calm when facing their fears in the game (Moldoveanu et al., 2023).

Feedback systems have also been shown to boost player motivation in digital learning environments and gameplay. As shown in Table 9, 66% of the papers analyzed in this study increased player motivation. Motivation can be intrinsic or extrinsic. A person's intrinsic motivation is to do something for personal satisfaction or enjoyment (Morris et al., 2022). In contrast, extrinsic motivation refers to participating in activities with the goal of obtaining external rewards or avoiding punishment (Ives et al., 2023).

Player engagement increases in 58% of studies with feedback systems. Educational games are preferred to traditional methods for learning, which increases engagement. After conducting a more thorough examination, it is commonly observed that feedback systems that affect motivation also result in heightened engagement (Amiri et al., 2022; Arner et al., 2021; Awais Hassan et al., 2019; Ben Itzhak et al., 2022; Derks et al., 2022; He & Loewen, 2022; Othlinghaus-Wulhorst & Hoppe, 2020; Passalacqua et al., 2020; Schättin et al., 2022; Schroeder et al., 2021; Sharma et al., 2022; Škola et al., 2019; Stefanidis et al., 2019; Ulmer et al., 2023; Zarglayoun et al., 2022).

According to the data, 50% of studies suggest that the feedback system has a positive effect on enhancing learning outcomes. This enhancement pertains to the augmentation of players' comprehension in a particular subject following their use of the educational game. The majority of research that contributes to improved learning outcomes comes from the field of education, specifically from schools or institutions of higher education (Awais Hassan et al., 2019; He & Loewen, 2022; Leonardou et al., 2020; Tang et al., 2020; Welbers et al., 2019).

Based on Table 9, 25% of the articles indicate that implementing the feedback system results in players receiving personalized benefits. Personalization in educational games involves modifying game content and learning experiences to suit the unique characteristics, preferences, and learning requirements of each student. This approach deviates from the conventional "one size fits all" methodology, with the goal of improving motivation, engagement, and learning outcomes by taking into account the distinctive characteristics of each learner (González-González et al., 2023; Imanian et al., 2022).

According to the information presented in Table 9, it is observed that 25% of the studies have an influence on altering the levels of difficulty. The adjustment of difficulty levels involves the examination and utilization of player activity feedback to alter the difficulty level in an educational game. It is crucial to carefully analyze the parameters required for dynamically adjusting the difficulty levels. The effect is comparable to the effect of personalization mentioned previously, but the effect on adaptive difficulty levels is more focused on modifying the difficulty level of game levels.

CONCLUSION

In relation to RQ1, studies have been carried out on feedback systems in diverse educational disciplines, such as academic, physical health, mental health, social sciences,

business, sports, manufacturing, and construction. The education sector is the focus of the most extensive research, comprising 38.9% of the studies. The technology used for implementing feedback systems in educational games encompasses various technologies such as virtual reality, augmented reality, mobile applications, desktop applications, web applications, and other motion-based technologies. Desktop applications are the most prevalent technology, accounting for 33.3% of usage. Finally, the categories of educational games that incorporate feedback systems consist of serious games, game-based learning, gamification, and e-learning, with serious games being the most dominant, accounting for 55.6%. Feedback systems in educational games are primarily implemented in the academic domain, with a particular emphasis on serious games that are based on desktop platforms.

Different methods for building feedback systems in educational games have been identified for RQ2. Initial step is choosing a feedback type, including immediate and delayed. The proportion of studies using immediate feedback is similar to those using delayed feedback, so there is no bias. Some studies combine immediate and delayed feedback. Methodology selection is the second method. This review analyzes feedback systems using AI, rule-based systems, and gamification. Only 4 of 36 articles use artificial intelligence, while rule-based systems and gamification dominate. The last method involves choosing user feedback components. Three main categories are textual, auditory, and visual. Player feedback is often given via text, including motivational sentences to keep players focused and instructions for mistakes. Audio and visual elements should supplement text.

Regarding RQ3, feedback systems in educational games have many benefits. The effects include Self-improvement, motivation, learning outcomes, engagement, personalization, and dynamic difficulty adjustment are these effects. Self-improvement helps players learn skills and reach their goals. Increased motivation and engagement prevent boredom and increase educational game participation. Compare to traditional learning methods, improved learning outcomes improve players' subject comprehension and expertise. Personalization lets players learn and play based on their abilities. Dynamic difficulty adjustment ensures that game levels are well-balanced, encouraging players to keep playing educational games. The most common effects are increased motivation, engagement, and learning outcomes.

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