

# **GAME-BASED LEARNING TO IMPROVE CRITICAL THINKING AND KNOWLEDGE SHARING: LITERATURE REVIEW**

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## **Abstract**

Game-based learning is an innovative approach that combines educational content with interactive gameplay, providing students with an engaging and immersive learning experience. By incorporating interactive and engaging elements, games have the potential to create an immersive learning environment that fosters active participation and deep understanding. However, despite the growing interest in this field, there is still a need for further exploration and understanding of how game-based learning can be effectively utilized to improve critical thinking and knowledge sharing. The purpose of this paper is to explore the potential of using games as an effective educational tool. It aims to investigate how game-based learning can enhance knowledge sharing among learners and foster the development of critical thinking abilities. To achieve this purpose, the research conducted in this paper includes a literature review on game-based learning and its impact on knowledge sharing and critical thinking skills. Additionally, the paper presents a case study that demonstrates the effectiveness of a specific game-based learning approach. The findings of this research contribute to the understanding of how games can be utilized to enhance educational outcomes and promote active engagement among learners. The paper provides guidelines for implementing game-based learning in educational settings and offers recommendations for designing effective game-based learning experiences.

## **Keywords**

Game-based learning, knowledge sharing, critical thinking, game mechanics, game elements.

## **1 | Introduction**

The purpose of the paper is to explore the effectiveness of using games to enhance knowledge sharing among individuals and foster the development of critical thinking abilities. The paper aims to investigate how game-based learning can be utilized as an innovative approach in educational settings to promote active engagement, collaboration, and problem-solving skills among learners.

Game-based learning has gained significant attention in recent years due to its potential to engage learners and enhance their educational experience (Cheng, Su, & Sciences, 2012; Liu, Shaikh, & Gazizova, 2020). By incorporating elements of gameplay, such as challenges, rewards, and competition, game-based learning can motivate students to actively participate in the learning process (J. L. Plass, B. D. Homer, & C. K. J. E. p. Kinzer, 2015b; Proulx, Romero, & Arnab, 2017). Moreover, it has been found that game-based learning can effectively promote knowledge sharing among students by fostering collaboration and teamwork (Blunt, 2007). Additionally, this approach has shown promising results in developing critical thinking skills as it encourages learners to think strategically and make decisions (Royle, 2008).

Game-based learning refers to the use of games and game-like elements in educational settings to enhance learning outcomes (Al-Azawi, Al-Faliti, & Al-Blushi, 2016; J. L. Plass, B. D. Homer, & C. K. Kinzer, 2015a). Game-based learning is an innovative approach that combines educational content with interactive gameplay, providing students with an engaging and immersive learning experience (Al-Azawi, Al-Faliti, Al-Blushi, & technology, 2016; Anastasiadis, Lampropoulos, & Siakas, 2018). It is a pedagogical approach that leverages the engaging and interactive nature of games to make learning more enjoyable and effective (Charles, Charles, McNeill, Bustard, & Black, 2011; Kapp, 2012; Squire, 2003). This is because games provide a sense of challenge, competition, and reward, which keeps students actively involved and eager to participate in their own learning journey. Game-based learning can involve various types of games, including digital or online games, board games, card games, or even physical activities with game-like elements (Kapp, 2012; Karagiorgas & Niemann, 2017).

Sharing knowledge, which is a characteristic of learning and refers to the act of imparting information, insights, or expertise to others (Savolainen, 2017). It involves the transfer of ideas, experiences, and skills from one individual to another, with the aim of increasing understanding and promoting learning (Abu-Rumman, 2021; Bada & Olusegun, 2015). When individuals share their knowledge, it creates a ripple effect, inspiring others to do the same and fostering a culture of continuous learning (Pasher & Ronen, 2011; Shao, Feng, & Liu, 2012). Sharing knowledge is important because it allows individuals to learn from each other's experiences and expertise (Krishnaveni & Sujatha, 2012; H. F. Lin, 2007). It promotes collaboration and innovation, as different perspectives and ideas can be shared and built upon (Lloyd-Walker, Mills, & Walker, 2014).

Critical thinking skills (CTS) are essential for success in today's rapidly changing world (V. Sepahi, M. R. Khazaei, A. Khoshay, S. Iranfar, & M. J. E. R. i. M. S. Timare, 2014b). Critical thinking skills refer to the ability to analyze information objectively, evaluate arguments and evidence, and make logical and reasoned judgments (Lai, 2011). Critical thinking skills also encompass problem-solving abilities, creativity, and the capacity to think independently. CTSs are essential for analyzing and evaluating information objectively. They involve the ability to question assumptions, consider alternative perspectives, and make logical connections between ideas. These skills enable individuals to make informed decisions, solve complex problems, and communicate effectively in various contexts.

By combining game-based learning, sharing knowledge, and critical thinking skills, educators can create an engaging and interactive learning environment. This approach not only fosters collaboration among students but also encourages them to think critically while applying their knowledge in a fun and practical way. By integrating educational content into gameplay, students can actively participate in problem-solving, critical thinking, collaboration, and decision-making, which helps to develop their cognitive and social skills (Adipat, Laksana, Busayanon, Asawasowan, & Adipat, 2021; Chen, Tsai, Liu, & Chang, 2021). Game-based learning provides immediate feedback and rewards, which can motivate students to persist in their learning and strive for improvement (Kiili, 2005; Krath, Schürmann, & Von Korfflesch, 2021). This approach also allows for personalized learning experiences, as games can be tailored to meet the individual needs and interests of each student (Alamri, Lowell, Watson, & Watson, 2020; Alsobhi, Khan, & Rahanu, 2015). It allows students to progress at their own pace and receive targeted support based on their individual needs and can be adapted to different subjects and age groups (Bontchev, Terzieva, & Paunova-Hubenova, 2021).

The aim of this paper is to investigate how game-based learning can enhance knowledge sharing among learners and foster the development of critical thinking abilities. Specifically, the present study poses the following two research questions: 1. How does game-based learning enhance knowledge sharing among players? 2. How does game-based learning contribute to the development of critical thinking skills in individuals? To provide answers to the above research questions the research conducted in this paper includes a review of existing literature on game-based learning, case studies of successful implementations, and an analysis of the impact of game-based learning on knowledge-sharing and critical thinking skills. By examining these factors, the paper aims to contribute to the growing body of knowledge on game-based learning and provide educators with practical insights on how to effectively integrate games into their teaching practices.

The main contribution of this research is to provide guidelines for implementing game-based learning in educational settings and offers recommendations for designing effective game-based learning experiences.

## 2 | Game based learning

Game-based learning is a field of study that explores the use of games as educational tools. GBL has gained significant attention in recent years due to its potential to enhance student engagement and motivation. This section aims to provide a comprehensive understanding of the underlying reasons behind its effectiveness, the specific types of games used in educational settings, the various contexts where game-based learning can be implemented, the optimal timing for its integration into curricula, and the key stakeholders involved in its implementation.

This section will explore different theoretical frameworks and models that have been proposed to understand the underlying mechanisms of game-based learning.

Game-based learning is an educational approach that incorporates elements of gameplay into the learning process (Plass et al., 2015b). It involves using interactive games or game-like activities to engage and motivate learners, while also teaching them specific skills or knowledge. This approach has gained popularity in recent years due to its ability to make learning more enjoyable and effective by providing a hands-on and immersive experience for students.

### What types of games are used for learning?

The specific types of games used for learning vary depending on the subject and desired outcomes. Some examples include educational video games, interactive simulations, gamified quizzes, virtual reality experiences, and board games designed to teach specific concepts or skills. These games are designed to engage learners, promote active participation, and facilitate the acquisition of knowledge or skills in an enjoyable and immersive way.

For example, in language learning, interactive games that focus on vocabulary and grammar can be effective. On the other hand, in mathematics education, games that involve problem-solving and critical thinking are often utilized. Ultimately, the choice of game depends on the specific learning objectives and the engagement level it brings to the students. The figure presented below (Figure 1) exemplifies three distinct games that center around three distinct subjects, each with its own set of objectives and outcomes; however, they are all rooted in learning.

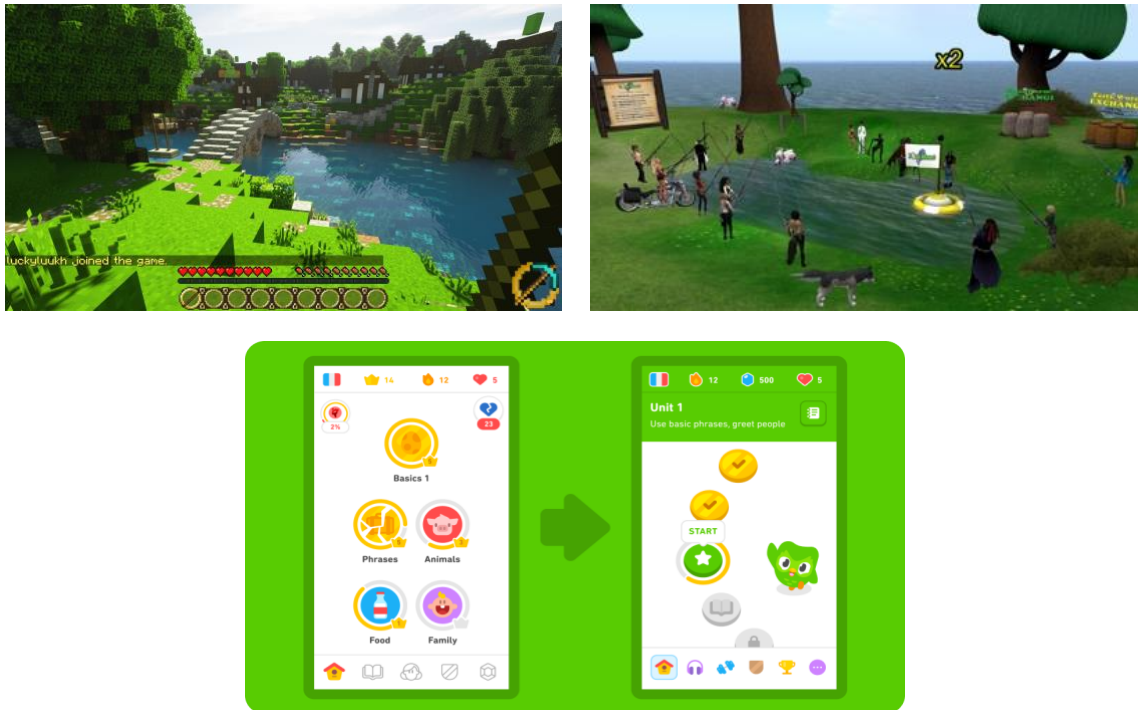


Figure 1 Screenshots of Minecraft, Second Life and Duolingo

Figure 1 showcases screenshots of three popular digital platforms: Minecraft, Second Life, and Duolingo. Minecraft is a highly immersive sandbox game that allows players to build and explore virtual worlds. Second Life, on the other

hand, is a virtual reality platform where users can create avatars and interact with others in a vast online community. Lastly, Duolingo is a language-learning app that gamifies the process of acquiring new languages through interactive exercises and challenges.

### Why are games used for learning?

Using games for learning has several advantages. Firstly, games make the learning process more engaging and enjoyable for learners (Cheng et al., 2012). By incorporating elements of competition, rewards, and challenges, games can motivate learners to actively participate and stay focused on the learning objectives (Molin, 2017; Pavlas, 2010). Furthermore, games provide a safe environment for learners to experiment, make mistakes, and learn from them without the fear of negative consequences (Barnett & Coulson, 2010). This promotes a sense of exploration and curiosity among learners, leading to better retention of knowledge and skills.

Game-based learning works because it taps into the natural human inclination for play and competition (Wu, 2015; Yochum, 2013). It engages learners by making the educational experience enjoyable and interactive. Additionally, games provide immediate feedback and rewards, which enhance motivation and retention of information (Plass et al., 2015b).

### Where to use games for learning?

Game-based learning can be implemented in a wide range of contexts, such as classrooms, corporate training programs, and healthcare settings. It is particularly effective in subjects that require problem-solving skills, critical thinking, and collaboration, as games provide an interactive and engaging environment for learners to practice and apply their knowledge (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014; Snyder & Snyder, 2008).

In classrooms, teachers can use educational games to engage students and make learning more interactive and enjoyable. It can be incorporated into subjects like mathematics (figure 2), science, languages, and history to make the learning process more engaging and interactive for students.

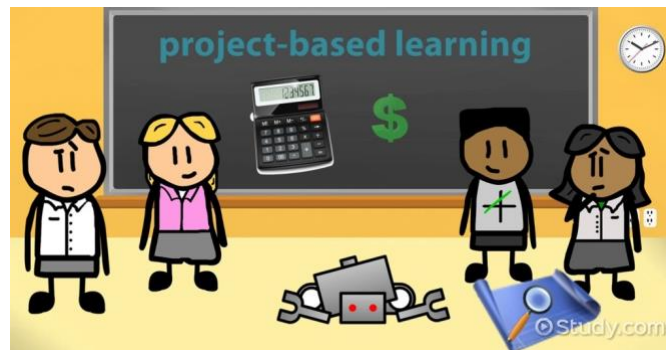


Figure 2 Game-based learning for math problems  
(<https://study.com/academy/lesson/critical-thinking-math-problems-examples-and-activities.html>)

Similarly, in corporate training programs, game-based learning can be used to enhance employee engagement and retention of information (Senderek, Brenken, & Stich, 2015). In healthcare (figure 3), professionals can utilize serious games to simulate real-life scenarios and improve clinical decision-making skills (Ahmed, Sutton, & Development, 2017).



Figure 3 Game-based learning in medicine (<https://www.indusgeeks.com/gamebasedlearning.php>)

GBL can also be utilized as a supplementary tool for individual self-study or as a means of reinforcing concepts learned in traditional teaching methods.

### **When are games used for learning?**

Games can be used for learning when educators want to engage students in a more interactive and hands-on approach to education (Dickinson, Woodard, Canas, Ahamed, & Lockston, 2011). Games can be particularly effective in teaching complex concepts or skills that require practice and repetition to master (Dickinson et al., 2011; Stott & Neustaedter, 2013).

GBL can be incorporated into lessons at any time, but it is particularly effective when students need to reinforce concepts or engage in collaborative problem-solving (Snyder & Snyder, 2008). One of the best times to include game-based learning in lessons is when introducing new concepts or topics (Marc I Cicchino, 2015; Hartt, Hosseini, & Mostafapour, 2020). Games can engage students' curiosity and make the learning experience more interactive and enjoyable. Furthermore, integrating game-based learning during review sessions or as a form of assessment can make the learning experience more enjoyable and memorable for students (Ifenthaler, Eseryel, & Ge, 2012).

### **Who will use games for learning?**

Various stakeholders are involved in games for learning, including educators, game developers, researchers, and students.

Educators play a crucial role in integrating educational games into their curriculum and facilitating the learning process. They are responsible for selecting appropriate games that align with the learning objectives and ensuring that students understand how to effectively use them (Martens, Diener, & Malo, 2008; P. Pivec, 2009). Additionally, educators provide guidance and support to students during gameplay, helping them make connections between the game content and real-world concepts (Stott & Neustaedter, 2013).

Game developers create engaging and interactive games that align with educational objectives. They use their expertise in both education and game design to create games that are not only fun but also educational. By incorporating elements such as problem-solving, critical thinking, and collaboration, game developers aim to enhance the learning experience for students. They also continuously update and improve their games based on feedback from educators and students to ensure they remain effective tools for learning.

Researchers contribute by studying the effectiveness of games for learning and providing insights into their impact on student outcomes. They conduct studies to measure the cognitive and academic benefits of educational games, as well as analyze how games can be integrated into traditional classroom settings. Additionally, researchers explore the

potential of gamification in various subjects, such as math, science, and language arts, to make learning more engaging and interactive for students.

Ultimately, students are the primary beneficiaries as they actively participate in these games to enhance their knowledge and skills. Through active participation in educational games, students not only improve their cognitive abilities but also develop critical thinking and problem-solving skills. Moreover, the integration of gamification in traditional classrooms fosters a more inclusive and interactive learning environment, catering to different learning styles and preferences.

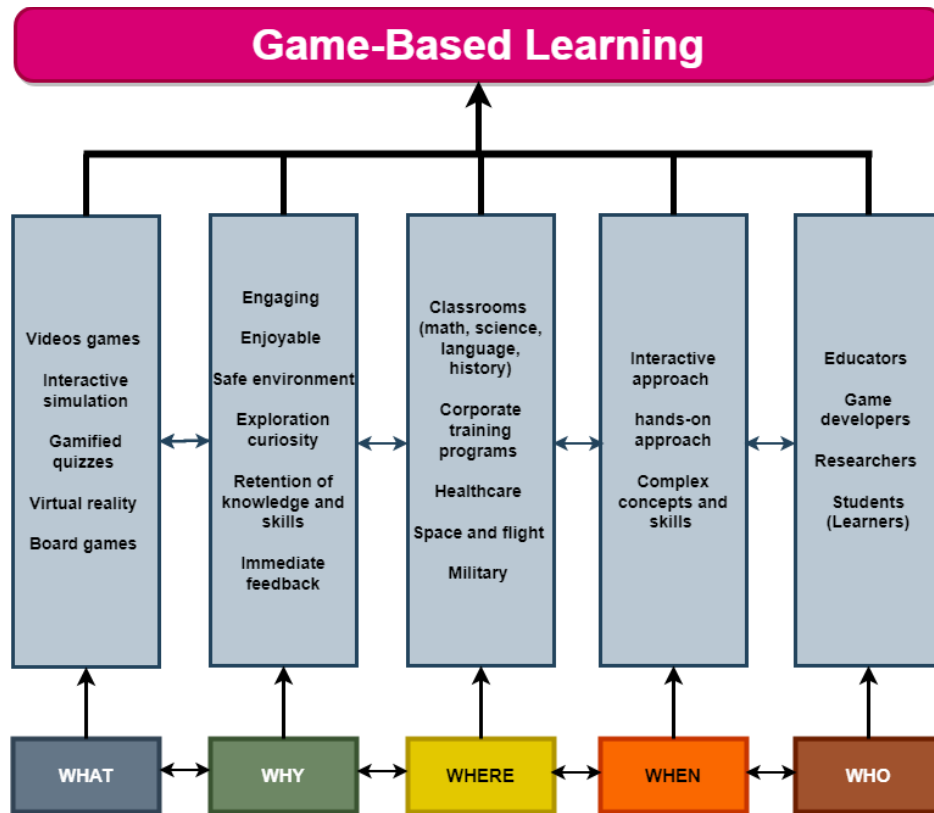


Figure 4 Game-based learning inquiries

Based on the aforementioned information, Figure 4 depicts the five inquiries that serve as a pathway towards the implementation of game-based learning. The image presented elucidates the notion that the five questions serve as foundational inquiries that underpin the viability of utilizing a game as a means of facilitating learning. These five inquiries are interrelated and serve as the foundational elements that underpin the summit of the learning game.

## 2.1 | Game-based learning fundamental pillars

Game-based learning is built on a foundation of fundamental pillars that guide the learning process. These pillars serve as a framework for students to explore and understand various concepts while engaging in gameplay. By incorporating these fundamental pillars into game-based learning, educators can encourage critical thinking, problem-solving, and collaboration among students. This approach not only enhances their understanding of the subject matter but also promotes active engagement and motivation in the learning process. Game-based learning is built on two fundamental pillars that guide its implementation and effectiveness (Plass et al., 2015b). These pillars are:

1. Immersion: Game-based learning provides an immersive experience that captivates students' attention and allows them to fully engage with the content. Through interactive gameplay, students are transported into a virtual world where they can explore, experiment, and make decisions that directly impact their learning.

2. Feedback: Games provide immediate and continuous feedback to students, allowing them to learn from their mistakes and make improvements in real-time. This feedback loop promotes a growth mindset and encourages students to persist in their learning journey.

Plass et al. (2015b) propose that game-based learning can be conceptualized as a rudimentary framework that encompasses the fundamental structure observed in most games. The structure comprises three essential components, namely a challenge, a response, and feedback (see Figure 2). A feedback loop arises when the provided feedback presents a novel challenge or motivates the player to offer an alternative response to the initial task. The design of a particular game is influenced by a learning theory, which is evident in the nature of the challenges presented, the types of answers it enables, and the feedback it offers.

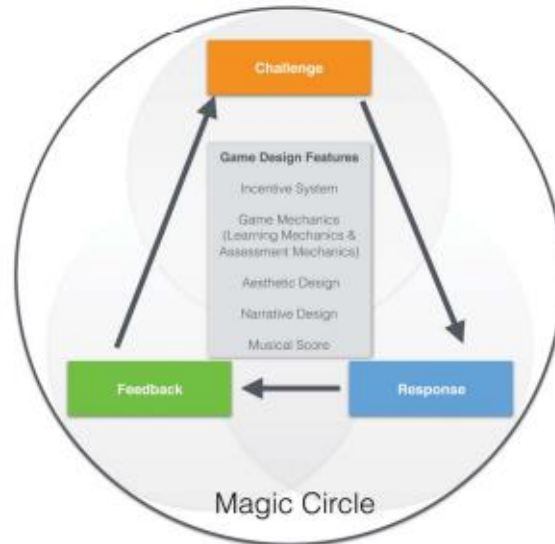


Figure 5 Model of game-based learning (Plass et al., 2015b)

The model of game-based learning in Figure 5 illustrates the integration of educational content and game mechanics. It showcases how games can be designed to engage learners, promote active participation, and provide meaningful learning experiences. The model highlights the importance of feedback, challenge, and response in game-based learning to ensure effective learning outcomes.

## 2.2 | Elements of game for learning

The elements of game-based learning include the integration of game mechanics and design principles into educational activities. This approach often incorporates elements such as interactive gameplay, immediate feedback, challenges and rewards, progress tracking, and immersive storytelling to enhance the learning experience.

In figure 6, we summarized the connection between game mechanics, educational activities and outcome (learning outcomes). The game mechanics serve as the underlying framework that drives the educational activities within the game. These mechanics provide the rules, challenges, and incentives that engage players and promote active learning (Proulx et al., 2017). The educational activities, in turn, are designed to align with specific learning outcomes, such as critical thinking skills or content knowledge acquisition. By understanding this connection, game designers can create meaningful and effective learning experiences for players.



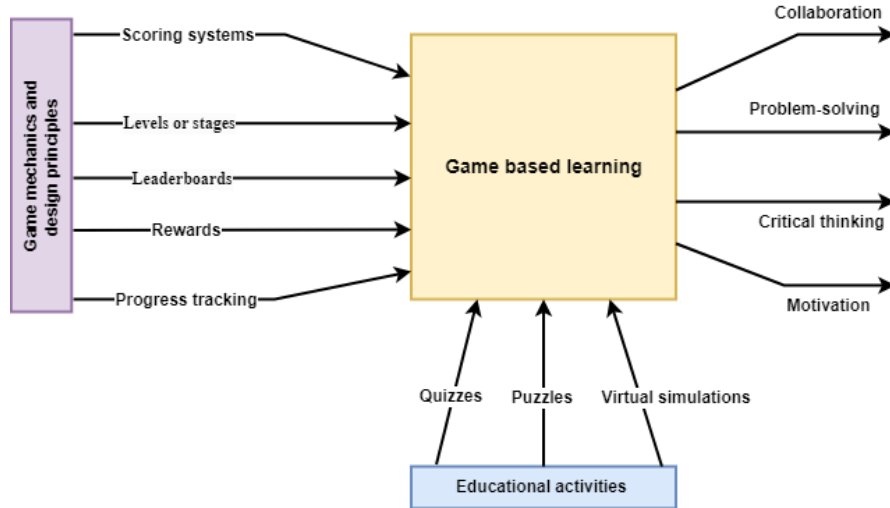


Figure 6 Game based learning principles

Table 1 provides our understanding of game mechanics, including their description and educational objectives. Game mechanics refer to the rules, systems, and interactions that govern gameplay and contribute to the overall experience of a game (Plass, Mayer, & Homer, 2020; Proulx et al., 2017). By understanding and mastering these mechanics, players can enhance their strategic thinking, problem-solving skills, decision-making abilities, and teamwork. The educational objectives associated with game mechanics vary depending on the specific game but often include fostering creativity, promoting critical thinking, encouraging collaboration, and developing adaptability. They can range from virtual simulations that replicate real-world scenarios to quizzes and puzzles that test knowledge and skills.

Table 1 Description of educational objectives of game elements

Element	Description	Educational objectives
<b>Scoring systems</b>	Scoring systems in game-based learning are designed to provide feedback and measure the progress of players throughout the game. They enable players to track their achievements, identify areas for improvement, and compete with others, fostering a sense of accomplishment and engagement in the learning process.	Allowing educators to assess students' knowledge and skills while making the learning experience more interactive and enjoyable.
<b>Levels or stages</b>	Levels or stages are a way to structure the learning process and provide a sense of progression for the players. Each level typically presents new challenges or concepts that build upon the previous ones, allowing players to gradually develop their skills and knowledge.	Are designed to promote skill development, critical thinking, problem-solving abilities, and content knowledge acquisition.
<b>Leaderboards</b>	Leaderboards are interactive features that display the rankings and scores of players within a game. They provide a competitive element to the learning experience by allowing players to compare their progress and achievements with others.	Leaderboards can also serve as a tool for educators to track student performance and identify areas where additional support may be needed.
<b>Rewards</b>	Rewards serve as powerful motivators for students. They are designed to provide positive reinforcement and encourage active participation. Rewards can include such as points, badges, or virtual currency.	To motivate and engage learners by providing a sense of accomplishment and progress as they navigate through the game.
<b>Progress tracking</b>	Progress tracking in game-based learning involves the systematic monitoring and assessment of a player's performance and achievements throughout the learning process. This includes collecting data on various aspects such as completion of levels, scores, time taken to complete tasks, and mastery of specific skills or concepts.	By analyzing this data, educators can gain valuable insights into each player's strengths, weaknesses, and learning patterns, allowing for personalized feedback and targeted interventions to enhance their learning experience.



Table 2 presents our understanding of game-based learning outcomes. These outcomes provide various educational benefits that can be achieved through it. It highlights the positive impact games can have on cognitive skills, such as problem-solving and critical thinking.

Table 2 Game-based learning outcomes

Element	Description	Game mechanics
<b>Collaboration</b>	Game-based learning promotes collaboration by creating an interactive and engaging environment where students can work together towards a common goal.	Cooperative gameplay, where players work together towards a common goal, and team-based challenges that require communication and coordination among players. Games may incorporate rewards or bonuses for collaborative actions, such as sharing resources or assisting teammates, to encourage collaboration.
<b>Problem-solving</b>	Game-based learning promotes problem-solving by engaging students in interactive and immersive gaming experiences, they are encouraged to think critically, strategize, and make decisions to overcome challenges within the game.	Puzzles and riddles that require critical thinking and logical reasoning to solve
<b>Critical thinking</b>	Game-based learning promotes critical thinking through interactive gameplay. Students are encouraged to think critically, assess different strategies, and adapt their approach based on the feedback they receive within the game. This process helps develop their analytical skills, logical reasoning, and ability to think creatively when faced with complex challenges.	Problem-solving challenges, puzzles, and decision-making scenarios.
<b>Motivation</b>	Game-based learning promotes motivation by creating an engaging and interactive learning environment. Using game mechanics, students are motivated to actively participate and strive for success.	Challenges, rewards, and competition

The outcomes also emphasize the potential for games to enhance motivation and collaboration in learning, leading to improved academic performance.

### 2.3 | Factors to influence the effectiveness of the game-based learning

It is important for educators and game designers to consider these factors when implementing game-based learning strategies. This section will examine the diverse aspects that can impact the efficacy of game-based learning. The analysis section of this study will specifically examine these factors.

#### Instructional design

Instructional design in game-based learning refers to the process of creating educational experiences that leverage the principles of game design to enhance learning outcomes (Nadolny et al., 2020). It involves designing and developing games or gamified activities that are specifically tailored to engage learners, promote active participation, and facilitate the acquisition of knowledge and skills. This approach combines the engaging and immersive nature of games with effective instructional strategies to enhance learning and knowledge retention (Ke, Shute, Clark, & Erlebacher, 2019). This approach not only enhances the overall learning experience but also allows for personalized learning paths and adaptive content delivery, catering to the individual needs and preferences of each learner. By incorporating elements such as challenges, rewards, feedback mechanisms, and immersive storytelling, instructional designers aim to create a dynamic and interactive learning environment that fosters motivation, critical thinking, problem-solving abilities, and collaboration among learners (Kapp, 2012). Previous research and paper shown that, gamification in instructional design increase learner engagement and retention, as well as provide opportunities for real-time assessment and immediate feedback, making it a valuable tool in modern education (Alsawaier, 2018; Leung & Pluskwik, 2018; Zainuddin, Shujahat, Haruna, & Chu, 2020).

## Game mechanics

As discussed earlier, game mechanics in game-based learning refer to the rules, systems, and interactions that govern the gameplay experience (Proulx et al., 2017). These mechanics are designed to engage and motivate learners by providing challenges, rewards, and feedback. They can include elements such as points, levels, quests, leaderboards, and achievements, all of which contribute to creating an immersive and enjoyable learning environment. They are designed to engage and motivate learners by creating a sense of achievement and progress as they navigate through the educational content. By incorporating game mechanics into educational settings, educators can enhance student engagement and facilitate active participation in the learning process (Alsawaier, 2018; Stott & Neustaedter, 2013).

## Learner characteristics

Learner characteristics in game-based learning refer to the individual traits, abilities, and preferences that influence how a learner engages with and benefits from educational games (Pavlas, 2010; J. C. Yang & Chen, 2020). These characteristics can include factors such as age, prior knowledge, cognitive abilities, learning styles, motivation levels, and even cultural backgrounds. Understanding these learner characteristics is crucial for designing effective game-based learning experiences that cater to the unique needs and interests of each learner, promoting engagement and effective learning outcomes. Considering learner characteristics allows educators to personalize instruction and provide targeted support to enhance engagement and learning outcomes (A. I. Abdul Jabbar & P. Felicia, 2015).

Numerous scholars have conducted investigations on the topic of game-based learning, yielding diverse outcomes and presenting varying suggestions. The findings shown in Table 3 provide evidence for the presence of five inquiries, as depicted in Figure 4. The studies included in table 4 explore various aspects such as engagement, motivation, knowledge sharing, and critical thinking skill development through game-based learning approaches.

Table 3 Research on game-based learning

References	Description	Findings
Tan, Ling, and Ting (2007)	This paper discusses the use of pedagogical aspects in designing game-based learning environments.	This paper identifies key components for developing educational games, starting with learner learning ability and progressing to game design, highlighting essential features for effective learning.
A. I. Abdul Jabbar and P. J. R. o. e. r. Felicia (2015)	This review explores game design features enhancing engagement and learning in game-based learning settings, addressing the lack of empirical evidence and developing general recommendations for instructional design.	The study highlights the cognitive and emotional impacts of gaming features in GBL, identifies engagement drivers, and identifies external factors influencing engagement and learning.
Royle (2008)	The article discusses the negative impact of integrating games into school culture, arguing that it dilutes the learning experience, and that teachers find games too long, immersive, and focused on wrong outcomes.	Digital technologies are reshaping curriculum delivery, necessitating collaboration between educators and game designers for more effective learning experiences in both commercial spaces and education.
Hartt, Hosseini, Mostafapour, and Research (2020)	This study examines the effectiveness of game-based learning in planning education. Specifically, we explore the impact of gamification on planning students' perception of learning, engagement, and teamwork.	Game-based learning enhances planning students' skills, highlighting its potential in education and paving the way for further research on student perceptions and non-technical gameful teaching activities.
Plass et al. (2020)	This book provides a comprehensive overview of research and theory in game-based learning, focusing on understanding its empirical and theoretical foundations.	The volume encompasses cognitive, motivational, affective, and sociocultural perspectives to effectively implement game-based learning.
Qian and Clark (2016)	This paper reviews 29 recent studies on game-based learning, focusing on 21st-century skills outcomes, analyzing game genres, design elements, learning theories, indicators, measures, and outcomes.	The paper suggests that game-based learning can effectively aid students in developing 21st-century skills, offering valuable insights for researchers, game designers, and educators in educational game design and implementation.

Tobias, Fletcher, Wind, and technology (2014)	This chapter reviews examines the effectiveness of video and computer games in teaching, focusing on transfer, cognitive enhancement, guidance, integration, player effects, attitudes, cost-effectiveness, and game evaluation.	Designing computer games is a complex task that requires a team of experts, including game designers, computer and interface specialists, subject matter experts, instructional systems design, cognitive task analysis, and game research.
Plass et al. (2015b)	The article asserts that the study or application of games as learning environments necessitates considering various perspectives.	The study suggests that a comprehensive understanding of cognitive, motivational, affective, and sociocultural perspectives is crucial for effective game design and research.
Ifenthaler et al. (2012)	The assessment method discussed in this chapter paper is crucial for evaluating the effectiveness of game-based learning. It explores various techniques and strategies that can be employed to measure learning outcomes and assess students' progress in a game-based environment.	This assessment method offers numerous benefits, including detailed insights into learning processes, tracking motivational, emotional, and metacognitive characteristics, and providing immediate feedback to identify areas of difficulty for learners.

Table 4 presents an overview of the research conducted on game-based learning. The table provides valuable insights into the effectiveness of using games as a learning tool, highlighting various studies that have explored this approach. These research findings contribute to our understanding of how game-based learning can enhance educational outcomes and engage learners in a more interactive and immersive way.

### 3 | Knowledge Sharing

This section will concentrate on the literature of knowledge sharing through the use of a game as a tool. The second part of this section will address how game-based learning can improve knowledge sharing. The final section of this section will provide guidelines for the previous question. The literature on knowledge sharing through games highlights the effectiveness of using game mechanics and elements to engage learners and facilitate information exchange. It explores various game-based learning approaches, such as gamification and serious games, that have been proven to enhance knowledge sharing in different contexts. Additionally, this section will delve into case studies and empirical evidence that demonstrate the positive impact of game-based learning on knowledge sharing outcomes. Sharing knowledge refers to the act of imparting information, insights, or expertise to others (Savolainen, 2017). It involves the transfer of ideas, experiences, and skills from one individual to another, with the aim of increasing understanding and promoting learning (Abu-Rumman, 2021; Bada & Olusegun, 2015). This can be done through various means such as teaching, mentoring, writing, speaking engagements, or even through digital platforms like blogs and social media. Sharing knowledge not only benefits the recipient by expanding their knowledge base but it is also a vital component for personal growth, professional development, and the advancement of society (Geiger, 2017; Simpson, 2008).

When individuals share their knowledge, it creates a ripple effect, inspiring others to do the same and fostering a culture of continuous learning (Pasher & Ronen, 2011; Shao et al., 2012). Additionally, sharing knowledge can lead to collaboration and innovation as different perspectives and ideas are brought together (Hoarau & Kline, 2014), ultimately driving progress in various fields and industries (Ellitan, 2020; Setini, Yasa, Supartha, Giantari, & Rajiani, 2020).

Sharing knowledge is important because it allows individuals to learn from each other's experiences and expertise (Krishnaveni & Sujatha, 2012; H. F. Lin, 2007). It promotes collaboration and innovation, as different perspectives and ideas can be shared and built upon (Lloyd-Walker et al., 2014). Additionally, sharing knowledge helps to empower others by providing them with the tools and information they need to succeed in their own endeavors (McInerney, 2002).

Our understanding of the knowledge sharing process, as depicted in Figure 7, involves the transfer of information and expertise from one individual or group to another. This process typically includes activities such as capturing knowledge, organizing it in a usable format, and disseminating it to those who can benefit from it. Additionally, feedback loops and continuous improvement efforts are often incorporated to enhance the effectiveness of knowledge sharing within an organization.

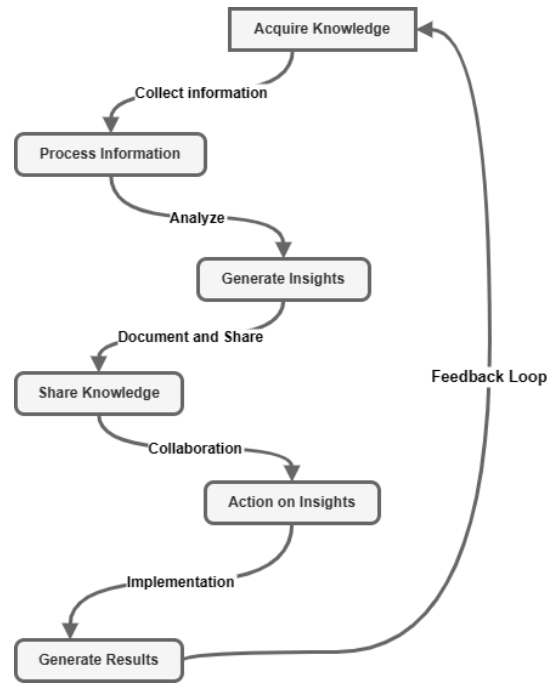


Figure 7 Knowledge sharing process

The process of sharing knowledge involves transferring information, skills, or expertise from one person to another (Kimble, Grenier, & Goglio-Primard, 2010; Liyanage, Elhag, Ballal, & Li, 2009). Sharing knowledge not only helps individuals expand their understanding but also fosters collaboration and innovation within communities and organizations (M.-J. J. Lin, Hung, & Chen, 2009; Zakaria, Amelinckx, & Wilemon, 2004).

Knowledge sharing can be facilitated through game-based learning. As seen before, game-based learning provides an interactive and engaging platform that encourages active participation and collaboration among learners.

### 3.1 | Game-based learning to shared knowledge

Game-based learning to shared knowledge is an innovative approach that combines the engagement and motivation of games with the educational benefits of shared knowledge (Anastasiadis et al., 2018; Huizenga, Admiraal, Akkerman, & Dam, 2009; Hwa, 2018; Sung & Hwang, 2013) and promotes collaboration among students and has gained popularity in recent years (Alam, 2022; Anastasiadis et al., 2018). By incorporating game elements into educational activities, students are more engaged and motivated to actively participate in the learning process (Su & Cheng, 2015; Vlachopoulos & Makri, 2017). This approach not only enhances their critical thinking and problem-solving skills but also fosters a sense of teamwork and communication as they work together to achieve common goals (Lee et al., 2016; Y.-T. C. Yang & Chang, 2013). This approach provides opportunities for immediate feedback and personalized learning experiences, allowing students to track their progress and identify areas for improvement in a fun and interactive way (Davidson & Candy, 2016; Radiani, Majchrzak, Fromm, & Wohlgenannt, 2020).

Table 4 provides an overview of the existing literature on game-based learning as a means to foster shared knowledge. The studies included in this table examine the effectiveness of using games as educational tools to promote collaborative learning and knowledge sharing among learners. These studies highlight the various approaches, methodologies, and outcomes associated with game-based learning in different educational settings.

Table 4 Literature on game-based learning to shared knowledge

References	Descriptions	Findings
Ahmed et al. (2017)	This paper critically reviews knowledge management, organizational learning, and the knowledge-based economy, providing in-depth insights into gamification and its various issues.	Game-based learning in business should align with training and development goals, demonstrating that learning can be evaluated and achieved. It can drive personal change and transformation by fostering acceptance of challenges, motivation, and constant innovation through participant commitments.
Teichmann, Ullrich, Knost, and Gronau (2020)	This paper aims to explore the use of serious games as additional tools in learning factories and to design and implement a practical prototype that aids learners in preserving knowledge.	Serious games can significantly enhance vocational training in learning factories by serving as additional teaching tools, thereby enhancing both the enjoyment and efficiency of learning.
Chang, Yeh, and Education (2021)	The study suggests a blended instructional approach that integrates game-based and mobile learning, which is more effective in attracting students to engage in learning, interaction, and knowledge sharing compared to traditional methods.	The combination of a traditional game and a mobile application enhances individual methods while promoting shared features like focused attention, brainstorming, active participation, logical thinking, and interactions.
Dernat et al. (2022)	Knowledge Sharing is a promising framework for renewing agricultural advisory systems, but its practical application remains a key research area. Increasing farmer motivation for decision-making participation is crucial.	The game-based methodology enabled farmers to participate in collective decision-making and engage in ongoing engagement, identifying a common vision for the future.
Cheng et al. (2012)	This paper introduces a game-based learning system that enhances student self-efficacy through the integration of educational and information technology.	The study indicates that students' learning motivations significantly influence their achievement, with game-based learning resulting in better outcomes compared to traditional face-to-face teaching methods.
M. Pivec, Dziabenko, and Schinnerl (2004)	Computer games provide diverse knowledge presentations and virtual application opportunities, enhancing learning processes by supporting and facilitating knowledge application within a virtual world.	The game concept enables students to acquire basic knowledge, practical experience, and soft skills for modern industrial manufacturing organizations by playing various roles. Instructors can apply game-based learning for specific topics and learning goals, introducing different contexts and knowledge to students.

### 3.2 | Game-based learning in the knowledge sharing process

Game-based learning and knowledge sharing processes are two distinct approaches to acquiring and imparting information. While game-based learning involves using interactive games and simulations to engage learners and facilitate active participation, the knowledge sharing process focuses on exchanging information and expertise through various mediums such as discussions, presentations, or online platforms. Both methods have their unique advantages; game-based learning enhances motivation and retention through immersive experiences, while the knowledge sharing process promotes collaboration and the transfer of practical insights.

Both game-based learning and the knowledge sharing process aim to enhance understanding and retention of information (figure 7 and table 3). While game-based learning utilizes interactive and engaging activities to promote active participation and motivation, the knowledge sharing process focuses on exchanging ideas, experiences, and expertise among individuals or groups. Both approaches foster collaboration, critical thinking, and problem-solving skills, ultimately leading to a deeper level of comprehension and application of knowledge.

The characteristics of game design for learning involve incorporating educational content and objectives into the gameplay (Plass et al., 2015b). This includes designing challenges and activities that promote problem-solving, critical thinking, and skill development. Additionally, game design for learning often incorporates elements such as feedback systems, progress tracking, and adaptive difficulty to enhance the learning experience (Plass et al., 2015b).

### 3.3 | Game-based learning to enhance knowledge sharing

Game-based learning is an innovative approach that combines educational content with interactive gameplay to engage learners and enhance their understanding of various subjects (Nadolny et al., 2020). By incorporating elements such as challenges, rewards, and competition, game-based learning creates a fun and immersive environment that motivates learners to actively participate and share their knowledge with others (Plass et al., 2015b). This not only fosters a collaborative learning experience but also encourages the retention and application of knowledge in real-world scenarios.

To design a game-based learning experience that enhances knowledge sharing, it is important to consider several key factors. Firstly, the game should be engaging and interactive, encouraging active participation from learners (Plass et al., 2015b). This can be achieved by incorporating elements such as challenges, rewards, and competition. Furthermore, the game should be designed in a way that promotes collaboration and communication among players, allowing them to share their knowledge and insights with each other.

Games have the ability to engage learners and create an interactive and immersive environment where they can acquire and exchange knowledge. By incorporating educational content into games, learners are motivated to actively participate, collaborate with others, and learn through problem-solving and critical thinking. This approach not only enhances knowledge retention but also promotes a fun and engaging way of sharing information among individuals.

Table 5 outlines our conclusion the key factors that can be utilized to enhance knowledge sharing through game-based learning. These factors include creating interactive and engaging gameplay experiences, incorporating collaborative elements to encourage teamwork and cooperation among players, and integrating feedback mechanisms to provide immediate and personalized learning opportunities. Additionally, incorporating social features such as leaderboards or multiplayer options can further facilitate knowledge sharing by fostering healthy competition and allowing players to learn from each other's strategies and experiences.

Table 5 Factors to enhance knowledge sharing in game designed for learning

Code	Elements	Descriptions
E1	Engagement	Refers to the active involvement and participation of learners in the process of acquiring and exchanging information through gamified activities. This approach leverages the elements of games, such as competition, rewards, and challenges, to motivate learners and enhance their level of engagement with the learning content.
E2	Motivation	Motivation in knowledge sharing using game-based learning refers to the intrinsic drive and enthusiasm that individuals have to actively participate and contribute their knowledge within a game-based learning environment. It involves creating a sense of purpose, engagement, and enjoyment through game mechanics, rewards, challenges, and feedback systems.
E3	Immediate feedback	Refers to the prompt and real-time responses provided to learners during the gameplay. It involves providing learners with instant information about their performance, progress, and understanding of the subject matter within the game. This feedback helps learners to identify their strengths and weaknesses, allowing them to make necessary adjustments and improve their learning outcomes.

A game is a valuable tool that can be utilized to promote knowledge sharing in game design for educational purposes. By incorporating these elements into the game design process, developers can create a platform that encourages players to exchange information, ideas, and insights. This fosters a collaborative learning environment where players can learn from each other's experiences and collectively enhance their knowledge.

## 4 | Critical thinking skills

According to Lai (2011), critical thinking skills refer to the ability to analyze information objectively, evaluate arguments and evidence, and make logical and reasoned judgments. Critical thinking skills also encompass problem-solving abilities, creativity, and the capacity to think independently. Critical thinking skills are essential for success

in today's rapidly changing world (Sepahi et al., 2014b). CTSs are essential for analyzing and evaluating information objectively. They involve the ability to question assumptions, consider alternative perspectives, and make logical connections between ideas. These skills enable individuals to make informed decisions, solve complex problems, and communicate effectively in various contexts.

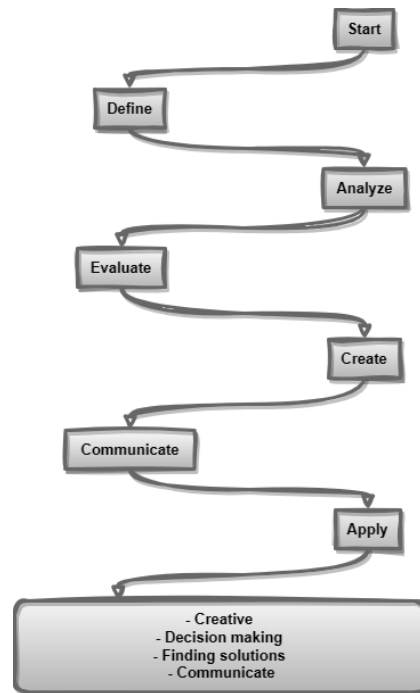


Figure 8 Critical thinking skills process

Figure 8 shows our understanding of critical thinking skills process as a structured approach that helps individuals develop their analytical and problem-solving abilities. It involves eight steps that guide individuals in gathering information, analyzing it, and making informed decisions. By following this process, individuals can enhance their ability to think critically and make logical and well-reasoned judgments. This process is applicable in various areas of life, such as academics, professional settings, and personal decision-making. It empowers individuals to evaluate information objectively and consider multiple perspectives.

There are several key elements that can be used to measure critical thinking skills. One important element is the ability to analyze and evaluate information from multiple perspectives. This involves being able to identify biases, logical fallacies, and inconsistencies in arguments. The skill of problem-solving is crucial in measuring critical thinking, as it requires individuals to think creatively and come up with innovative solutions to complex problems.

The critical thinking skills process, as shown in figure 8, is a systematic approach that helps individuals analyze information and make informed decisions. It involves several steps such as identifying the problem or question at hand, gathering relevant data and evidence, evaluating the credibility of sources, and considering alternative perspectives. By following this process, individuals can enhance their ability to think critically and make well-informed decisions.



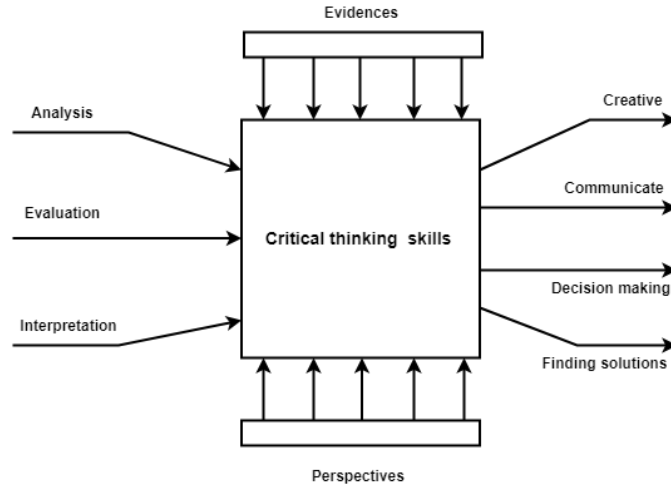


Figure 9 Critical thinking scheme

Additionally, figure 9 illustrates outcomes that can be achieved through the application of critical thinking skills. These outcomes are a result of individuals being able to analyze information objectively, evaluate different perspectives, and make informed decisions based on logical reasoning. By employing critical thinking skills, individuals can enhance their problem-solving abilities, improve their decision-making processes, and gain a deeper understanding of complex issues.

Table 6 presents various indicators that measure critical thinking skills together with our understanding of the meaning thereof. These indicators serve as a valuable tool for assessing an individual's ability to analyze, evaluate, and interpret information effectively. By examining these indicators, educators and researchers can gain insights into the extent of an individual's critical thinking abilities and identify areas for improvement.

Table 6 Indicators of critical thinking skills

Indicator	Description
Analysis	Refers to the process of examining and evaluating information or ideas in a systematic and logical manner.
Deduction and inference	Refers to the process of drawing logical conclusions based on available evidence and reasoning.
Evaluation	Refers to the process of assessing and analyzing information or arguments to determine their validity, reliability, and overall quality.
Interpretation	Refers to the process of analyzing and making sense of information or data.

### Game-based learning in critical thinking skills

Authors claims support that, game-based learning has immense potential when it comes to developing critical thinking skills (An, Bonk, & Learning, 2009; Whitton, 2012). By engaging in interactive and challenging gameplay, students are encouraged to think strategically, analyze situations, and make informed decisions. This not only enhances their problem-solving abilities but also fosters creativity and adaptability as they navigate through complex scenarios. Additionally, game-based learning provides a safe environment for students to experiment with different strategies and learn from their mistakes, further honing their critical thinking skills. Table 7 presents a compilation of reviews focused on the impact of game-based learning on critical thinking skills.

Table 7 Reviews on game-based in critical thinking skills

References	Description	Findings
Sun et al. (2022)	The study explored the impact of collaborative problem-solving behaviors and interactions on performance in a game-based learning environment, revealing associations between fine-grained indicators and collaborative problem-solving success.	The study highlights the importance of individual contributions, constructive interactions, and cognitive and social aspects in collaborative problem-solving, contrasting with existing models that often overlook this interconnectedness.
Kailani, Newton, and Pedersen (2019)	This paper reviews research conducted between 2009 and 2016 on the impact of game-based learning on problem-solving skill development.	The study revealed that games with collaborative elements, such as role-playing, peer assessment, and social gameplay, significantly enhance problem-solving skills development compared to games without these elements.
Lai (2011)	This literature review explores critical thinking definitions, development, teacher encouragement, and best practices for assessing skills, aiming to provide insights into critical thinking development in students.	The study shows that critical thinking involves analyzing arguments, making inferences using inductive or deductive reasoning, judging or evaluating, and making decisions or solving problems.
Achilov (2017)	The research aims to provide comprehensive information on critical thinking, explore methods for improving it, analyze its connection to creative writing, and observe its development through creative writing tasks.	The study revealed that critical thinking enhances students' reasoning, problem-solving, and evaluation skills, preparing them for a better workforce. Creative writing, intertwined with critical thinking, significantly contributes to its development.
Changwong, Sukkamart, and Sisan (2018)	The paper explores the mastering of critical thinking skills to enhances academic performance in high school and prepares students for college rigor and increased expectations.	The study suggested that creative problem-solving necessitates critical thinking and students' confidence in their ability to offer unique solutions.
V. Sepahi, M. R. Khazaei, A. Khoshay, S. Iranfar, and M. Timare (2014a)	The study aimed to explore the relationship between critical thinking and academic achievement in preclinical and clinical medical students' cognitive activities.	The study finds that to teach critical thinking to students, it's crucial to foster interaction between students and teachers, establish an organized framework for thinking processes, and utilize relevant skills and situations.

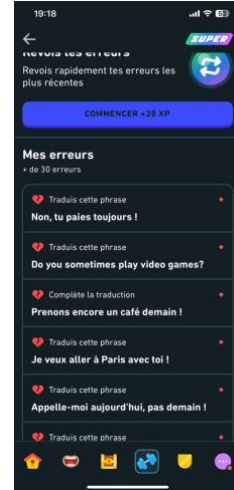
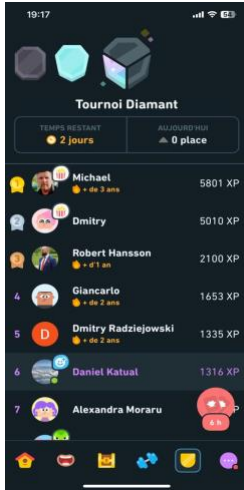
### Game-based learning to develop critical thinking skills

Game-based learning is an innovative approach that combines the engagement of games with educational content to foster the development of critical thinking skills. By presenting challenges and problem-solving scenarios within a game environment, students are encouraged to think critically, analyze information, and make informed decisions. This interactive and immersive learning experience not only enhances their ability to think critically but also promotes creativity, collaboration, and adaptability in solving complex problems.

By engaging in game-based learning, students are able to develop these skills in a fun and interactive way. They learn to evaluate information, consider multiple perspectives, and make reasoned judgments, all of which are crucial for making informed decisions in real-life situations. Moreover, game-based learning also promotes collaboration and communication among students as they work together to solve problems and achieve common goals (Romero et al., 2012). This not only strengthens their critical thinking abilities but also prepares them for the collaborative nature of the modern workforce. By engaging in group discussions and projects, students learn how to effectively communicate and work together towards a common goal. This prepares them for the real-world scenarios where teamwork and collaboration are essential for success.

## 5 | Demonstrations

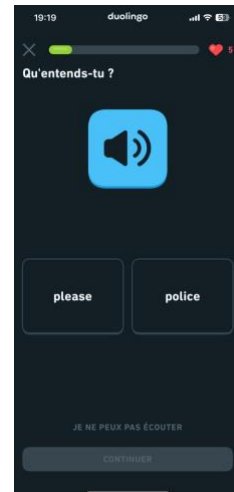
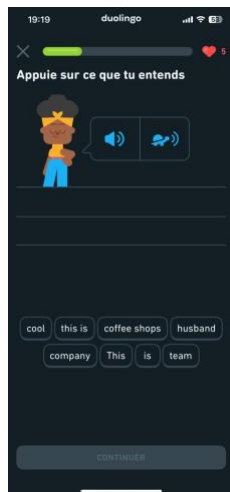
This section provides a demonstration of three different games named **Duolingo** showcases the diverse ways in which game design can foster knowledge sharing and critical thinking skills. Duolingo, for instance, utilizes gamification techniques to engage users in language learning, encouraging them to actively apply their knowledge in real-world scenarios. Duolingo is a private language tutor that provides individualized instruction that motivates its users through game-like activities to promote language acquisition. **Game elements used:** Leaderboard, score, levelling, points, badges, virtual currency.



- Encouraging learners to challenge themselves and track their progress.
- Provide challenge to develop collaboration and teamwork among peers.

Encouraging learners to challenge themselves and track their progress.

Providing real-time guidance and reinforcement, enabling learners to understand their strengths and weaknesses, and facilitating knowledge transfer beyond the game environment.



Critical thinking skills developed form Duolingo:

- Various challenges and exercises encourage them to analyze and problem-solve in real-time. Additionally, the game's adaptive nature prompts users to make informed decisions and strategize their learning process.
- Exercises offer diverse challenges, promoting knowledge sharing and active participation. They encourage problem-solving, decision-making, and understanding, fostering a collaborative environment where learners can apply their knowledge in diverse contexts.

Knowledge sharing enhance form Duolingo:

- Provide a new area and learn about different environments.
- Provide the cognitive aspect of learning.
- The game partly used constructivism as it uses real-world experience. Duolingo's emphasis on contextualized practice and real-life scenarios further supports the application of constructivist principles in language acquisition.

The previous figures represent the screenshots of the Duolingo game. These screenshots serve as a demonstration of learning a language in a game.

These screenshots demonstrate the application and use of the different theories on knowledge sharing and the competence of critical analysis applied in this game.

By analyzing the screenshots, we can observe how Duolingo incorporates gamification elements to engage users and enhance their language learning experience. Additionally, these screenshots explore how the game's interface and interactive exercises facilitate the acquisition of vocabulary, grammar, and pronunciation skills in an immersive way.

## **6 | Recommendations**

This section provides guidelines to both educators and researchers in the field. The guidelines presented in this section aim to address the aforementioned questions by highlighting the key strategies and approaches for incorporating game-based learning into educational settings. By understanding these guidelines, educators, game contractors, and researchers can effectively leverage game-based learning to enhance knowledge sharing and foster critical thinking skills among learners.

Table 8 Guidelines to enhance knowledge sharing using game for learning.

Guidelines	Enhancement of knowledge sharing	Game elements	References
Provide for different learning styles.	Incorporating interactive graphics, audio instructions, and visual cues for visual learners and audio instructions for auditory learners, creating an inclusive and engaging learning environment.	Collaborative gameplay.	Loderer, Pekrun, and Plass (2020); Smith, Abrams, and Technology (2019)
Incorporates a variety of interactive exercises.	Use interactive exercises to promote active participation and deeper understanding of subject matter, catering to different learning styles and preferences, making the learning experience more enjoyable and effective.	Leaderboards or scoring systems, team-based challenges, or multiplayer modes.	Jääskä and Aaltonen (2022); Juhari, Hani, and Bakar (2020); Loderer et al. (2020)
Create a narrative that engages the player in a story.	Presenting information and concepts within a compelling framework, players become invested and actively seek knowledge. Interactive elements make the learning process memorable, increasing retention and willingness to share knowledge.	Interactive dialogue options.	A. I. Abdul Jabbar and P. Felicia (2015) Govender and Arnedo-Moreno (2021); Silseth (2013)
To provide feedback that is immediate and meaningful.	Providing real-time guidance and reinforcement, enabling learners to understand their strengths and weaknesses, and facilitating knowledge transfer beyond the game environment.	Branching narratives, scoring system.	Ismail et al. (2022); Jackson (2017); Larrabure ; Pellas and Mystakidis (2020)
Incorporating elements of competition.	Multiplayer modes foster a cooperative learning environment where knowledge is shared among learners.	Multiplayer modes, leaderboards.	Jääskä and Aaltonen (2022); Juhari et al. (2020); Loderer et al. (2020)
Encouraging learners to challenge themselves and track their progress.	This encourages active seeking of new information and sharing insights. Tracking progress helps identify areas for improvement, promoting knowledge sharing.	Tracking progress, leaderboard.	Alaswad and Nadolny (2015); Romero et al. (2012)
Provide a new area and learn about different environments.	Allows individuals to explore diverse environments, gaining a broader understanding of different cultures, ecosystems, and challenges. This interactive nature enhances knowledge sharing among players, as players can exchange insights and perspectives on these new environments, fostering collaboration and cooperation.	Interactive dialogue options, multiplayer modes, leaderboard.	A. I. Abdul Jabbar and P. Felicia (2015) Govender and Arnedo-Moreno (2021); (Jorge & Sutton, 2017; Nadolny et al., 2020; Perryer, Celestine, Scott-Ladd, & Leighton, 2016); Silseth (2013)
Provide the collaborative environment.	Through game-based tasks and challenges, students exchange ideas, perspectives, and insights, leading to a deeper understanding of the subject matter. Features like chat functions and discussion boards facilitate communication and encourage students to share their thoughts and ask questions.	Role-playing, peer assessment, social gameplay.	Hämäläinen (2011) Sung and Hwang (2013)

Table 9 Guidelines to develop critical thinking skills using game-based learning.

Guidelines	Impact on critical thinking skills	Game elements	References
Provide the cognitive aspect of learning.	By engaging in complex problem-solving tasks and decision-making processes within the game environment, learners are challenged to think critically and strategically. This not only enhances their cognitive abilities such as analysis, evaluation, and synthesis.	Puzzles, quizzes, problem-solving activities, or interactive simulations.	Marc I Cicchino (2015); Franco, DeLuca, and Gaming (2019)
Provide strategies against enemies.	By requiring players to analyze their opponents' strengths and weaknesses, devise effective tactics, and adapt their strategies accordingly, games promote problem-solving abilities and strategic thinking.	Depends on the specific game. (e.g., weapons)	Cozine (2015); Dignan (2011); (Lambert, 2011)
Giving players the freedom to make choices and see the consequences of their action.	By allowing players to explore different paths and outcomes, they are encouraged to think critically about the potential consequences of their decisions. This process enhances their ability to analyze situations, evaluate options, and make informed choices, ultimately strengthening their critical thinking abilities.	Branching narrative system.	Marc I Cicchino (2015); Whitton (2012)
Include the possibilities of players to explore their imagination.	By allowing players to think creatively and problem-solve within the virtual world, they are encouraged to think outside the box and consider alternative perspectives. This not only enhances their ability to analyze and evaluate different situations, but also fosters a sense of curiosity and adaptability, which are essential components of critical thinking.	Open-world environment.	Franco et al. (2019); Hamlen and Blumberg (2015)
Encourage different plausible answers in multiple choice.	When multiple plausible answers are provided in a game-based learning environment, it challenges learners to evaluate each option critically and analyze the given information. This process promotes the development of critical thinking skills as it requires them to assess the validity and relevance of each answer choice before deciding.	Distractors (side quests, hidden collectible), levels of difficulty.	Hussein, Ow, Cheong, and Thong (2019); Lester et al. (2014); Nietfeld, Shores, and Hoffmann (2014)
Provide investigation, adventure and strategy.	Investigation, adventure, and strategy in game-based learning provide students with opportunities to analyze complex situations, think critically, and make informed decisions. These elements encourage players to explore different paths, gather information, and evaluate the potential outcomes of their choices.	puzzles or riddles, branching narrative system.	A. I. Abdul Jabbar and P. Felicia (2015); Arpin (2021); HANDBOOK (2010)
Encourage players to think outside the box and develop their problem-solving skills.	By presenting complex challenges and puzzles within the game, players are required to analyze situations, consider multiple perspectives, and devise innovative solutions. This process not only enhances their ability to think critically but also nurtures their creativity and adaptability in approaching problems in real-life scenarios.	Time limit, open-ended challenges or puzzles.	Avargil (2022); Marc I Cicchino (2013); Mathrani, Christian, and Ponder-Sutton (2016)
Provide challenge to develop collaboration and teamwork among peers.	When peers are challenged to develop collaboration and teamwork in game-based learning, it fosters an environment where they need to communicate and problem-solve together. This collaborative approach enhances critical thinking skills as students are required to analyze different perspectives, evaluate strategies, and make informed decisions collectively.	Role-playing, peer assessment, social gameplay.	Hämäläinen (2011) Kailani et al. (2019)

By analyzing the different guidelines, we can say that the same game cannot contain all the elements. However, an educational game must incorporate most of the recommendations in Table 8, and a game that wants to develop the ability to think critically must integrate one or more of the proposals in Table 9. This suggests that game developers need to carefully consider their objectives and target audience when designing educational with the purpose of knowledge sharing or critical-thinking skills games. By incorporating the appropriate recommendations from Table 8 or Table 9, they can ensure that the game aligns with its intended purpose and effectively engages players in the desired skill development. Ultimately, the success of these games lies in their ability to effectively combine elements that align with their intended goals.

By following these guidelines, educators can create engaging and immersive game-based learning environments that facilitate effective knowledge sharing.

After the literature review and the guidelines, we are here to return to the why of this study and try to give the answers to the questions posed in the introduction. By revisiting the purpose of this study, we aim to delve deeper into understanding the underlying motivations and objectives that drove the research. Through a comprehensive analysis of the literature and adherence to established guidelines, we can now focus on providing insightful responses to the initial question raised in the introduction. This study focused on two main questions asked in the introduction. These questions were asked to investigate how game-based learning can enhance knowledge sharing among learners and foster the development of critical thinking abilities.

The following was the two questions:

*How does game-based learning enhance knowledge sharing among players?  
How does game-based learning contribute to the development of critical thinking skills in individuals?*

To answer these questions, the following tables (tables 10 and 11) provide recommendations to enhance knowledge sharing using game-based learning and develop critical thinking skills based on resume of guidelines in table 8 and 9.

Table 9 provides guidelines to enhance knowledge sharing using games for learning. These guidelines are based on research findings and best practices in the field of educational gaming. They aim to maximize the effectiveness of game-based learning experiences by promoting active participation, collaboration, and reflection among learners. They emphasize the importance of incorporating elements such as competition, collaboration, and feedback to encourage active participation and knowledge sharing among learners. The following are our recommendations on game-based learning to enhance knowledge sharing.

*Table 10 Resumes of guidelines of table 8.*

<b>Num.</b>	<b>Recommendations</b>
1	Incorporate elements of competition and collaboration into the game design to motivate participants to actively engage in knowledge sharing.
2	Provide clear objectives and rewards within the game that encourage players to seek out and share valuable information with their peers.
3	Utilize interactive features such as leaderboards or achievement badges to foster a sense of achievement and recognition among participants, further motivating them to share their knowledge.
4	Design game mechanics that promote social interaction and communication, allowing players to discuss and exchange ideas during gameplay.

Table 10 provides guidelines to develop critical thinking skills. These guidelines are based on research and best practices in educational game design. They offer a framework for educators to effectively integrate game-based learning into their teaching strategies and promote the development of critical thinking skills among students. By following these guidelines, educators can create engaging and immersive learning experiences that encourage problem-solving, decision-making, and analytical thinking in a fun and interactive way. The following provides the recommendations to educators, game developers as well as researchers for the game to develop the critical thinking skills.



Table 11 Resumes of guidelines of table 9.

Num.	Recommendations
1	Incorporate problem-solving challenges within the game that require players to think critically and strategize their moves.
2	Provide opportunities for players to analyze and evaluate different options and consequences before making decisions in the game.
3	Integrate elements of uncertainty and complexity in the game to encourage players to think critically and adapt their strategies accordingly.
4	Include collaborative gameplay features that foster communication, teamwork, and the exchange of ideas among players.

The use of game elements in the design of game-based learning depends on the specific learning objectives and the target audience. Game elements can be used to enhance engagement and motivation, making the learning experience more enjoyable and effective. Additionally, incorporating game elements can also provide opportunities for feedback and assessment, allowing learners to track their progress and identify areas for improvement. For example, game elements such as points, levels, and leaderboards may be effective in engaging younger learners and motivating them to complete tasks. On the other hand, older learners may prefer more complex game mechanics that require problem-solving and critical thinking skills to achieve their learning goals. Additionally, incorporating game elements can also enhance collaboration and competition among learners, fostering a sense of community and driving them to excel in their learning journey.

The choice of game element depends on the desired skill development, knowledge sharing or critical thinking skills, and the specific learning objectives. For example, if the goal is to enhance knowledge sharing, incorporating game elements such as collaborative challenges or group discussions can encourage participants to actively share information and insights. On the other hand, if the focus is on developing critical thinking skills, game elements like problem-solving scenarios or decision-making simulations can provide opportunities for participants to analyse situations and make informed choices. Ultimately, selecting the appropriate game element is crucial in creating an engaging and effective learning experience. For example, if the goal is to enhance knowledge sharing, game elements such as collaborative challenges or group discussions can be incorporated. On the other hand, if the focus is on developing critical thinking skills, game elements like problem-solving scenarios or decision-making simulations may be more suitable. Ultimately, understanding the specific skill development objective is crucial in determining the appropriate game element to employ.

In conclusion, we would like to recommend that in order for a game to be considered educational, whether it be for educators, researchers, or game developers, it must revolve around the five questions shown in figure 4 as a check list, and it must also take into account the recommendations that are presented in tables 9 and 10.

The recommendations developed in this paper can be used for analysis of existing games and to guide development of new games.

## 7 | Conclusions

The purpose of the paper was to explore the effectiveness of using games as a tool for enhancing knowledge sharing among individuals and fostering the development of critical thinking abilities. The paper aims to investigate how game-based learning can be utilized as an innovative approach in educational settings to promote active engagement, collaboration, and problem-solving skills among learners. The study shows that the use of game elements in the design of game-based learning depends on the specific learning objectives and the target audience. Game elements can be used to enhance engagement and motivation, making the learning experience more enjoyable and effective. The choice of game element depends on the desired skill development, knowledge sharing or critical thinking skills, and the specific learning objectives. Understanding the specific skill development objective is crucial in determining the appropriate game element to employ.

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