Jan L. Plass, Richard E. Mayer and Bruce D. Homer (Eds.), *Handbook of Game-Based Learning*, The MIT Press, 2020; 600 pp.: ISBN: 978-0-2620-4338-0

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The book 'Handbook of Game-Based Learning' is a fundamental work in its field. It provides a systematic and detailed insight into the theoretical foundations, the state of the art in the field, guidelines for research, considerations on design principles, and examples of good practice in the use of educational games in different subject areas. Unlike other books focusing on game development or best practices, 'Handbook of Game-Based Learning' stands out for its reliance on empirical evidence and its foundation in psychological and learning sciences theory. The research field of game-based learning (GBL) investigates the use of games and game elements in education to support different aspects of learning. Games have numerous characteristics that can be used effectively in the learning process. They allow learners to have authentic experiences in a safe and controlled environment where they can test hypotheses, experiment, and learn from mistakes. Active participation enables the acquisition of in-depth knowledge and the development of problem-solving skills and critical thinking. While playing the game, learners receive immediate feedback and can effectively identify gaps in their knowledge. The data collected about the learner during gameplay can be used to address their specific learning needs. The use of games can also support the collaborative aspect of learning, teaching social skills, responsible and ethical communication skills, teamwork, task sharing and leadership skills.

This book can be a valuable resource for a variety of stakeholders in the learning process, as understanding the fundamental principles of learning and current research trends in the field is crucial. Teachers will have access to more tools and strategies to implement ideas from modern learning theories

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to improve the learning process. Knowing the criteria for selecting appropriate games can effectively support specific learning objectives and create a dynamic, interactive, and stimulating learning environment. The use of games in the learning process opens up new possibilities for the observation of students and the formative and summative assessment of knowledge, as the collection and analysis of data generated during learning can provide a more comprehensive picture of an individual student's current level of knowledge. This allows lessons to be more individualised, the learning process to be adapted to current needs, and progress to be assessed. Parents need to understand this area to understand better the role of games in their children's learning and select quality games that align with the family's values. Understanding game-based learning is important for education professionals and researchers as it allows them to keep up with current educational trends and innovations. By monitoring research, best practices, and new technologies in game-based learning, professionals can improve their teaching approaches, formulate strategies and recommendations, and thus ensure quality education. Finally, knowledge of game-based learning is also extremely important for students, as it enables them to take advantage of the benefits and opportunities that games offer in learning. When students understand how games can improve their motivation, engagement, understanding and skills, they can engage more actively in the learning process and achieve better results.

The book is divided into four thematically self-contained sections: 1) Introduction to Game-Based Learning (GBL), 2) Theoretical foundations of GBL, 3) Design of educational games, and 4) Applications of GBL. In the first section, the book introduces the basic concepts of game-based learning, which are discussed from four interrelated perspectives: motivational, cognitive, affective, and socio-cultural. Under the motivational aspect, the characteristics of games that positively influence learning motivation are presented. Among these, the authors highlight those that influence motivation through the implementation of a reward system, the meaningful use of different game mechanics, the inclusion of engaging activities and a design that conceptualises errors as a necessary step in the learning process. They argue that this is particularly important as it encourages exploration, risk-taking, and trying out new strategies without severe consequences, creating the basis for self-regulated learning. In terms of the cognitive aspect, the book looks at game characteristics that can be used to implement meaningful and relevant learning situations that can be adapted to the specific needs of the learner. It then looks at the affective aspect by explaining how positive emotions improve the player's attention, decision-making skills, creative problem-solving, and related higher cognitive activities,

thus enhancing the learning effect. Finally, the socio-cultural aspect is presented, focusing on developing communities created through games as one of the most important aspects of such learning. In this respect, learning is realised in the interaction between players who can construct shared knowledge and apply it within cultural norms and about others. The authors then introduce the concept of play, highlighting its main principles and its use in the context of education. In this context, it encompasses more than just entertainment and amusement, as it positively impacts the inner motivation to learn and enables self-actualisation. The authors argue that such learning enables the application of a poly-theoretical approach that combines the principles of different learning theories to support learning, thereby increasing educational effectiveness. They introduce information processing theory, behavioural learning theory, cognitive constructivism, and social constructivism, among others. They also look at how modern technologies offer new opportunities for the realisation of learning through games. In this context, they emphasise that to realise effective learning through games, it is important that both aspects – learning and enjoyment – are represented in game-based learning activities. The use of games based on digital technologies is seen as a particularly effective means of implementing the principles of learning through games, as they enable effective storytelling and the implementation of opportunities for social interaction. The authors then look at the concept of 'engagement' in the context of learning through games. This is extremely important as it has a positive effect and forms the basis for the learning process. It influences interest and motivation for learning, perseverance in solving more complex tasks, a better understanding of the subject matter and the acquisition of conceptual knowledge, which positively impacts the achievement of learning objectives. The authors present different types of engagement – emotional, cognitive, and behavioural – and analyse other factors that influence it. In this context, they consider the aspect of the player in terms of personal characteristics such as attention, self-regulation, and self-efficacy, as well as the aspect of the system involved in the game, which has its own characteristics such as adaptability, feedback, included challenges or opportunities for social interactions and the active role of the player. Particular attention is paid to the importance of a game design that promotes intrinsic motivation and aims to maintain engagement throughout the game. At the end of the first section, they present practical implications that serve as recommendations for game developers who wish to implement aspects of engagement appropriately. They emphasise the creation of dynamic game environments with challenges, interactions and feedback, the inclusion of measuring the level of player engagement as part of the system's evaluation strategy,

and the creation of games that are relevant and adapted to the demands and needs of the target audience, thereby creating a positive emotional connection of the player with the game.

In the second section, the authors present theoretical foundations that summarise important research findings in the field of game-based learning, building on the classification of the first section. In the context of research focusing on the cognitive aspect of GBL, they present the fundamentals of cognitive processing of visual and verbal information during gameplay and its effects on learning. These are based on the principle of two data intake channels: limited capacity and active processing. From these theoretical foundations, they derive rules for designing educational games that promote the fundamental processing necessary for learning and the unnecessary processing that hinders it. They also show how games can be used to learn different types of knowledge (factual knowledge, conceptual knowledge, procedural knowledge, strategic knowledge, attitude formation) and describe the key cognitive components of learning with games: playing the game, which illustrates the lesson; changing the knowledge, which represents the learning; and assessment, which reflects progress toward learning objectives. An important contribution of the book is the classification of approaches in existing research that addresses the cognitive consequences of the use of games in education. These are divided into those examining the learning effect of using a particular game element, comparing the cognitive impact of using specific and general games, and comparing the learning outcomes of using games versus traditional learning approaches. The authors then focus on aspects of learning with games that relate to emotions. The basic idea is the key role of emotions in an individual's behaviour and the resulting improvement in learning effectiveness. Games can influence the arousal of positive emotions in individuals in various ways, for example, through an interesting story, game mechanics, good graphic design or even sound design, thereby improving their attention, decision-making ability, creative problem solving, and activities related to higher cognitive processes. Studies have also shown that the learning effect is improved by using agents that can recognise the player's emotions and react accordingly. The authors have developed a classification system for using emotions in game learning that uses the dimensions of valence and activation but also considers other dimensions, such as intensity, duration, and utility of emotions. This system categorises game characteristics in terms of their impact on motivation, task performance, and learning outcomes. This section also addresses the use of games in learning or the integration of gamification elements into the learning process as a strategy to motivate students in educational and organisational contexts. The authors present research showing that games can

successfully attract and sustain attention and explore how these characteristics can be appropriately utilised in an educational context. They focus on methods that can be used to achieve intrinsic motivation and autonomous engagement as the ultimate goal of motivational efforts. In defining these methods, they draw on 'self-determination theory', which states that people tend to engage in activities that satisfy three basic psychological needs: Autonomy, Competence, and Relatedness. This is important in understanding how games can be used to satisfy psychological needs. This can contribute to decision making when designing games or gamification elements for use in educational contexts and consequently increase their motivational potential. In presenting the theoretical foundations related to the socio-cultural aspect of using games in education, the authors present research examining how the realisation of social interactions in games can contribute to learning. They focus on mechanisms of mediation – the transformative process in which an individual internalises tools, practices and cultural patterns of the community, modelling – cognitive or digital practices and behaviours of experts observing and imitating novices, creating an understanding of how new behaviours or skills are performed, and teaching – practices based on Vygotsky's concept of the zone of proximal development, in which an expert supports and guides a novice, helping them to acquire knowledge and establish themselves in the community. One of the key points is that games are a platform that provides the opportunity to implement these forms of social interaction and enable the construction of a social identity. When players master the game mechanics and showcase their skills in the community, they receive recognition and validation, which is crucial for building self-esteem and identity.

In the third section, the authors deal with various aspects of the design of educational games. This section provides a comprehensive overview of the progress made in the field of learning with games, focusing mainly on the development of theoretical frameworks for the use of games in education and pointing out the key challenges that still need to be addressed in this area. Among other things, they emphasise the importance of building a support system in game mechanics that can facilitate the provision of feedback and advice. Research is presented that shows that direct guidance in the form of explanatory information is more effective for providing feedback than minimal guidance with corrective feedback, which is common in most educational games produced to date. In terms of guidance, the importance of a human mentor providing personalised feedback and support according to the learner's needs and interests is emphasised. The authors discuss using educational games to promote self-regulation and self-reflection, allowing learners to monitor and

control their activities, which in turn affects the efficiency of learning. In this context, they present different cognitive, affective, metacognitive, motivational, self-regulatory and reflective processes that the learner can carry out. They emphasise the importance of emotional self-regulation, which can affect the maintenance of intrinsic motivation to complete tasks. They also included a diagnostic worksheet, a valuable tool for evaluating the information obtained, improving understanding of the problem, monitoring the problem-solving process, and making informed, evidence-based decisions. This section presents the importance of adaptability and personalisation in educational games and their impact on individual learning. Examples of games are presented in which adaptability is considered in various ways – by dynamically changing the level of difficulty, considering the player's prior knowledge and cognitive abilities (planning, reasoning, working memory), assessing specific learning variables and adapting to maintain an appropriate level of challenge. Examples are also used to describe different methods of personalisation, such as considering individual characteristics and needs of the learner, providing learning material that suits their learning style, choosing the order in which to go through the learning material, and different ways to ensure a sense of belonging and motivation. The authors argue that the adaptation and personalisation strategies presented can stimulate intrinsic motivation, increase engagement, and support self-efficacy, especially when both approaches are combined in games. The section continues with the role of storytelling in educational games. A good story can create a compelling experience and make the learner more engaged in learning. The biggest challenge in game design is the integration of storytelling with interactive elements, as this is a complex and demanding process. However, when done correctly, it can positively impact a better understanding of the topic, better retention of knowledge and the ability to use critical thinking and problem-solving skills. Storytelling can effectively present complex ideas and the relationships between different variables of the problem, helping the learner achieve learning objectives and meet learning needs. In the context of educational game design, the authors emphasise the importance of applying principles for multimedia content creation, such as signalling, redundancy, pre-training, and self-explanation, and their importance for reducing cognitive load and improving learning outcomes. The principles presented are an excellent resource for educators and creators of learning materials who want to create effective learning environments based on game principles or incorporating gamification elements. The authors then discuss the role of collaboration and competition in learning games. They can be conceptualised as alternative types of goal structures within which learners cooperate and behave in

learning activities. Research studies are presented examining the cognitive and affective effects of incorporating collaboration and competition. While some pointed to collaboration and competition as inherent and fundamental aspects of motivation in games, others highlighted negative experiences as competition discouraged some from learning. It can be concluded that the effectiveness of their introduction depends on the learning objectives, the characteristics of the learners, the group configuration and the type of learning activities in which they are used. Three concepts of educational game design that have not yet been sufficiently researched are then presented: the design of elements intended to influence learners' emotions, including musical accompaniment, and the design of game mechanics. The authors explain the concepts of designing game elements and methods that can evoke an emotional response in learners. They emphasise the causal relationship between emotional states and cognitive processes and how theories such as the control-value theory of achievement emotions and the integrated cognitive-affective theory of learning provide a theoretical framework for understanding the effects of emotions on learners. The inclusion of musical accompaniment is discussed in terms of its ability to evoke emotion, its role in achieving learning objectives and creating a sense of inclusion. Approaches to designing musical elements for their use in educational games are also presented. The role of game mechanics is presented in the context of their impact on the emotional state of learners, motivation to learn and the promotion of learning outcomes. Approaches to the design of game mechanics are described, such as balancing challenge and skill, providing choice and intervention for the player, and considering the game context and learning objectives. The third section concludes by outlining the following aspects of educational game design: reward system design, social presence, and identity formation. Reward systems include internal and external elements of reward. Examples of external rewards are points, stars, badges, trophies, etc., while internal rewards are those that directly influence gameplay. The authors discuss aspects of the design of such systems and how they can influence the satisfaction of basic psychological needs and connection with others and the community.

In the fourth section, the authors present concrete examples of the use of learning games in various content areas. They show how the use of games in STEAM provides opportunities to explore and gain authentic experiences that help to understand complex concepts, integrate new ideas into existing knowledge, and progressively increase complexity, enabling the acquisition of knowledge in Vygotsky's zone of proximal development. Using specific examples of the use of commercial and specially developed educational games

in mathematics, statistics, physics, and biology, they show how games can be used effectively to improve the learning process. They then examine the aspects of using games in language learning. They highlight how games can provide the opportunity to interact with multimodal forms of representation, linking the grammatical form of words and sentences to their meaning and function, which defines their use in different contexts or to achieve different communication goals. In games, learners are confronted with texts that strengthen their reading comprehension and, at the same time, motivate them to engage with them. The design of the games provides immediate feedback that helps the learner to adapt their learning strategy and thus be more effective. The authors emphasise that appropriately designed and implemented educational games have great potential as interesting and effective learning environments for foreign language acquisition and present a theoretical framework for the creation of such games. The authors then address the use of games to improve learners' cognitive abilities, particularly using reinforcement learning, which can be realised through the design of a feedback system. The authors argue that games are an effective learning tool to improve cognitive skills as they can present advanced representations of concepts, thus influencing the ability to generalise knowledge. Despite their promising potential, more research is needed to investigate further their effectiveness, their possible limitations, and the best practices for their implementation. This section then presents aspects of the use of learning games for training and improving employee efficiency. These differ from general learning games in the objectives of the training, which in this case, are focused on improving the efficiency of specific work tasks performed by the employer. Games can be used effectively for this purpose as they can enhance traditional learning approaches in terms of the learner's active involvement in the learning process and thus support further training, the acquisition of problem-solving skills and the achievement of specific target knowledge. Examples of best practices in financial analysis and training in virtual car workshops are presented, demonstrating the success of using games in work environments. They then present the use of games as an effective tool for assessing complex skills such as problem solving and creativity. The authors argue that assessment through games is better than traditional methods as it provides a more accurate assessment of learners' knowledge, skills, and attributes. The chapter emphasises the importance of aligning the learning objectives with the content to be assessed and provides a framework for structuring assessments in multiplayer games. An overview of research in this area is provided, including psychometric aspects and the validity of games as an assessment environment. At the end of the fourth section, the authors examine the use of learning analytics

in educational games. The potential of games to provide insights into learners' behaviour and decision-making processes is discussed, and various methods, such as descriptive statistics, cluster analysis, and factor analysis, are described. They show how different methods can be used at different stages of the game and how an in-depth understanding of the interaction between players, their play patterns and decision-making processes can be gained. Based on this data, adapting and optimising learning experiences is possible.

The book 'Handbook of Game-Based Learning' provides a comprehensive insight into the field of game-based learning, enabling both developers of educational games and those working with learners to gain a structured overview of fundamental concepts, practices, and examples of the effective use of games in the educational process.