

Designing a User-Centred Adaptive Gamified Learning System: A Multidisciplinary Approach from Pedagogy to Artificial Intelligence

Moataz Elkady^{1,2}, Elvira Zazzera^{1,3}, Giambattista Stigliano³ and Michele Dassisti¹

¹Mechanical Department, Polytechnical University of Bari, Italy

²Istituto Universitario di Studi Superiori (IUSS), Pavia, Italy

³Kad3, Monopoli, Italy

moataz.elkady@iusspavia.it

m.elkady@phd.poliba.it

e.zazzera@phd.poliba.it

stigliano@kad3.com

michele.dassisti@poliba.it

Abstract: A multidisciplinary approach is crucial for developing a user-adaptive gamified learning system, starting with pedagogy and continuing through psychology, user experience (UX) design, and artificial intelligence (AI). This study inspects different layers of knowledge, starting from foundational pedagogical theories such as constructivism, behaviourism, and Bloom's taxonomy. Moving to individual learner needs with all related complexities, which include cognitive traits, learning styles, personality types, motivational drivers, and player types, is important. Thus, the gamified learning experience can be tailored for optimal engagement and effectiveness. The gamified learning experience is influenced by a set of factors, including learners evolving traits and experiences. A user system must track and interpret these changes in real time to maintain interaction and effectiveness. Modern Technological tools like AI and machine learning (ML) can be used to design personalized predictive models. Human-computer interaction (HCI) through UX and interaction design is crucial for maintaining learners' engagement throughout the learning process. The complexity of user-adaptive processes requires the use of HCI via UX design. This study proposes a framework that integrates andragogy, psychology, and intelligent technologies, such as AI and ML, to create a personalized learning system. This approach optimizes the learning process, allowing learners to develop their knowledge and skills and enhance productivity, efficiency, and work quality. It focuses on professional retraining for longer-tenured workers who have been away from formal education for several years and require customized learning paths to close the digital skill gap essential for operating in smart, sustainable manufacturing environments.

Keywords: Adaptive learning, Gamification, User-Centred design, Artificial intelligence, Lifelong learning, Personalized education

1. Introduction

The workforce upskilling landscape is undergoing significant transformation due to the integration of advanced technologies like AI and the growing demand for Smart Manufacturing and Industry 5.0. This necessitates the use of adaptive and technologically enhanced training systems. Traditional training approaches are insufficient due to individual learning differences and lack of engagement, making upskilling workers more challenging.

Organizations are integrating gamification strategies and AI-powered educational tools to create a learner-centred environment. AI allows for personalized tutoring and a learner-centred approach, fostering motivation and efficiency. Gamification elements like rewards and challenges help reduce upskilling time and improve productivity. Integrating AI, education, and gamification is crucial for improving learning quality and building a future-ready workforce for high-tech industries. This approach is essential for fostering a more dynamic and productive workforce.

According to (Lopez and Tucker, 2021) gamification has gained significant interest in improving individual motivation. Designers incorporate game elements, such as points, leaderboards, and levels, to encourage users to complete tasks. However, perceptions and preferences of game elements vary individually. A gamified application that motivates one person may affect another differently. These results are consistent with the Self-Determination Theory (SDT) and Cognitive Load Theory (CLT), which state that the effects of a stimulus (e.g., game element) on an individual's motivation are mediated by their perception of the stimulus itself. Researchers are exploring how individual game element preferences might be measured using player-type models, which can be utilized to tailor or personalize gamified applications. Adaptation and personalization are closely related, as their goal is to deliver a superior user experience. Personalization involves tailoring content to individual tastes, whereas adaptation involves tailoring interactions to different users in the same context.

Adult education is a crucial aspect of lifelong learning. It includes all forms of education and training that support adults in finding job opportunities and playing a functional role in their communities. The adult's ability to retain information decreases with age; thus, active teaching methods are crucial to enhance motivation and improve the development of skills and talents because they ensure the highest level of participation in the learning process (Grebin *et al.*, 2020).

There is a need in gamified online learning to create a conceptual framework for a user-centred adaptive system that would organize a multidisciplinary approach to handle the process from the pedagogical theories passing through psychological and cognitive aspects through the gamification design utilizing AI and data-driven personalization to optimize the user experience and have optimum human-computer interaction.

2. Pedagogical and Adult Learning Foundations

2.1 Andragogy

The term "Andragogy" refers to pedagogical practices performed for adult learners (Wang and Farmer, 2008). Andragogy for adults consists of six principles (Huang, 2002).

1. Understanding the purpose of learning: what, delivery, and significance.
2. Self-Concept: Adults view themselves as self-directed learners responsible for learning goals.
3. Experience: Life experiences shape learning and influence perspectives.
4. Readiness to Learn: Adults are ready to learn when new knowledge or skills are required.
5. Orientation to Learning: Adult learning is problem-centred and contextual, best when content is applicable to real-world tasks.
6. Motivation: Adults are driven by internal factors like personal growth, self-esteem, and goal fulfilment.

2.2 Constructivism

Learners can actively acquire and generate new information based on their existing knowledge. Education primarily aims to enhance students' thinking skills. Motivated learners are better able to recognize their difficulties. Thus, study topics should align with their interests. Constructivism focuses on developing learners' problem-solving skills for real-world situations. Consequently, problem-solving and free discovery were combined. Knowledge constantly evolves through the discovery process. Vygotskian theory highlights how sociocultural settings influence learning outcomes. In cognitive growth, Vygotsky's "social constructivism" theory emphasizes the importance of contact with others, particularly instructors and learners (Huang, 2002).

2.3 Behaviourism

According to (Allen, 2007), Hull saw learning because of stimulus-response interactions, like other behaviourists'. The potential response to a particular stimulus is the consequence of multiplying intervening variables such as habit:

- Strength: the number of previous and reinforced pairings between a stimulus and its response.
- Drive: refers to the need to fulfil the requirements of the body
- Stimulus dynamism refers to the power of a stimulus.
- Incentives are the strength of a reward that meets the body's requirements.

Learning occurs when a learner is motivated to pursue a goal. Effective learning involves personalizing experiences, measuring behavioural change, creating an anxious environment, and allowing learners to reward themselves for their accomplishments

2.4 Blooms Taxonomy

One of the most dominant mental constructs of thinking and learning is used globally. A two-dimensional taxonomy model was presented by Krathwohl, with one dimension, the knowledge dimension, representing the learning outcomes and being divided into four categories: factual, conceptual, procedural, and metacognitive. The second dimension refers to cognitive processes, including remembering, understanding, applying, analyzing, evaluating, and creating as shown in (Figure 1). Table 1 shows a set of indicator verbs used to describe associated knowledge (Wang and Farmer, 2008).

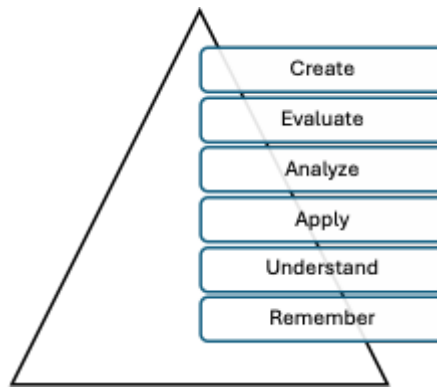


Figure 1 : Revised Blooms Taxonomy

Table 1: Instructional the Taxonomy Table (Wang and Farmer, 2008)

Knowledge Domain	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	List	Summarize	Classify	Order	Rank	Combine
Conceptual Knowledge	Describe	Interpret	Experiment	Explain	Assess	Plan
Procedural Knowledge	Tabulate	Predict	Calculate	Differentiate	Conclude	Compose
Metacognitive Knowledge	Appropriate Use	Execute	Construct	Achieve	Action	Actualize

3. Psychological Drivers and Learner Characteristics

3.1 Gamification and Individual Motivation

This chapter introduces SDT, a foundational framework for understanding how gamification addresses users' core psychological needs—autonomy, competence, and relatedness. According to SDT, individuals are most motivated when their needs are satisfied, although the means of satisfaction may vary between users (Lopez and Tucker, 2021).

3.2 Cognitive Load, Learning Styles, and Individual Differences

According to the Cognitive Evaluation Theory, the effect of extrinsic incentives (e.g., game elements) on an individual's innate psychological needs is controlled by whether they see these extrinsic rewards as controlling or informative (Lopez and Tucker, 2021). CLT highlights the restricted capacity of working memory and is critical for understanding the learning processes in digital educational games. CLT distinguishes between intrinsic cognitive load, which is attributed to the inherent complexity of the learning material, and extraneous cognitive load, which is caused by poorly planned instructional aspects or distracting factors unrelated to learning. In study (Hawlitshchek and Joeckel, 2017), discovered that instructional cues encouraging players to focus on a game's educational material increased extraneous cognitive load, lowering learning outcomes. This unexpected finding implies that such reminders may disrupt the natural flow of gameplay, causing students to engage in wasteful mental strategies that hinder effective learning. These findings emphasize the significance of reducing extraneous load by incorporating instructional assistance directly into game design rather than adding it later.

3.3 Learning Styles

VARC (Visual, Aural, Read/Write, and Kinesthetics) is a prominent learning style classification based on physiological dimensions (Idrizi, Filiposka and Trajkovik, 2018).

Learning Styles Overview

- Visual learners prefer demonstrations and descriptive learning methods.
- Oral learners learn through listening and are easily distracted by noise.
- Read/write learners take notes and use drawings for memory recall.
- Kinaesthetic learners benefit from hands-on learning.

According to (Idrizi, Filiposka and Trajkovic, 2018), learning styles do not significantly influence test results. There was no compelling correlation between academic performance and the learning styles. However, Kinaesthetic learning was the most preferred style in online classes and was ranked first.

3.4 Player Typologies and Motivational Design

Gamification participants value specific psychological needs more than others, suggesting that more research is needed to understand Gamification's weighting process. Individuals' gamification beliefs correlate with their perceptions of valuable applications. Therefore, it is important to consider individuals' unique characteristics when designing gamified applications (Lopez and Tucker, 2021).

Marczewski introduced the Gamification User Types Hexad Framework to evaluate individual preferences for game elements in gamified applications. The Hexad player-type model is the most frequently used model in gamification. The model introduces six player-type dimensions: philanthropists, disruptors, socializers, free spirits, achievers, and players (Lopez and Tucker, 2021). The validity of the user types was tested, and it was confirmed that they were meaningfully associated with personality traits, thus helping in designing gamification that is more effective and engaging (Tondello et al., 2016).

Table 2: Summary of the Hexad player types. NOTE: This summary is based on (Lopez and Tucker, 2021) and (Tondello et al., 2016)

Player Type	Motivators	Description	Suggested Design Elements
Philanthropists	Purpose, meaning, altruism	Motivated by contributing to others without expecting rewards. Demonstrate altruism and value the positive impact.	Collection and trading, gifting, knowledge sharing, administrative roles
Disruptors	Change, innovation, system challenge	Seek to disrupt and improve the systems. Test limits to push innovation. It can be constructive or chaotic.	Innovation platforms, voting mechanisms, development tools, anonymity, anarchic gameplay
Socialisers	Relatedness, connection	This is driven by social interaction and bond formation. Value communities and shared experiences.	Guilds or teams, social networks, social comparison, social competition, social discovery
Free Spirits	Autonomy, self-expression, exploration	Enjoy creativity, freedom and independence. They like to explore and express themselves without constraints.	Exploratory tasks, nonlinear gameplay, Easter eggs, unlockable content, creativity tools, customization
Achievers	Competence, mastery, accomplishment	This study was motivated by task completion and the need to overcome challenges. Strive for growth and excellence in the field.	Challenges, certificates, learning new skills, quests, levels/progression, epic challenges ("boss battles")
Players	Extrinsic rewards	They are motivated by points, prizes, or rewards. Focus on the outcome rather than the nature of the activity.	Points, rewards or prizes, leaderboards, badges/achievements, virtual economy, lotteries or games of chance

Researchers have used storyboards to study the correlation between individuals' Hexad player types, game element preferences, and perceptions in physical-interactive applications. The Hexad player type model examines the relationship between player type, perception of game elements, and performance on gamified and non-gamified applications. The study found that an individual's dominant Hexad player type does not have sufficient discriminative power to differentiate individuals based on their game element preferences, supporting the need for partial membership between them (Lopez and Tucker, 2021). Table 2 summarizes the Hexad player types, their motivators, and the suggested design elements.

Individuals' Hexad player types have inspired numerous studies that have investigated various strategies for adapting gamified applications. (Lopez and Tucker, 2021) Adaptive Gamification, which tailors game components to specific player types, has dramatically improved user performance compared to non-adapted or mismatched gamified systems. (Knutas et al., 2019) proposed a ML technique for tailoring the content of gamified applications depending on individual player types. In research, four alternative educational gamified applications were developed, with the game aspect of rewards changed based on students' Hexad player type

(Mora *et al.*, 2018). (Böckle *et al.*, 2018) and (Lavoue *et al.*, 2018) present a design paradigm for adapting gamified applications based on distinct Hexad player types. (Lavoue *et al.*, 2018) used a matrix factorization approach to determine which game aspects students would interact with in an instructional gamified application. (Tondello, Orji and Nacke, 2017) provided a recommended system structure for tailoring gamified apps to specific player types and game element choices.

4. Gamification Elements and Strategic Design

4.1 Core Gamification Mechanics and Dynamics

This chapter explores gamification as a design strategy to improve motivation and educational effectiveness in learning contexts. It examines key elements in gamified experiences and how they promote user engagement and participation. Gamification has gained popularity by incorporating game mechanics into non-gaming contexts, aiming to engage users, promote learning, and solve problems. Game mechanics include rules, feedback systems, and playful structures, creating enjoyable and engaging experiences. Each element is implemented to provide a sense of playfulness.

Several gamification design frameworks have been proposed. One such framework is the "6R Framework," which includes 30 game elements. Another example is the "GAME Framework," which comprises 52 game elements mapped to specific user types. Among the most influential theories underpinning gamification design is the SDT, which remains central to gamification research (Mustafa *et al.*, 2023).

The following are commonly used gamification elements according to (Mustafa *et al.*, 2023):

- **Activity Points:** A point system within Learning Management Systems (LMSs) that awards points for specific actions or tasks, incentivizing active participation.
- **Badges:** Digital symbols awarded for completing tasks or achieving milestones. They promote pride and motivation and can be shared to foster a healthy competition.
- **Leaderboards:** Visual displays ranking learners based on their performances. Leaderboards promote competition-based motivation by enabling peer comparisons.
- **Levels:** Based on the activities they have completed, learners are categorized into tiers (e.g., Novice, Intermediate, Expert). Progression through levels reflects skill development and requires continued engagement in periodic challenges to achieve mastery.
- **Feedback Systems:** Ongoing, constructive feedback—accompanied by visual indicators—helps learners to monitor their progress and maintain psychological motivation and stability.
- **Avatars and Customization:** Allowing learners to personalize their digital presence within the LMS strengthens their emotional attachment and fosters deeper engagement.
- **Discussion Forums:** Topic-based forums encourage interaction, and learners receive points for their contributions, promoting collaboration, peer learning, and critical thinking.

4.2 Designing for Engagement: Intrinsic vs. Extrinsic Motivation

The importance of tailoring game mechanics to individual learner differences is also emphasized in the study. Evidence shows that gamification can result in an 80% increase in student motivation, and that outcomes correlate strongly with user profiles (Mustafa *et al.*, 2023). Motivation, a central factor in digital learning games, exists in two forms: intrinsic motivation (driven by personal interest or enjoyment) and extrinsic motivation (driven by rewards or outcomes, such as grades). Game design significantly influences motivation, particularly intrinsic motivation, which tends to increase when learners perceive a game as enjoyable and meaningful (Hawlitshchek and Joeckel, 2017). AI-powered personalized learning experiences are increasingly replacing one-size-fits-all education. Intelligent tutoring systems offer real-time support, making the learning process more adaptable. In tandem, virtual assistants, gamification, and simulations enhance student engagement and facilitate deeper immersion in learning content, improving understanding (Bushuyev *et al.*, 2024).

Finally, this chapter explores narrative integration, the use of storytelling to make learning more immersive and emotionally resonant (Palomino, 2022) highlights the critical role of coherent narratives in transforming gamification from a collection of mechanical elements (e.g., points and badges) into a meaningful journey. Drawing from narrative theories such as the Hero's Journey, the study suggests a framework that aligns game elements with the learner's path of growth and challenge. Using storytelling in gamification shifts learning from a tedious task to an engaging adventure, enhancing motivation, retention, and emotional connection in virtual environments.

5. Artificial Intelligence and Data-Driven Personalization

This chapter addresses the critical role of AI and data-driven personalization techniques in enhancing the effectiveness of gamified learning systems. Initially, it introduces Learning Analytics, emphasizing its potential to monitor and optimize student engagement by analysing data generated from user interactions with educational platforms. Learning analytics is a rapidly growing subject in the field of Technology-Enhanced Learning (TEL). Learning analytics is an important aspect of gamification because it examines the data generated by learning systems (Mustafa *et al.*, 2023). Using learning analytics, (Mustafa *et al.*, 2023) compared traditional Gamified Learning management systems (GMLS) and traditional learning management systems (TLMS) and found that students using GMLS logged in more times (7,200 to 3,151, respectively), and in general, students on GLMS performed better academically and had better scores.

Subsequently, the application of ML algorithms is discussed, highlighting their ability to predict and dynamically adapt educational content according to users' cognitive and emotional states. In a study by (Lopez and Tucker, 2020) a ML model successfully used key point data collected from participants for subtle facial expressions that are linked to emotional and cognitive states to predict the student's performance before they perform a task. The ML model can help create personalized adaptive gamification.

Moreover, the concept of real-time adaptation is examined, illustrating how the combination of static and dynamic adaptation techniques contributes to continuous improvement in learning experiences. (Hallifax, 2020) research focused on improving the effectiveness of gamification in education by personalizing game elements based on individual learner characteristics and engagement levels. The study, conducted with the Ludo Moodle project, proposes a generic adaptation engine that integrates static and dynamic adaptation mechanisms. Static adaptation assigns game elements based on initial profile data, whereas dynamic adaptation monitors the learner's engagement in real time using learning analytics and interaction trace data. This dual approach ensures that gamification evolves in sync with each learner's needs, maximizing motivation and engagement throughout the learning process. This study offers a comprehensive model, empirical validation, and practical design recommendations, contributing significantly to adaptive learning technologies.

Finally, this chapter explores significant ethical considerations arising from the use of AI, stressing the importance of transparency, data privacy, and social responsibility in designing advanced educational systems. While AI holds great promise, it also raises ethical questions regarding data privacy, algorithmic bias, and the displacement of instructors. To promote inclusive and egalitarian education for all, these concerns must be addressed directly through responsible development, transparent data methods and continual human monitoring (Bushuyev *et al.*, 2024).

6. User Experience (UX) and Human-Computer Interaction (HCI)

UX is an essential component in the design and assessment of gamified educational platforms. (Palomino, 2022) research emphasizes that effective gamification goes beyond simply adding game mechanics; it must address how students perceive, engage with, and emotionally respond to the learning environment. This study used empirical investigations to explore how aspects such as usability, engagement, enjoyment, and emotional resonance influence students' satisfaction and motivation in virtual learning environments. The findings demonstrate that a positive and well-crafted UX, achieved through the purposeful integration of narrative and interactive elements, leads to higher levels of engagement, deeper immersion, and enhanced learning outcomes. (Chaganti *et al.*, 2023) investigated the vital role of User Interface (UI) and UX design in the effectiveness of online learning platforms. Surveying 530 students, it was found that poor UI/UX might drastically affect user retention, with over 73% of students abandoning platforms with unsatisfactory designs. Students preferred simplicity of use, mobile accessibility, technical assistance, pricing, and high-quality content.

7. The Proposed Framework: Development and Structure

7.1 Framework Development and Validation Approach

This conceptual framework was developed using a multidisciplinary literature study that included pedagogy, psychology, UX design, and AI. Systematic investigation of academic databases such as Scopus and Google Scholar was conducted to identify essential components and their interdependencies, resulting in a variety of theoretical and empirical findings.

8. Application Context: Professional Retraining for Industry 5.0

(Buckley and Castro Jorge, 2024) research shows that more than 70% of companies face a substantial skills gap. Consequently, ongoing skill development and adaptation have become crucial for supporting workplace innovation and resilience. However, limited time, engagement, and budget hinder the learning and development process. To address these problems, it is critical to move beyond one-size-fits-all solutions and implement individualized learning strategies that help varied learners, particularly those who are disadvantaged by generational or contextual factors.

Training should be tailored to the needs of each generation. Millennials and Gen Z were raised with technology, whereas Gen X had to adapt to it. Gen Xers may be reluctant to learn new skills, often labelling themselves as "technophobes." Deficiencies in traditional schooling may leave Generation Z unprepared for a tech-driven employment market. Recognizing generational disparities in learning experiences and training approaches can help prepare all learners, regardless of age, to meet the demands of the modern workforce (Buckley and Castro Jorge, 2024).

9. Conclusion and Future Work

This study presents a multidisciplinary conceptual framework for a user-centred adaptive gamified learning system. Designed to navigate current challenges facing the industries, such as skill gaps and inefficiency of training, retraining and upskilling. Integrating Andragogical fundamentals such as Bloom's taxonomy and constructivism in addition to a psychological insight into motivation, cognitive load, and players' typologies. The framework ensures a personalized and engaging experience for the learner. The framework will be supported by AI-driven analysis and UX design, fostering engagement, satisfaction, and learning performance. Ethical design, real-time feedback loops, and ongoing personalization make it suitable for the current requirements of adult learners with different hibernations and cultural backgrounds. That matches the continuous demand and challenges in Smart Manufacturing and Industry 5.0. Using a learner-centric approach, the module improves learning outcomes and organizational productivity.

Future research would include validating the framework utilizing a pilot implementation in the context of industrial training. Validation results can be obtained through qualitative research by interviewing the learners in the pilot. Based on the analysis of the results, adjustment, and further development can be recommended. Other technologies, such as biometric data, emotion recognition, and AR/VR, can be integrated to enhance real-time personalization and learner engagement. Quantitative research can be performed when the module is implemented in the industry.

Acknowledgements

Funding: This research was funded by "P.O. FESR 2014-2020 – Regolamento Regionale n.17/2014 - Titolo II Capo2 - "Aiuti ai programmi integrati promossi da PICCOLE IMPRESE" – PIA (ART.27) – Progetto: AMNESia - Adaptive learning MaNagEment System - CUP B65H24000100006 - Codice Progetto: TMKCEX8

Ethics declaration: Ethical clearance was not required for the research

AI declaration: Semantic Scholar, Scispace, and Google Scholar were used to search for needed journal articles. Perplexity was used to help break down relevant papers. Quillbot was used for paraphrasing and summarizing. ChatGPT was used for brainstorming, outlining, and reorganizing tables and references. The final proof edit was done with the aid of Grammarly and Paperpal. Zotero was used as a references manager.

References

- Allen, S.J. (2007) 'Adult Learning Theory & Leadership Development'.
- Böckle, M. et al. (2018) 'A Design Framework for Adaptive Gamification Applications', in. *Hawaii International Conference on System Sciences*. Available at: <https://doi.org/10.24251/HICSS.2018.151>.
- Buckley, C. and Castro Jorge, M.F. (2024) 'Best Practices for Increasing Employee Engagement and Completion Rates in Online Courses: A Case Study on Creating a Culture of Learning', *International Journal of Advanced Corporate Learning (IJAC)*, 17(1), pp. 4–12. Available at: <https://doi.org/10.3991/ijac.v17i1.43277>.
- Bushuyev, S. et al. (2024) 'Transformation of the Education Landscape in an AI Environment', in *Proceedings of the 12th IPMA Research Conference "Project Management in the Age of Artificial Intelligence"*. 12th IPMA Research Conference "Project Management in the Age of Artificial Intelligence", International Project Management Association – IPMA, IPMA USA, pp. 57–64. Available at: <https://doi.org/10.56889/strd5315>.
- Chaganti, K.R. et al. (2023) 'UI/UX Design for Online Learning Approach by Predictive Student Experience', in *2023 7th International Conference on Electronics, Communication and Aerospace Technology (ICECA). 2023 7th International*

- Conference on Electronics, Communication and Aerospace Technology (ICECA)*, Coimbatore, India: IEEE, pp. 794–799. Available at: <https://doi.org/10.1109/ICECA58529.2023.10395866>.
- Grebin, N. et al. (2020) 'Applying Benjamin Bloom's Taxonomy Ideas in Adult Learning', *Journal of Education Culture and Society*, 11(1), pp. 61–72. Available at: <https://doi.org/10.15503/jecs2020.1.61.72>.
- Hallifax, S. (2020) *Adaptive gamification of digital learning environments*.
- Hawlichschek, A. and Joeckel, S. (2017) 'Increasing the effectiveness of digital educational games: The effects of a learning instruction on students' learning, motivation and cognitive load', *Computers in Human Behavior*, 72, pp. 79–86. Available at: <https://doi.org/10.1016/j.chb.2017.01.040>.
- Huang, H. (2002) 'Toward constructivism for adult learners in online learning environments', *British Journal of Educational Technology*, 33(1), pp. 27–37. Available at: <https://doi.org/10.1111/1467-8535.00236>.
- Idrizi, E., Filiposka, S. and Trajkovik, V. (2018) 'VARK Learning Styles and Online Education: Case Study'.
- Knutas, A. et al. (2019) 'A process for designing algorithm-based personalized gamification', *Multimedia Tools and Applications*, 78(10), pp. 13593–13612. Available at: <https://doi.org/10.1007/s11042-018-6913-5>.
- Lavoue, E. et al. (2018) 'Adaptive Gamification for Learning Environments', *IEEE Transactions on Learning Technologies*, 12(1), pp. 16–28. Available at: <https://doi.org/10.1109/TLT.2018.2823710>.
- Lopez, C. and Tucker, C. (2020) 'Toward Personalized Adaptive Gamification: A Machine Learning Model for Predicting Performance', *IEEE Transactions on Games*, 12(2), pp. 155–168. Available at: <https://doi.org/10.1109/TG.2018.2883661>.
- Lopez, C.E. and Tucker, C.S. (2021) 'Adaptive Gamification and Its Impact on Performance', in X. Fang (ed.) *HCI in Games: Experience Design and Game Mechanics*. Cham: Springer International Publishing (Lecture Notes in Computer Science), pp. 327–341. Available at: https://doi.org/10.1007/978-3-030-77277-2_25.
- Mora, A. et al. (2018) 'Effect of personalized gameful design on student engagement', in *2018 IEEE Global Engineering Education Conference (EDUCON)*. 2018 IEEE Global Engineering Education Conference (EDUCON), Tenerife: IEEE, pp. 1925–1933. Available at: <https://doi.org/10.1109/EDUCON.2018.8363471>.
- Mustafa, M.Y. et al. (2023) 'Does Gamification Influence Students' Online Learning Behaviors and Academic Performance? A Learning Analytics Perspective', in C. Anutariya et al. (eds) *Smart Learning for A Sustainable Society*. Singapore: Springer Nature Singapore (Lecture Notes in Educational Technology), pp. 127–138. Available at: https://doi.org/10.1007/978-981-99-5961-7_14.
- Palomino, P.T. (2022) *Gamification of Virtual Learning Environments: A Narrative and User Experience Approach*.
- Tondello, G.F. et al. (2016) 'The Gamification User Types Hexad Scale', in *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play. CHI PLAY '16: The annual symposium on Computer-Human Interaction in Play*, Austin Texas USA: ACM, pp. 229–243. Available at: <https://doi.org/10.1145/2967934.2968082>.
- Tondello, G.F., Orji, R. and Nacke, L.E. (2017) 'Recommender Systems for Personalized Gamification', in *Adjunct Publication of the 25th Conference on User Modeling, Adaptation and Personalization. UMAP '17: 25th Conference on User Modeling, Adaptation and Personalization*, Bratislava Slovakia: ACM, pp. 425–430. Available at: <https://doi.org/10.1145/3099023.3099114>.
- Wang, V. and Farmer, L. (2008) 'Adult Teaching Methods in China and Bloom's Taxonomy', *International Journal for the Scholarship of Teaching and Learning*, 2(2). Available at: <https://doi.org/10.20429/ijstl.2008.020213>.