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AUTHORS

Stephen Bezzina & Alexiei Dingli

University of Malta, Department of Artificial Intelligence

ABSTRACT

The integration of Artificial Intelligence (AI) into gamified digital learning environments represents a significant shift in educational technology. AI-enabled gamification enhances traditional gamification by introducing dynamic, adaptive elements that cater to individual learning needs, thereby addressing long-standing challenges in student engagement and motivation. This paper explores the theoretical underpinnings of gamification, emphasising the importance of intrinsic motivation as described by the Self-Determination Theory, and critiques traditional methods for their reliance on extrinsic rewards. AI's characteristics of autonomy and adaptivity allow for real-time data analytics and learner behavior prediction, creating personalised educational experiences that evolve with the learner. This approach fosters deeper engagement and sustained motivation, potentially leading to improved academic outcomes. However, the adoption of AI in education raises ethical concerns regarding data privacy and algorithmic bias, necessitating careful consideration and transparent practices. Ultimately, AI-enabled gamification offers a more nuanced and effective methodology for teaching, learning, and assessment, marking a paradigm shift from static, one-size-fits-all approaches to dynamic, learner-centered education.

KEYWORDS

artificial intelligence, gamification, motivation, engagement, personalised learning

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Introduction

1 The increasingly changing landscape of educational technology, especially with the recent unprecedented rise of Artificial Intelligence (AI), has the potential to underpin a significant paradigm shift in digital education. AI-enabled gamification, or the inclusion of AI technologies to support and enable game-design elements, potentially paves the way for more motivating, engaging, adaptive, and personalised learning experiences (Bezzina & Dingli, 2023). This relatively new approach addresses key and longstanding challenges in traditional educational, related to student engagement, motivation and diverse learning needs. Such an approach is mainly achieved through the introductions of dynamic and interactive elements that are tailored to individual learner profiles and needs (Koravuna & Surepally, 2020).

2 The significance of AI-enabled gamification in and for education lies in its potential to rethink the pedagogical underpinnings that have been traditionally influenced by one-size-fits-all approaches (Hamari et al., 2014). By leveraging AI to enhance gamified digital learning environments, educators can foster more motivating and engaging teaching, learning and assessment experiences (Dichev & Dicheva, 2017). This integration is particularly relevant in an era where digital education has been recognised as a key player in teaching, learning and assessment and consequently the demand for personalised and adaptive digital learning solutions is on the rise (Bennani et al., 2021).

3 The aim of this paper is to explore the origins and potential implications of AI-enabled gamification in gamified digital learning environments (Bezzina & Dingli, 2023). It will examine how this not only has the prospect of enhanced engagement and motivation, but also underpins the creation of personalised educational experiences that cater to individual students' needs. Through an analysis of seminal and current research and practical applications, this paper seeks to provide an in-depth understanding of AI-enabled gamification as a new paradigm in digital education, especially for gamified digital learning environments.

Gamification in Education: Theoretical Underpinnings and Critiques

4 Gamification, defined as the use of game-design elements in non-game contexts (Deterding et al., 2011), leverages parts of games, such as game thinking and mechanics (Zichermann & Cunningham, 2011) to create engaging and effective practices, both in and around the educational experience (Pfeiffer et al., 2020). In essence, gamification applied to educational contexts seeks to apply the principles and techniques of

game design and its elements to educational contexts, in order to augment student engagement, motivation, and learning outcomes (Hamari et al., 2014). Throughout the years, this has fuelled the interest of educators to research and apply gamification and other game-informed approaches in various educational contexts (Pfeiffer et al., 2023).

5 Key to the theoretical underpinnings of gamification is the concept of motivation (Buckley & Doyle, 2016). Theoretical frameworks like the Self-Determination Theory (SDT), applied to gamification in education, potentially suggest that gamification can foster intrinsic motivation by fulfilling basic psychological needs: autonomy, relatedness and competence (Ryan & Deci, 2000). Autonomy is addressed by giving students control over their educational experience, through concrete choices and agency. Relatedness is fostered by incorporating social elements, such as collaboration and competition. Competence is enhanced by providing challenges that fall within the students' zone of proximal development (Vygotsky, 1978). This can potentially lead to a state of deep absorption and enjoyment, or flow, which Csikszentmihalyi (1997) describes as the balance struck between the challenges presented and the current user's skill level.

6 However, gamification especially in education, is often criticised for its over-reliance on extrinsic motivation (Loughrey & O'Broin, 2018). The use of game design elements such as points, badges, and leaderboards (Vanduhe et al.,2019), can potentially lead to a situation where external incentives become the main focus of the learning process (Pastushenko et al., 2018). While these elements are commonly used to provide feedback, acknowledge achievements, and stimulate a sense of competition or progress (Dichev & Dicheva, 2017), an undue dependence on such external factors may lead to an overjustification effect. This occurs when intrinsic motivation is reduced by being offered a reward, which in the long run negatively impacts intrinsic motivation itself (Deci et al., 1999). Furthermore, the static nature of traditional gamification practices can potentially undermine the individual needs and preferences of the diverse students (Knutas et al., 2016). This is mainly due to their one-size-fits-all application, whose inherent rigidity presents identical content and challenges, set at the same level of difficulty, and recognises the same achievements based on common metrics for every student (Bezzina & Dingli, 2023). As such, this often fails to adapt to the diverse and evolving needs of different students (Kamunya et al., 2019).

Artificial Intelligence to Support and Enable Gamification

7 Artificial Intelligence (AI) is defined as "a system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals

and tasks through flexible adaptation" (Kaplan & Haenlein, 2019, p. 17). This definition brings to the fore two important characteristics of AI, which are autonomy and adaptivity. These enable the system to operate independently, without the need for constant human intervention and to change its behaviour whilst learning from such data (Floridi & Sanders, 2004).

8 Together, autonomy and adaptivity in AI systems provide the foundation for dynamic and responsive learning environments. Autonomy enables AI systems to make decisions, solve problems, analyse data in real-time and implement tasks thereof (Russell & Norvig, 2016). Moreover, adaptivity enables these systems to learn from the various user interactions and consequently adjust their operations in response to evolving scenarios and individual user requirements (Floridi & Sanders, 2004). Consequently, AI's inherent qualities of autonomy and adaptivity directly address the criticisms levelled against traditional gamification methods in and for education (Bezzina & Dingli, 2023). AI's autonomy enables systems to independently modify gamification experiences, based on the individual students' preferences and needs, moving beyond a one-size-fits-all approach. This means that AI can create personalised gamification paths that are not solely reliant on extrinsic motivators like points and badges but are instead balanced with the individual learner's journey in the gamified digital learning environment.

9 Such systems and underpinning gamified approaches, supported and enabled by AI, play a key role in shaping digital learning environments in view of enhanced motivation, engagement and learning achievement. These can identify and adapt to a student's unique learning journey, including the progress made and achievements gained, thereby augmenting intrinsic motivation (Daghestani et al., 2020). Furthermore, such an approach enables the dynamic adjustment of the learning experience in real-time, allowing for non-static content, challenges, and rewards which evolve according to the student's educational journey inside the digital learning environment (Szegletes & Koles, 2015). By continuously analysing the student's performance, motivation and engagement levels, AI can modify the content level, type and difficulty of proposed challenges, achievement paths and metrics utilised. This is done in order to maintain an optimal balance between challenge and skill, keeping the learning experience within the student's zone of proximal development (Vygotsky, 1978). Such a dynamic approach fosters sustained motivation, engagement and deeper learning, as it automatically and adaptively adjusts to meet the learner's changing needs and preferences, effectively targeting the limitations of traditional gamification's static nature (Kamunya et al., 2019).

AI-enabled Gamification

10 In essence, AI-enabled gamification is defined as the integration of AI to support and enable gamification in order to bring about an enhanced level of personalisation, underpinned by autonomy and adaptivity. Through its autonomous, decision-making and real-time adaptive capabilities, AI transforms gamification from a rigid, extrinsically motivated system into a fluid, intrinsically engaging experience that resonates with each individual user.

11 The constructive alignment of AI with gamification techniques represents a significant step forward in enhancing gamified digital learning environments. This moves beyond traditional static game-design elements to create dynamic playful learning environments. Consequently, this enabling process comprises embedding AI algorithms, including machine learning, into the core of gamified systems. These advanced technologies support gamified approaches in order to personalise the gamified experience to align with individual educational goals, preferences and needs. This synergy not only enriches the level of interactivity of gamified approaches but also enhances their capability to autonomously adapt to the different students, offering more nuanced and responsive learning and gamification experiences.

12 Most notably, the integration of AI and gamification enhances the personalisation of learning experiences through real-time data analytics and learner behaviour prediction (Barata et al., 2016). This signals an important educational transition from generic and static gamified learning to a personalised and dynamic approach. Through machine learning algorithms, AI-enabled gamified systems are adept at analysing vast datasets in order to derive insights about learner interactions and preferences (Daghestani et al., 2020). This capability enables the anticipation of general as well as specific learner needs and tailor the resulting gamification experience, based on past and in view of future performance patterns. This ensures that each learner engages with content that is most relevant and beneficial to their unique educational journey (Szegletes & Koles, 2015). In doing so, learners face challenges and earn rewards that are within but on the outer periphery of their zone of proximal development (Vygotsky, 1978). Consequently, AI-enabled gamification transforms the digital learning environment into a dynamic, responsive space that constantly evolves in line with the learner‘s educational journey. This represents a paradigm shift towards adaptive teaching, learning and assessment, whereas the system personalises the gamified experience in real-time. This is in turn based on the learner‘s past, current and evolving performance and accomplishments (Nedungadi & Raman, 2012). Such an approach potentially leads to an educational experience which remains motivating and engaging, whilst possibly averting feelings of

frustration and detachment (Moon & Seo, 2020). This significantly improves the overall educational experience, potentially leading to an enhanced academic achievement (Iyer et al., 2021). These adjustments are underpinned by a continuous analysis of the users' interactions within the gamified environment, ensuring a constructive alignment between the teaching, learning and assessment activities (Biggs, 1996).

13 An AI-enabled gamification approach also supports smart feedback and adaptive assessments, which have the potential to enhance the overall learning experience (Barrett et al., 2021). Information on action within the gamified system provides immediate and personalised insights based on the student's individual performance. This level of one-to-one (rather than a one-to-many) interaction sets the basis for a more relatable gamified experience, enabling the personalisation of both the nature of the assessment task and the set difficulty to match the learner's current level of understanding. This in turn ensures that assessments are challenging yet achievable (Emond, 2020). This dynamic and continuous assessment supports a more holistic evaluation of the individual student's progress and needs (Goldberg, 2019). Such intelligent and adaptive systems foster an unprecedented level of interactivity and responsiveness in digital learning environments, which are in turn crucial in supporting the pedagogical endeavours of educational processes.

14 While transformative, the constructive alignment of AI to support and enable gamification, presents challenges and raises a number of key ethical concerns, especially in terms of learning analytics and data privacy (Hong et al., 2022). This is due to the collection and analysis of the large amounts of student and teacher data generated by such systems. While this is essential for a truly personalised educational experience, it requires adequate considerations, in terms of security and confidentiality (Katznelson & Gerke, 2021). Furthermore, the use of such data necessitates a transparent underpinning, including clear information and consent on which data is being collected, for which purpose and how one can access this data (Miller & Brown, 2022). Another ethical consideration that must be undertaken is the potential for bias in AI algorithms (Holmes et al., 2021). AI systems rely on the data they are trained on; hence, there's a risk of perpetuating already existing biases or even creating new ones in educational content and assessments (Baker & Hawn, 2021). For instance, if an AI-powered platform is primarily based on historical performance data from a subset of learners who have had more time to study through the material and previous access to more resources, its recommendations may inadvertently favour content and approaches that support such learners, potentially side-lining those who are new to the material and without previous access to curricular resources. In turn, this can affect the gamification elements, where the engagement and motivation strategies might not resonate equally across

diverse learner groups, thus influencing the fairness of decisions made by the system based on supposed learner progress and interests. Consequently, institutions and education technologists need to continuously monitor and refine AI algorithms to ensure fairness and equity throughout.

Conclusion

15 This paper has explored the concept of AI-enabled gamification and how it potentially represents a new paradigm for gamified digital learning environments (Bezzina & Dingli, 2023). The three central characteristics of AI-enabled gamification, that is real-time data analytics and learner behaviour prediction (Barata et al., 2016), the autonomous and dynamic adjustment of content and challenges (Russell & Norvig, 2016) and the provision of smart feedback and adaptive assessments (Barrett et al., 2021) mark a significant leap in digital education methodologies. These features support a dynamic learning environment where challenges and content evolve with the learner's educational experience, based on individual users' data and behaviour predictions. This potentially not only enhances students' motivation and engagement but can also lead to greater academic achievement.

16 The constructive alignment of AI and gamification transcends traditional educational one-size-fits-all modalities, addressing longstanding challenges in student engagement, motivation, and academic achievement (Hamari et al., 2014). Despite its reported benefits, conventional gamification approaches are quite often built around an over-reliance on static models and extrinsic motivation (Pastushenko et al., 2018). In contrast, AI-enabled gamification, leverages the defining AI characteristics of autonomy and adaptivity to offer a personalised gamified learning experience (Kaplan & Haenlein, 2019). In turn, these directly target the limitations of traditional gamification by underpinning an educational experience that is not just playful, but also deeply personalised and responsive (Koravuna & Surepally, 2020). Consequently, the concept of AI-enabled gamification has the potential to offer a more nuanced and effective approach to teaching, learning and assessment in the digital age, paving the way for the rethinking of gamification in and for education.

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About the authors

Stephen Bezzina is a Research Support Officer at the Department of Artificial Intelligence at the Faculty of ICT at the University of Malta. His research interests include the application of Artificial Intelligence to playful and game-informed approaches.

Alexiei Dingli is an AI expert and Professor at the University of Malta. With over 20 years of experience in the field, he has helped numerous companies successfully implement AI solutions. He is also a member of the Malta.AI task force.