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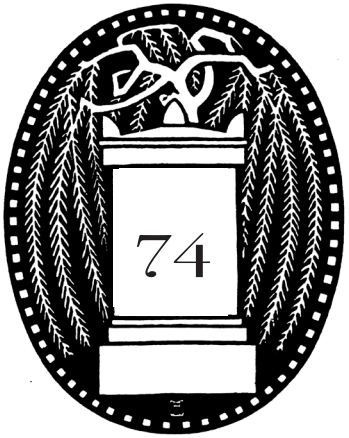

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Artificial Intelligence, Gamification, and Constructivist Pedagogy

Jonas Vilaire, Universidad Da Vinci, and
Ralph Olliges, Webster University

…technology is not neutral, and it must be steered by our agency.
—UNESCO, 2024

Introduction

Technological advancements in recent decades have transformed access to information, changed how one studies, and created new tools through which one learns and constructs knowledge. Because the world runs on digital technologies, integrating technology use into education has become essential to ensuring students function well in the working world they enter as adults. We posit that beyond knowing how to use digital tools, one might enhance learning processes and outcomes via digital technologies, particularly when teachers combine these technologies with constructivist pedagogies. Specifically, we suggest weaving together artificial intelligence (AI), digital gamification, and constructivist pedagogies not only offers students unique opportunities to engage, explore, and experiment as they construct their own knowledge but to receive immediate feedback on their learning processes, growth, and "products" they have created. First, we address AI's educational possibilities and challenges. Second, we consider digital learning gamification, and, third, we define constructivism before turning to AI, digital gamification, and constructivism in liaison.

Artificial Intelligence and Education

Given AI's potential to free teachers from administrative work and students' applying it to school assignments, educators are incorporating AI into schooling internationally. UNESCO (2021) recognizes AI's educative value, identifying it as innovative, providing rapid feedback and information to students, especially information helping to guide problem solving and resolving doubts (Fonseca, Benitez, & Oliva, 2019), and as delivering intelligent tutoring systems (UNESCO, 2021). Despite excitement over AI's power and although AI projects itself as a "smarter-than-most" expert, AI remains a *tool* one should not use to replace a human teacher and subject expert (Rodríguez, Castro, Pilay, & Quimiz, 2021). Indeed, developing AI's digital capacities for education should include linking those capacities with

students' educational levels, the content and specific subject, the course curriculum, and specific exercises and activities aligning with these levels, contents, subjects, and curricula (Rodríguez et al., 2021). While maintaining AI's integration into schooling should prepare students for adulthood in a world where digital technologies will continue to play a strong role and may well improve the efficiency in which students learn, we recognize one should not embrace AI before considering numerous challenges its use calls to the forefront. We consider three such challenges.

First, one must question AI-generated responses' quality and then, as a result of that quality, the value of AI-generated responses to the teacher or learner. Part of response quality and value concerns misinformation, including false bibliographic references. Although to teachers and students such misinformation is of negative value, one must ask, "To whom is such misinformation of value?" and "Who values disseminating such information of value?" Second, UNESCO (2021) is only one international organization asking how AI might pose obstacles to human rights. For example, AI programs may collect and store personal information without users' consent or permission, which violates one's Right to Protection of Personal Data. In turn, algorithms, when trained on user information, can perpetuate prejudices and discrimination. Recognizing AI's possible detriments to human rights, UNESCO (2021) has composed its recommendations for using AI ethically in its "Recommendation on the Ethics of Artificial Intelligence" (UNESCO, 2021). With bullying rampant at school sites and among students on cyberspace, school administrators and educators need to address AI ethics upfront as well as the legal, reflective, and critical elements involved when choosing to use AI (Mengi-Dinçer, Ediger, & Yesevi, 2021). Some critical elements that need to be strengthened include reliable and consistent fairness, transparency, and user privacy. Finally, should one wish ethically, legally, critically, and effectively to incorporate AI into teaching and learning, one must provide training on AI's operation, usage techniques, algorithms, and data handling before delivering training specific to teachers' administrative and pedagogical use. The training time required to use AI depends on the intensity, depth, and specialization desired, as well as the level of familiarity that the user has up front. All of these aspects are taken into consideration with the aim of AI supporting, enhancing and amplifying the effects and knowledge of pedagogy.

Gamification and Education

Humans and other animals have used play to teach children and to supply relief after concentrated learning since ancient times. Indeed, the brain seems to work and thrive on play (Bruner, 1960)! Today, many humans' audiovisual and interactive preferences seem to beg educators to combine digital technologies with play to enhance cognitive processes and speed

knowledge construction. Although leaders in the economic, marketing, and production sectors have experimented with digital gamification's usefulness for many years, demonstrating its effectively improving these sectors' work outcomes, increasing students' motivation to participate in classes (Landers, Bauer, Callan, & Armstrong, 2015), students' positive learning experiences, and students' actual learning (Kim & Lee, 2015) premise digital gamification in schools. In contrast to the use of elaborate games requiring previous content knowledge and knowledge of game design and how it develops, digital gamification tools use game-thinking and game-design structures to encourage students' motivation, engagement, positive experiences, and learning (Deterding, Dixon, Khaled, & Nacke, 2011).

Over 40 years ago, Malone (1980) began instead with the notion of "fun," identifying three criteria for making learning fun. For learning to be fun and thereby motivate students to learn, Malone (1980) contends the task must be *challenging*, arouse *curiosity*, and be under the learner's *control*. Malone (1980) further stipulates the challenge must incorporate relevant objectives for students' learning; building previously unconceived mental images through visual and auditory effects are to arouse students' curiosity; and giving students ownership for their own learning via choices within the game is to promote self-determination constituting Malone's criterium for "control." Malone's (1980) criteria—challenge, curiosity, and control—indeed connect to Gee's (2003) later stipulation that making quality game-based simulations requires game-makers to create flexible spaces where students may experiment, make decisions, and see their actions' consequences in an interactive, healthful environment. These three criteria further link to digital gamification supporters' connecting to intrinsic motivation theory to ground digital gamification within schooling (Kim & Lee, 2015).

Before constructing a digital learning game, fun and thereby motivational, those creating the digital game, in principle, analyze the discipline(s) included in the game, the students' knowledge base and levels, and students and their local context; define learning objectives; design the experience; apply relevant contextual elements to curricular content; ascertain how to ground the game process in learning and pedagogical theories; and know how to use the game's operational elements to systematize what all students in the class will come to know via the game (Valenzuela Alfaro, 2021).

Moreover, similar to AI, one must analyze and evaluate the ethical and social aspects involved when students access and engage in the game, for their engagement influences how students behave in the school environment while calling responsible use, data privacy, and equal access to the gaming tools and play into question (Deterding et al., 2011). Also, like AI, one must ensure the game adapts to students' different learning styles, intelligences, and educational and developmental levels (Plass, Homer, & Kinzer, 2015).

Last, although one's tendency may be to evaluate students according to their game play vs. their learning, growth, and knowledge construction, for digital gaming to be worth the class time invested and confidence in its educative value, teachers should identify progress, growth, and knowledge acquisition indicators and effective mechanisms for monitoring and measuring these indicators (Kapp, 2012).

Constructivism, Gamification, and Artificial Intelligence

Although one might ground AI and gamification in multiple different learning theories, we select constructivist learning theories and pedagogical applications because they are student-centered, and focus on learners' constructing their own knowledge using their prior knowledge, interactions with the environment, and building upon each new experience gained during the teacher's scaffolding for learning (Bada & Olusegun, 2015).[1] Constructivism thus builds upon the imperative that all students' experiences are of value. With this value as a preliminary, teachers and students recognize students each construct knowledge uniquely; teachers personalize teaching and learning, accordingly; and teachers scaffold learning to support students' unique means of knowledge construction.

Although Zegarra (2014) posits constructivist teaching liaised with AI influences "learning processes…in order to generate autonomous development," we maintain adding digital gamification increases the sense of play and the students' sense of control over their own learning and knowledge acquisition. Some of this control arises because constructivism suggests the possibility of attempts, errors, exploration, evaluation, and reflection, processes through which one constructs knowledge. By providing opportunities for students actively to explore and experiment within a game context, students must make decisions, analyze, evaluate, and solve problems, and reflect on their experiences, which, in a suitable environment with teachers' guidance, could improve their understanding and assimilation of the subject. Thus, although the teacher initially sets up the digital gamification tool to direct students' learning to some degree, students' participation in digital gamification in turn directs teaching to improve learning performance with AI's help. In this sense, AI can analyze how students respond to the challenges of gamified teaching and support them in overcoming obstacles and taking advantage of strengths in real time with teaching adapted to their particular needs, which must be monitored by an attentive teacher.

In contrast to teacher-centered, direct instruction in which the teacher holds all knowledge, teachers combining AI and gamification with constructivist pedagogies prioritize students, their learning, and their experiences' value, encouraging, supporting, and promoting students' learning through play. Ideally, play grounded in constructivism helps students not only come to know but internalize the knowledge they

construct, so they may build upon it (Türkmen & Soybaş, 2019). Using AI and digital educational games as classroom learning tools and activities is promising because AI and games center fun as their motivational component and because games promote, support, and reinforce such skills as problem solving, collaboration, and communication while students enjoy themselves (Dicheva, Dichev, Agre, & Angelova, 2015). Using AI to generate game content and dynamics, digital gamification as the learning activity, and constructivist pedagogy as the overall design can transform what might be a dry, lifeless encounter into a meaningful and memorable educational experience. The bonus beyond students' learning to value their own and others' learning experiences, interactions, and means of knowledge construction is their receiving immediate feedback concerning their progress and growth.

Endnote

[1] Cognitive constructivist theorists include Jean Piaget (1970) and Jerome Bruner (1960) as well as cognitivist and sociocultural constructivist, Lev Vygotsky/Vigotsky (1978). Piaget and Bruner focus on the child's learning style and developmental stages while Vygotsky focuses on meaning and understanding's growth from social encounters and dependence upon sociocultural context.

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