ENHANCING TEACHING EFFECTIVENESS THROUGH TECHNOLOGY: A COMPREHENSIVE OVERVIEW

MIGLIORARE L'EFFICACIA DELLA DIDATTICA ATTRAVERSO LA TECNOLOGIA: UNA PANORAMICA COMPLETA

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ABSTRACT

Teaching in higher education is constantly evolving through the interaction between educators, students and curriculum. Educators are instrumental in presenting the curriculum and stimulating classroom discussions. It is the responsibility of educators, who have different pedagogical beliefs, teaching styles and experiences, to carry out teaching. The quality of teaching done individually affects overall effectiveness. This article provides an overview of technologies that can help improve teaching. The adoption of technologies ensures consistent delivery of the curriculum and allows some of the educator's role to be delegated to technology, enabling greater student engagement.

L'insegnamento nell'istruzione superiore è in continua evoluzione in base all'interazione tra educatori, studenti e curriculum. Gli educatori hanno un ruolo fondamentale nel presentare il curriculum e nello stimolare le discussioni in classe. È responsabilità degli educatori, che hanno convinzioni pedagogiche, stili di insegnamento ed esperienze diverse, erogare una didattica efficace. La qualità dell'insegnamento svolto individualmente influisce sull'efficacia complessiva. Questo articolo fornisce una panoramica delle tecnologie che possono aiutare a migliorare l'azione didattica. L'adozione delle tecnologie garantisce un'erogazione coerente del curriculum e consente di delegare parte del ruolo dell'educatore alla tecnologia, consentendo un maggiore coinvolgimento degli studenti.

KEYWORDS

Technology, Educators, Teaching, Student Engagement, higher education.
Tecnologia, Educatori, Insegnamento, Coinvolgimento dello Studente, Istruzione Superiore

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Introduction

Technology plays an important role in digitization, both as a means of enabling the learning process and disrupting the traditional system. For example, virtual and augmented reality technologies are being adopted in high schools to provide a transformative learning experience. The use of technology in teaching dates back to 1924 with the introduction of the first Learning Management System called the "Teaching Machine." Over the years, various platforms have been developed, such as Moodle in 2002, which allow students to access online learning materials and assignments. The pedagogy adopted by educators is guided by their teaching approach and facilitated by the appropriate technology. This paper aims to explore best practices for effective course delivery using technology. It also examines the use of game-based platforms in university teaching and provides a perspective on integrating artificial intelligence into the learning experience. The paper details technologies and pedagogies, analyzes how these technologies can be adopted in the classroom through the use of gamification, immersive learning, and artificial intelligence-based learning. Finally, it summarizes the main conclusions in the last section.

1. Constructivist technologies and pedagogies

Constructivism pedagogy, based on the theories of Papert, Piaget, Inhelder and Vygotsky, focuses on engaging students in the learning process in order to develop meaning, understanding and critical thinking. Students construct knowledge through active negotiation of their previous learning experiences and newly acquired knowledge. Educators must design processes that allow this negotiation to take place, but constructivism can also present challenges, such as a lack of structure for understanding how students arrive at their responses. Therefore, it is important to provide clear structure for the learning process, especially for novice students. Constructivist lessons often involve group exercises to encourage discussion and expression of students' opinions. However, the risk of groupthink can arise during these activities. A common model in constructivism is the 5E model or its later development, the 7E model, which guides the learning process.

1.1 Collaborative learning

Collaborative learning refers to a range of educational approaches in which students or teachers work together to achieve common goals. It was proposed by Dillenbourg (Dillenbourg, 1999a, 1999b) in 1999 and involves students evaluating

and monitoring the work of other group members. The emphasis is on group work in or outside the classroom, where students actively participate in discussion and the development of ideas. This learning model enhances critical thinking and communication skills, and can be structured through setting internal rules and assigning specific roles to group members. Some examples of collaborative pedagogy include debate-based learning (Malone & Michael, 2018) and game-based learning (Feigenbaum & Feigenbaum, 2013).

1.2 Inquiry based

Inquiry-based pedagogy is similar to the scientific method used by scientists to formulate hypotheses and test them through experiments (Keselman, 2003; Pedaste et al., 2012; Pedaste et al., 2015). Students are involved in the discovery process and develop questions to seek logically correct answers. This pedagogical approach is supported by scientific evidence and is considered a form of constructivism, in which students construct their knowledge by searching for answers. A meta-analysis conducted by Lazonder and Ruth (2016) showed that orientation is fundamental to inquiry-based learning, regardless of the specific method used. However, there are still challenges in assessing the quality of inquiry and in effectively planning inquiry-based learning. The learning process should include opportunities for student interaction, formulation of key questions, peer or self-directed investigation, and reflection on how to approach questions. In recent years, there has been increasing attention to online inquiry-based learning. The next section of the text will discuss related technologies and provide a map of types of learning.

2. Technologies for Deliveries

Acceptance of different technologies takes longer in education (Salmon, 2019). Over the years, education has gone through different phases: Education 1, 2, 3 and is currently in the Education 4.0 phase. This process is closely related to industry, as education prepares the workforce for the industry. Salmon (2019) presented a historical overview of education and pointed out how industrial revolutions 1, 2, and 3 influenced education, preceding the corresponding stages of Education 1, 2, and 3. The current stage of Education 4 coincides with Industry 4.0 and develops in parallel with it. The first educational revolution focused on educator-centered pedagogy, in which students passively learned resources provided during lectures. The second movement introduced a "blended" mode of learning, with some educators beginning to use social media platforms for course delivery. Education 3

shifted the focus toward online learning, in which students became more responsible for their own learning, generating knowledge independently while educators created a context for students to search for the desired content. Education 4.0 incorporates a wide range of technologies for course delivery and requires greater student engagement throughout the learning process. Key features of Education 4 include connected technologies, personalized learning pathways, and comprehensive digital analysis of students in order to prepare them for the future. This topic can be discussed in relation to Industry 4.0 and the broader context of Global Adaptation 4.0 to gain a comprehensive view (Feldman, 2018; Schwab, 2018). Anealka (Hussin, 2018) presented ideas for teaching and a case for Education 4 implementation. Vichian (Puncreobutr, 2016) discussed the challenges facing education in the context of Education 4. Vishal (Jain & Jain, 2021) examined educators' acceptance of technology using the Unified Theory of Technology Acceptance and Use (UTAUT) model within the Education 4 movement. Finally, Monica et al. (Ciolacu et al., 2017) conducted analyses based on machine learning techniques to predict students' learning outcomes based on their profiles.The following sections will present the key technologies driving this revolution in education.

2.1 Gamification

Gamification is an approach that engages students by using game elements and rewards to enhance learning. The use of platforms such as Kahoot!, Quizizz, Socrative, and Wooclap is common in the education context, but there are differences in the level of student engagement and ease of setup for educators. For example, Kahoot! and Quizizz offer high student engagement through features such as badges and competitions, while Socrative and Wooclap tend to provide less instantaneous engagement. Quizizz receives the highest score in terms of ease of setup due to the ability to import pre-existing questions. However, all platforms support different pedagogies, such as constructivism, collaborative learning, and inquiry. They also provide features to evaluate student responses and adjust teaching accordingly.

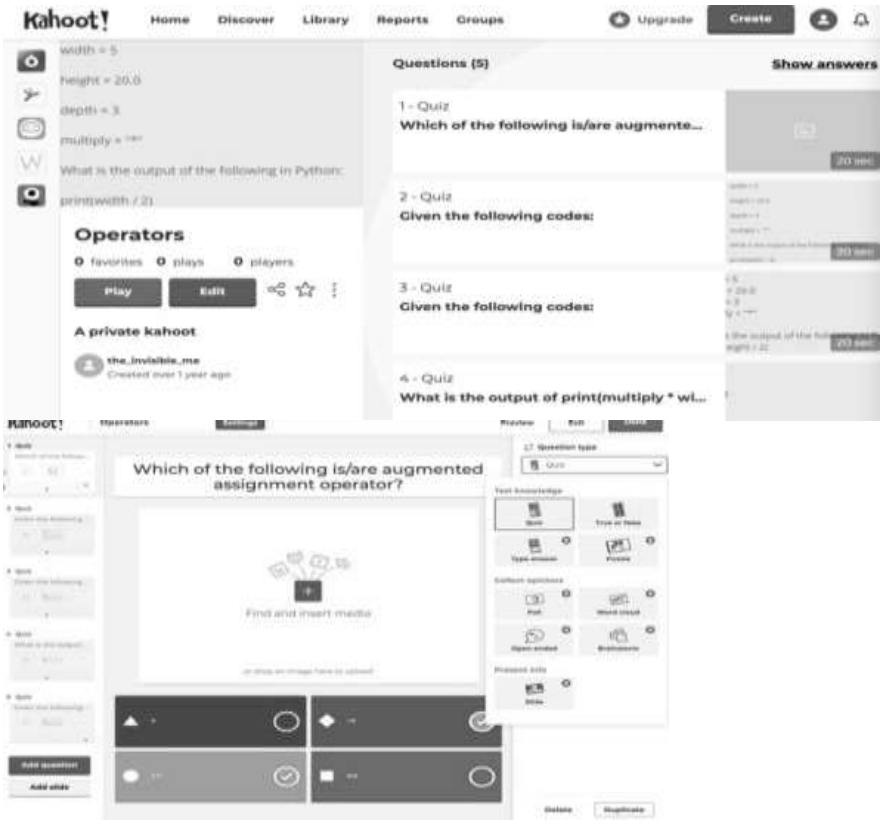

Figure 1: Kahoot interface

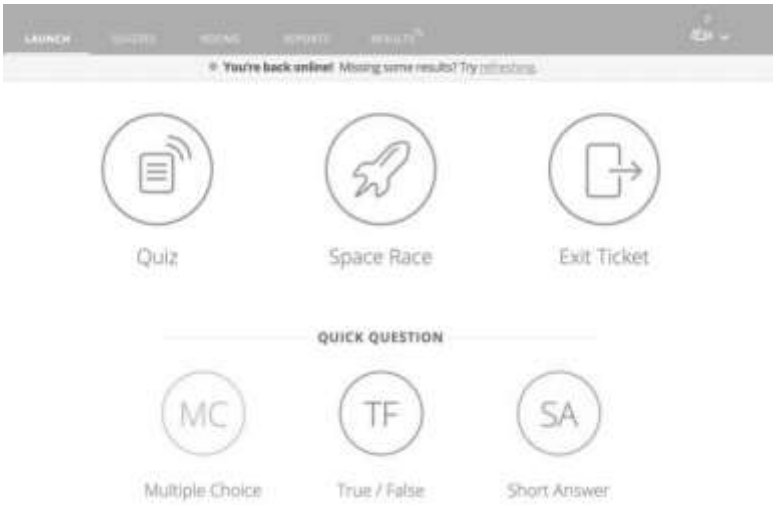

Figure 2: Socrative interface

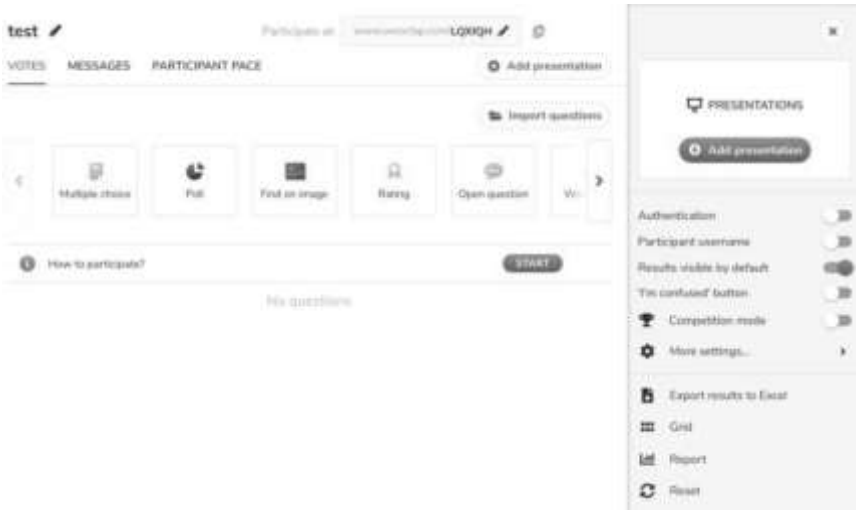

Figure 3: Wooclap interface

Figure 4 Quizizz interface

	Constructivist	Collaborative	Inquiry-based	Rewards	Ease of Setup
Kahoot	*****	****	****	*****	***
Socrative	***	*****	**	***	***
Wooclap	*****	nil	*****	***	****
Quizizz	*****	****	***	*****	*****

Table 1 Game based Platforms Comparison Table - *Table Legend: * is the Minimum Value (Negative) - ***** is the Maximum Value (Positive)*

2.2 Immersive learning (augmented reality and virtual reality)

Augmented reality (AR) was first introduced in 1992 by Thomas Caudell and David Mizell, researchers at Boeing, with the goal of providing wiring instructions in an industrial context. Subsequently, AR has been used in various industries to superimpose computer-generated images on real environments. A famous example of AR is the Pokémon Go application, which uses AR technology to allow players to search for Pokémon characters in the real world. On the other hand, virtual reality (VR) aims to create a fully virtual environment that replaces reality, providing an immersive experience. VR originated back in the 1960s with the invention of the first head-mounted display (HMD) called the Telesphere Mask. Since then, VR has been used in the entertainment industry, corporate sectors, and medical and military training. In the educational context, AR and VR are often used in medical and health education. For example, trainees can learn through surgical simulation, simulating a surgical procedure before actually performing it. This significantly reduces the risk of making mistakes that could be fatal. Other uses include treating autism, relieving limb pain, and teaching anatomy. However, the implementation of AR and VR in education has some challenges, such as high costs, lack of realism in simulations, and hardware limitations. Some solutions that have been proposed include the use of low-cost HMDs such as Google's Cardboard and the use of platforms such as Nearpod, EON Reality and ClassVR for lesson creation and delivery. In conclusion, AR and VR offer many opportunities to enhance the learning experience in higher education. However, challenges need to be addressed and appropriate solutions found to ensure effective implementation of these technologies in education.

Platforms	Works	Course	Students Feedback	Integration
Nearpod	(Hakami, 2020) deployed Nearpod in Najran University, Saudi Arabia	School Administration	Increased engagement. Promote active learning. Questionnaires showed positive learning experience.	Integrate with students' device and video-conference learning system
EON Reality	(Al-Allaq et al., 2021) incorporated EON to construct VR of 6-axes robotic as a prototype for future engineering learning tool.	Engineering Course	No self-reporting from students' perspective. The work provided detailed writings on implementation	Involves EON studio, SDK, Dynamic Load, and Raptor. Connect to Vicon tracking system and CAD system.
ClassV R	(Kurniawati et al., 2019) deployed ClassVR to Special Needs Students (age from 6-20 years old). The lesson is designed for students to follow instructions on picking objects in the classroom.	Tasks-based learning .	No self-reporting on engagement. Students were observed to look happy and focused during the learning.	Integrate with the use of Google Cardboard and Unity 3D.
Google Expedition	(Brown & Green, 2016) explored the use of Google Expedition for a Greek language course.	A pre-course for Nursing course.	Students reported learning sticks better and increased curiosity in the domain.	VR Cardboard, Android phones with Google Expeditions installed.

Table 2: Platforms for VR

3. Learning enabled by artificial intelligence

Popenici and Kerr (2017) conducted a study on the use of AI in teaching in higher education, exploring challenges and future directions. They emphasized the need for universities to reconsider their role and pedagogical models, focusing on imagination, creativity and innovation. The University of Edinburgh team developed a "Teacherbot" for co-teaching a large cohort of 90,000 students with diverse backgrounds. The Teacherbot, programmed to distribute tweets in response to students' questions, encouraged formal and informal text exchanges with students. Fahimirad and Kotamjani (2018) presented a conceptual review on the emergence of AI in education, examining its educational consequences for institutions and student learning. They highlighted several areas where AI could be integrated into education, including automated assessment, AI tutoring for student support, AI feedback and monitoring for teachers and students, AI facilitation for weaker students, and role separation to provide a non judgmental environment for trial and error. Previous research linking AI and teaching was also explored. These include Balacheff's (1993) postulation that machines should be able to handle and produce educationally relevant information to interact and collaborate with teachers. Kumar and Meeden (1998) described a project in which AI robots were used to teach AI courses, enhancing the role of AI in computer science curricula. Another educational project (Burgsteiner et al., 2016) focused on school-level AI education, adapting and structuring content based on students' prior knowledge and educational background to promote AI culture. Tuomi (2018) published a report on the impact of AI on learning, teaching and education, stating that AI is "the next electricity" and will have a significant impact in educational settings in the coming years. The report covered recent developments in learning, teaching and education, including the use of AI in test generation, assessment, diagnosing attention, emotions and student conversations. However, the report also highlighted the challenge of obtaining sufficiently large datasets for more complex cognitive tasks, such as course development and management. In addition, Ciolacu et al. (2018) implemented an AI-assisted higher education process using smart sensors and wearable devices for self-regulated learning. By linking prior student data, an early recognition system predicted final exam scores, enabling early identification and support of at-risk students. This intervention led to a 50 percent reduction in exam failure rates

Conclusions

Technology for education began with the use of technology as a platform for students to attempt questions. This paper has examined different technologies to

support education from the perspective of gamification, immersive learning to artificial intelligence. From the perspective of gamification, we examined some gamification platforms based on major pedagogies. There is a lack of ready tools that can gamify long-term course content to provide structural engagement. Commonly used gamification platforms were examined based on their relevance to different pedagogies, rewards, and ease of setup. Immersive learning immerses students in an "augmented" environment for a different learning experience. It has been commonly practiced in medical and health education. The cost and complexity of setup is higher as it involves both hardware and software. Some recent work on immersive learning was reviewed. The last section examined AI-enabled learning outlining the possible integration of AI in assessment, tutoring, tracking and monitoring student performance. The adoption of technology in education requires higher installation costs in terms of resources and time. The benefits of consistent delivery, shorter subsequent setup times, and the contextualized learning experience for students are worth the initial investment.

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