TECHNOLOGY SUPPORTED ACTIVE LEARNING

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Abstract. Active learning promotes student-centered approaches to the learning process, allowing students to develop skills and competences that traditional, passive learning methods cannot foster. In turn, supporting active learning with digital technology tools creates new possibilities in terms of pedagogical design and implementation. This article shows how active pedagogical methodologies like problem-based learning, design thinking, and others can be effectively supported by digital environments and tools like collaboration platforms, serious games and virtual and augmented reality by presenting several projects that I've been involved in the past few years**.** Therefore, it is also an overview of my recent research and practitioner activity in that domain.

Key words: Active Learning, learning technology, serious games.

INTRODUCTION

Learning is a personal process that is influenced by a learner's existing knowledge, abilities, skills, motivations, and other factors. The traditional, industrial approach to education that assumes all learners will respond identically to the same teaching methods has proven to be ineffective. This passive approach fails to tap into a student's individual experiences and doesn't help them develop the skills needed for their future careers.

Active Learning is a pedagogical approach that encourages students to take an active role in their own learning. By involving students in their education, active learning recognizes and leverages their personal experiences and helps them reach higher cognitive levels. The concept of Active Learning was popularized by Bonwell and Eison (1991), who defined it precisely as a method where students actively participate in the learning process. They emphasized that students must do more than just listen to lectures, they must also engage in activities like reading, writing, discussing, and problem-solving. This approach aligns with the constructivist ideas that students build their understanding by making connections between new information and their previous knowledge. Active learning improves critical thinking, problem-solving, motivation, collaboration, communication, entrepreneurship, and integration into society. It also fosters lifelong learning by promoting student autonomy and control over their own education.

Active learning can be implemented through different methodologies like problem-based learning, project-based learning, experiential learning, design thinking, inquiry-based learning, and others. And while these methods often involve group work, they can also be used for individual reflection.

Many studies have shown that active learning is also efficient, with students in active learning courses being less likely to fail and performing better on exams and assessments than students in passive lecture-style courses (Vaz de Carvalho & Bauters, 2021).

Active learning places a higher degree of responsibility on the learner, but instructor's guidance is still crucial to direct learners to the right path. Skilled teachers and facilitators

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promote learning by providing challenges, advice and support adjusted to the student's ability. Teachers usually find that the increased level of academic discussion with their students is much more rewarding than the simple passive lecturing.

Active learning can be facilitated through technology, such as virtual learning communities, personalized learning platforms, games, simulations, virtual labs, and virtual/augmented reality systems. These interactive and immersive tools, which are considered advanced Open Educational Resources (OER), can be used to effectively support higher education students in developing required competencies. Policymakers, researchers, developers, and educators must take these emerging technologies into account and design educational programs that utilize these new-generation learning tools to enhance the learner's autonomy, collaboration, creativity, and critical analysis skills. Learning with these tools should prioritize visual, auditory, tactile, experiential, and interpretive experiences to facilitate active knowledge construction. (Batista et al, 2008; Pereira et al., 2007).

In this article, we describe a set of projects that show how active learning can be applied to different target groups, using different pedagogical models and technologies.

PROJECTS AND BEST PRACTICES

The following set of exemplary active learning implementations derive from different projects applied in different European countries and result from the last years of research and practice of teams that I've collaborated with in this domain.

ALIEN (Active Learning in Engineering Education) project

The ALIEN project introduced an active learning intervention for engineering education which gathered 4 European universities and 12 South Asian Universities. The project setup problem-based learning environments addressing real-life issues related to science, technology, engineering, and math (STEM) concepts. The intervention aimed to facilitate the more effective transition of students from the academic environment to the world of work through digital activities linked to engineering curricula skills mismatches through learning scenarios inspired by real life industry and societal challenges (Tsalapatas et al, 2021; Tsalapatas et al, 2019).

Figure 1: PBL Lab at University Tenaga Nacional, Malaysia.

The project also promoted the deployment of digital technology as a complementary learning medium that enriches student engagement and provides meaningful feedback. The project's intervention was based on a complementary set of vectors:

- Problem-Based Learning (PBL) laboratories: The ALIEN consortium established physical PBL laboratories in 12 universities in South Asian countries including Malaysia, Vietnam, Cambodia, Pakistan, and Nepal (as shown in Figure 1). The labs were customized to meet the specific needs of each institution and enabled active learning through the integration of digital services and educational content. The labs facilitated the use of digital tools such as serious games, simulations, and augmented/virtual reality in educational settings through specialized equipment. These labs also had writable surfaces for group work on solution design and 3D printers for prototyping, providing a comprehensive and technologically advanced learning environment.

- Digital Platform for Engineering Education: The digital services were created to enhance educational activities through increased engagement, interaction, and feedback. The platform allowed educators to structure, publish, and reuse problems, challenges, and activities, providing access to rich, digitally-enhanced educational content and facilitating student interaction across participating universities.

- Community Services: The ALIEN platform had a strong emphasis on community building to encourage knowledge exchange among educators, experts, industry players, and students regarding best practices in problem-based learning in engineering education. The services were open to all interested in problem-based learning and included features such as profile management, messaging, activity tracking, and forums. The special interest groups aimed to further promote problem-based learning through discussions on topics such as gamification, AI in education, tools and approaches, specific areas like software engineering, and best practices.

- Instructor Training: The ALIEN program aimed to address the issue of insufficient instructor training, which was identified as a hindrance to modernizing higher education. The instructor capacity building services aimed to empower educational institutions to effectively integrate digitally-enabled problem-based learning into their existing practices to better prepare students for the workforce.

LEAP (Lean and Agile Practices Linking Engineering Higher Education to Industry) project

The LEAP project aimed to educate engineering students in higher education on emerging lean and agile design industry practices to better prepare them for the workforce. The project showed how these practices can be applied to a variety of engineering contexts beyond their original sectors, such as automobile construction and software engineering, to improve production efficiency, reduce waste, and prioritize customer needs through user-centered design (Rodriguez et al., 2018).

The project utilized active learning through hands-on experience in a virtual environment that mimicked real-world industry practices in the form of serious games. The first game demonstrated the benefits of the 5S model of lean practices in diverse sectors and the second

game highlighted the value of the SCRUM Agile Design Model in engineering for both end-users and producers (see Figure 2).

Figure 2: The LEAP serious game.

NATURE project

The NATURE project is a European initiative that creates a highly interactive digital learning platform to educate higher education students on responsible natural resources management and environmental sustainability. The platform raises awareness of the significance of sustainable natural resources management and provides students with both theoretical knowledge and practical skills to become active citizens in designing sustainable solutions. NATURE utilizes a digital game that simulates real-life scenarios where students act as stewards of natural ecosystems, balancing preservation, economics, and quality of life. The game provides instant feedback on the consequences of their choices, enhancing their knowledge on the impact of human activity on the environment (Caeiro-Rodriguez et al, 2022).

The NATURE project's educational framework is based on the results of a learning needs analysis and takes into account existing environmental education practices and policies. The platform also offers educational activities inspired by real-world challenges and can be easily adapted to meet different needs. These activities aim to build knowledge, skills, and positive attitudes towards responsible natural resources management through a game-based approach.

AUDID (Adults, Data, and Emerging Identities) project

The AUDID project was established to address the growing issue of digital illiteracy among the adult population, particularly those aged 55 and above, who are at risk of social exclusion and vulnerability with regards to the use of digital tools and internet safety. The goal was to

enhance their awareness of online identities by providing practical, motivating, and easily understandable training and learning tools that would protect them against dangers that come with online presence and cybercrime. The project aimed to enhance the quality of life, social participation, and cohesion of these individuals, increasing their online confidence and trust, and thus fighting against senior exclusion (Zanchetta et al, 2022).

The consortium developed an innovative, experiential pedagogical approach and a set of interactive digital learning tools to improve understanding of the subject and related competencies, such as critical thinking. These tools were designed to provide recognition of skills and achievements through Open Badges.

To meet the needs of the adult population, the solution was implemented in three parts. The first two involved creating an interactive multimedia curriculum for adults and adult educators to empower them with essential skills and knowledge, and providing tools to understand the risks associated with online identities. The third part involved providing practical exercises for adult educators to facilitate the training themselves and become key facilitators.

The solution was interactive and experience-based, designed to engage learners, link to the growing importance of visual information, and have a dual implementation capability, both in the classroom and online. To apply the acquired knowledge in real-life situations, the project developed a dynamic demonstrator, an interactive web-based tool based on real-life scenarios, available in all national languages and including 28 different scenarios. This tool served as a valuable methodological tool for adult learners to empower their transversal skills and develop their professional competences. All of these features were integrated into a Learning Motivation Environment (LME) that supported social and peer learning, the interactive multimedia curriculum, and the dynamic demonstrator.

MINDLIVEN (Mindfulness in Nature) project

The MINDLIVEN project is focused on using mindfulness-based training to help individuals cultivate mindfulness and integrate it into their daily lives. Mindfulness can impact the six main areas of work design - demand, control, support, relationship, role, and change - by altering automatic thought processes, increasing response flexibility, and promoting working memory, self-determination, and persistence. This can lead to better problem-solving, decision-making, and attentional control, as well as higher creativity and empathy (Menardo et al, 2022).

Mindfulness also promotes cognitive flexibility and adaptive capacity, allowing individuals to better adapt to new situations and think outside of past patterns. Exposure to nature can also positively impact stress and mental fatigue, reduce negative moods, enhance positive emotions, and provide calming effects. The MINDLIVEN project has developed a mindfulness-based instructional approach that combines formal training with mindfulness practices and exposure to visual and immersive nature environments (Figure 3).

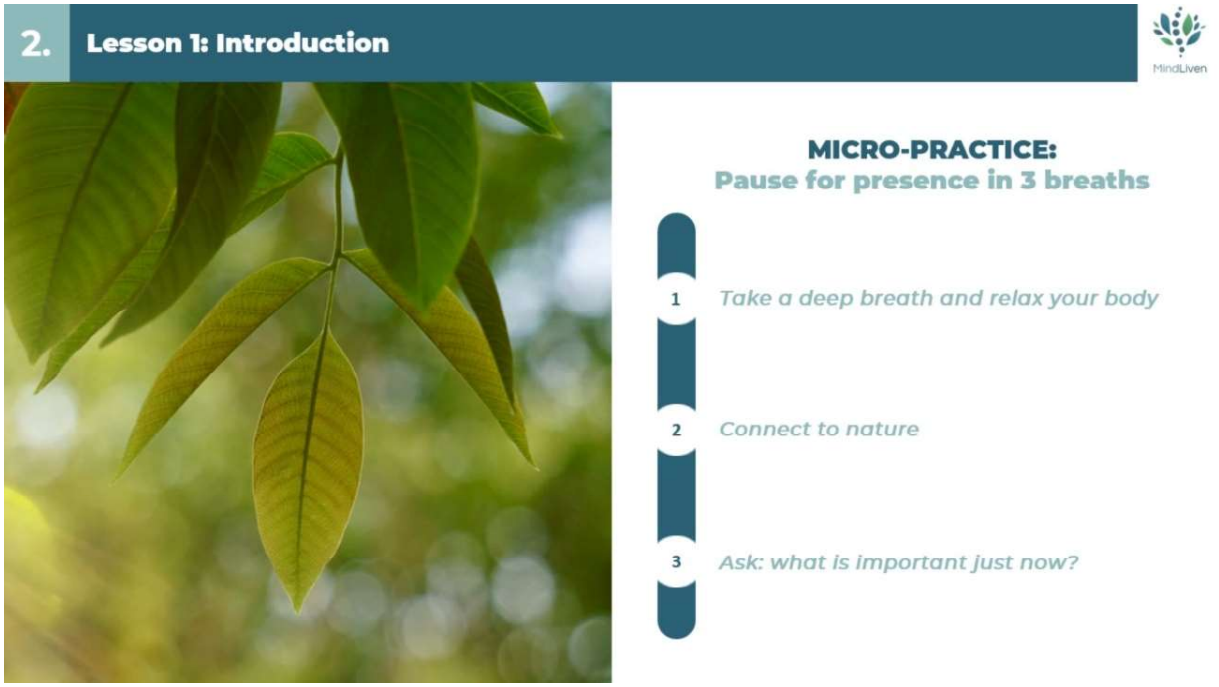

Figure 3: MINDLIVEN practices.

DeSTRESS (Developing Competencies for Stress Resilience @SMES) project

The project focused on creating a digital platform for enhancing workers' and managers' skills in handling technostress at the workplace. The centerpiece of the project was the design and creation of a digital game-based training platform, which was developed based on the findings from the initial phase of the project. The game utilized a 3D role-playing approach, providing learners with a dynamic, immersive, and hands-on experience in dealing with stress caused by technology in the workplace. The role-playing aspect was also reflected in the character attributes related to technostress, whose values changed based on the player's progress, tracked through game analytics, to evaluate the player's performance and learning outcomes. The development of the platform followed an Agile software process, with regular interaction with end-users. Both employees and employers were the target audience for the game, which was designed to train both groups on how to handle technostress (Pasini et al, 2021).

Before playing the game, learners completed a self-assessment questionnaire to determine their level of technostress. During the game, they would alternate between the role of employer and employee and face various scenarios where they would need to choose the best course of action. They could respond through language, actions, or postures, and the consequences of their choices would determine whether they gained or lost points based on their ability to manage technostress effectively (Figure 4).

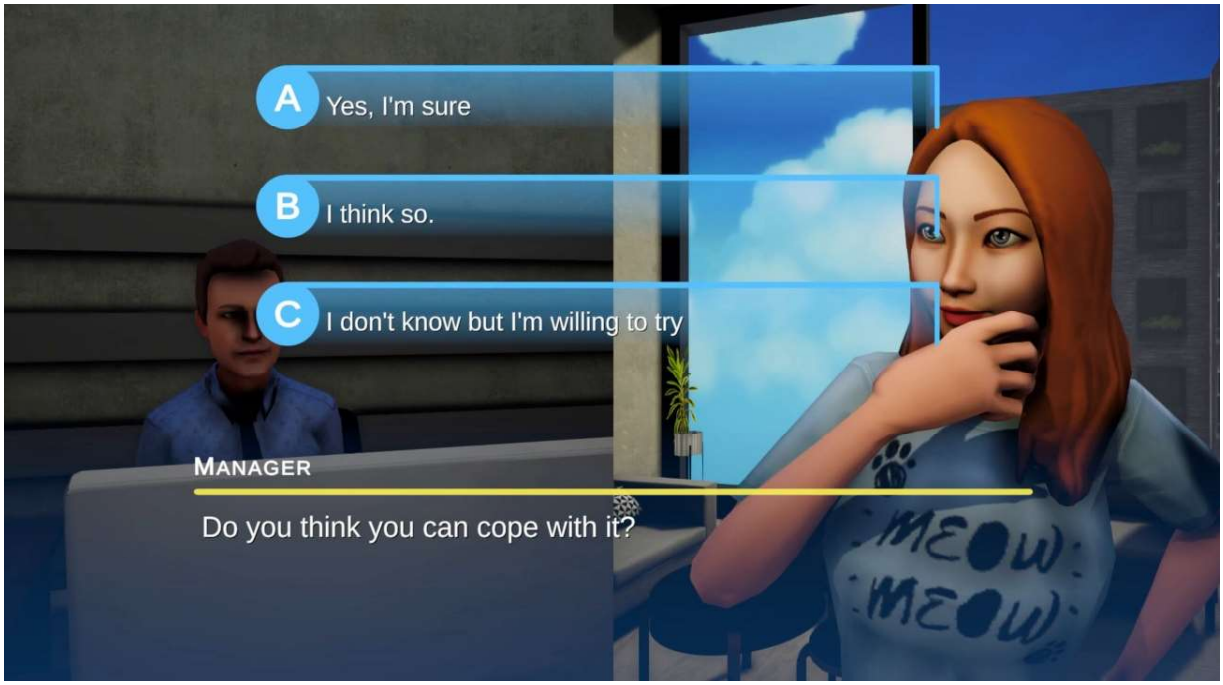

Figure 4: The DeSTRESS game.

HERA (Higher Education Re-engineering through Active Learning for Growth) project

HERA developed a digital learning game platform that aimed to challenge students by integrating knowledge from multiple fields and simulate the way engineers and economists work and collaborate in real-world scenarios. The platform is set in a virtual city, where players can take on various roles representing different stakeholders and make decisions related to city design, budget allocation, and citizen satisfaction, among others. The game allows players to collaborate and requires them to balance various interests and resources (Caeiro-Rodrígues et al, 2020).

The platform features a game editor with various options for designing complex scenarios, including terrain formatting, a wide range of buildings and city infrastructures, and other elements such as parking lots and city decorations. It also implements traffic, weather, day/night cycles, and seasons, all of which affect the scenario's evolution as the game is played. The game provides a rich and immersive experience, allowing students to experience the complexities of real-world scenarios (Figure 5).

Figure 5: The HERA serious game.

LoEL (League of Emotions Learners) project

The project aimed to empower young people to enhance their emotional intelligence, allowing them to recognize and express their own emotions, and to establish effective communication both online and offline, especially in professional settings. The project had five main objectives: to create empowering training materials that help young people understand the source and nature of emotions, to offer a diverse range of activities that mix real digital communication methods and environments, to provide linguistic expressions that express basic emotions across different cultures, to teach appropriate verbal and nonverbal cues to communicate effectively in negotiations and conflict situations, and to offer a motivating training approach to organizations that work with young people (Santos et al, 2021).

The target group was young people and youth trainers who could benefit from the results by becoming more aware of their emotional intelligence, recognizing the benefits of managing emotions, and knowing how to express emotions and communicate through digital means. They could also learn how new technologies and their own channels and signs can shape communication and express emotions.

The LoEL approach brought together two important aspects that are not often combined in a training process: the significance of language in identifying and expressing emotions and the creation of professional scenarios through hands-on learning and gamification strategies suited for the business world.

The LoEL app uses innovative gamified educational methods, tailored to the digital habits of young people, to help players develop their emotional intelligence. This combination of digital content in the form of a serious game available on a mobile platform has been shown to be highly effective for the target group, as measured by their ability to apply the learned skills in real-life tasks. The app includes three key components: "Emotions Box," a

multilingual dictionary of emotions; "Express Yourself," a collection of games to test and improve emotional expression skills; and "Emotional Organizations," an activity that allows players to role-play and practice managing emotions in professional scenarios. The app includes a progression system that moves players through increasing levels of difficulty.

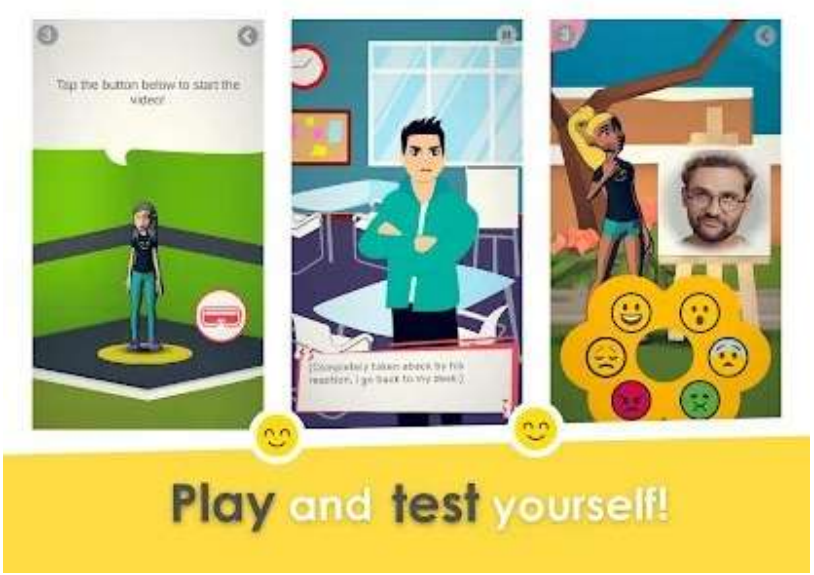

Figure 6: The LoEL serious game.

CONCLUSIONS

Active Learning is a pedagogical approach that motivates students to take an active role in their learning process. This approach leverages their personal experiences, encourages higher cognitive levels and improves improved critical thinking, problem-solving, motivation, collaboration and communication. Active learning can be implemented through different pedagogical methodologies like problem- and project-based learning, experiential learning, design thinking, and inquiry-based learning. The use of technology allows to use an extended range of pedagogical activities and methods to support active learning practices.

As a researcher and practitioner (teacher and trainer), Active Learning has been a major focus but also tool in the past few years. This article intention was precisely to show that Active Learning can be effectively and successfully deployed using different pedagogical approaches and technologies and for different target groups.

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