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Future Learning in Higher Education: Pedagogical and Technological Shifts Towards 2030

Javier Rodrigo-Ilarri; Luis M. Sánchez-Ruiz; Nuria Llobregat-Gómez; María-Elena Rodrigo-Clavero; Claudia P. Romero-Hernández; Eduardo Cassiraga; Santiago E. Moll-López
Universitat Politècnica de València, Spain, <jrodrigo, LMSR, nllobre, marodcla, clroher, efc, sanmollp>@upv.es

Abstract*– Higher education institutions are undergoing some rapid transformations due to several factors such as technological advancements, pedagogical shifts, and changing student demographics. The Alpha Generation, born after 2010, has unique learning preferences including haptic device interaction, digital fluency, and a demand for personalized learning. As a response, educational institutions are integrating innovative methodologies to enhance engagement, improve inclusivity, and optimize learning outcomes. This paper explores key aspects of future learning, including pedagogical shifts, technology integration, adaptive learning, and multimodal learning, while examining the LESLIE project as a relevant example of a project that embodies these future learning principles.

Keywords—Future Learning, Technological Shifts, ERASMUS+ Capacity Building

I. Introduction

Pedagogical approaches are shifting towards more interactive, student-centered models, replacing the traditional lecture-based format with more dynamic and engaging strategies. Student-centered learning fosters autonomy, critical thinking, and creativity, creating flexible environments where students actively engage in inquiry and collaborative projects. Collaboration plays an essential role in this transformation, with digital platforms facilitating teamwork beyond the classroom and enabling real-time exchanges across disciplines.

The integration of technology is at the forefront of future learning methodologies, [1]. Its arrival enhances accessibility, engagement, and efficiency, for several reasons among which we may point out the following ones:

- Immersive technologies such as virtual reality and augmented reality create engaging learning experiences, particularly in disciplines where simulations can replicate real-world scenarios.
- Artificial intelligence further enhances this process by enabling adaptive learning systems that analyze student performance data to provide personalized instruction, real-time feedback, and automated assessments.
- Haptic feedback devices offer a multisensory approach to learning and are particularly relevant in STEM disciplines, [2], allowing students to engage with virtual experiments and improve cognitive retention.
- The Internet of Things contributes to this transformation by facilitating smart classrooms where interconnected devices monitor student engagement and optimize learning conditions.

The seamless integration of these technologies is essential in fostering a learning environment that adapts to the diverse needs of students.

In this work we outline some of the strategies universities should adopt to integrate haptic technology and embrace the STEHEAM paradigm, ensuring they are well-prepared to support the academic and personal growth of the Alpha generation. Indeed, they have been considered within a CBHE project financed by the European Education and Culture Executive Agency (EACEA), namely the so-called LESLIE (Land Management, Environment & Solid Waste: Inside Education and Business in Central Asia), [3], an ambitious initiative whose scope we detail as a case study hereafter.

II. Challenges in Higher Education

Our world is living a profound transformation nowadays. In the midst of it, Higher education institutions (HEIs) are not an exception. At the bottom of this transformation, we find the digital revolution which has introduced an array of new tools and platforms that have redefined how knowledge is shared and acquired.

The arrival of students to HEIs that are just preceding the Alpha generation—those born from 2010 onwards—is marking the need of a significant shift in higher education, [4].

The members of these young cohorts of students are characterized by a high level of proficiency in using haptic technologies endorsing them with a natural proactive approach to learning. This new learning style was coined as the AROHA learning style in [2] as the members of the Alpha generation were Active, performing Research actions, Open-minded, and utilized Haptic devices in their standard lives.

Consequently, the youngest generations are demanding not to remain as passive recipients of information but active participants in a dynamic and interactive learning process in their daily lives.

To effectively prepare for the Alpha generation, universities must transition from a traditional STEM (Science, Technology, Engineering, Mathematics) perspective to a STEHEAM (Science, Technology, Engineering, Humanities, Ethics, Arts, Mathematics) framework. This expanded perspective, which includes Humanities, Ethics, and Aesthetics, promotes a more holistic and human-centered approach to education that takes into account the preferred learning styles of this generation—visual and digital—.

To face the innovative teaching strategies that these styles demand. HEIs find several challenges such as:

1. Adapting to the Alpha Generation: The arrival of the Alpha generation, born after 2010, presents a unique challenge. This generation's digital fluency and preference for haptic learning necessitate significant adjustments in teaching methods and curriculum design, [5].

2. Technological Integration: Integrating advanced technologies like haptic devices into the curriculum requires substantial investment. This goes beyond just acquiring the technology, as it also involves training educators on how to effectively utilize it for optimal learning outcomes.

3. Pedagogical Adaptation: Traditional lecture-based teaching methods are becoming increasingly ineffective for engaging today's students. The Alpha generation thrives on interactive and hands-on learning experiences, demanding a shift towards more participatory pedagogies, [6].

4. Curriculum Relevance: Keeping curricula relevant in a rapidly changing job market is an ongoing challenge. This requires incorporating interdisciplinary approaches and emphasizing critical skills like critical thinking, creativity, and ethical reasoning.

5. Student Engagement: Engaging students accustomed to instant information access and immersive digital experiences demands innovative teaching strategies. HEIs need to find ways to create a compelling learning environment that keeps students actively involved, [7].

6. Critical viewing skills: While adept at creating and navigating digital environments, the Alpha generation might lack critical viewing skills. Equipping them with the ability to analyze and interpret visual content critically is essential. This includes understanding visual rhetoric, identifying biases, and recognizing the intent behind media messages. Developing strong critical viewing skills will empower them to assess the credibility, relevance, and impact of visual information they encounter.

III. Characteristics of the Alpha generation

The Alpha generation is unlike any other, characterized by a unique approach to learning. They are active learners, taking the initiative to seek out additional resources and opportunities that deepen their understanding and hone their skills. This goes hand-in-hand with their research-oriented nature, where they are inclined to explore, discover, and validate information through independent investigation. Growing up in a globalized and interconnected world fosters open-mindedness, making them receptive to diverse perspectives and innovative ideas [4,8].

Perhaps the most defining characteristic is their affinity for haptic interaction. Highly proficient with technology, they excel at using digital tools, particularly those offering tactile feedback through haptic devices. This proficiency extends to their learning preferences, as they gravitate towards interactive and hands-on experiences over passive information reception.

Furthermore, they possess strong digital skills; and are adept at using digital tools. Their fluency extends to collaborative online environments, making them resilient to leveraging digital platforms for communication, learning, and innovation, [9].

These characteristics drove to introducing the so-called BI-AROHA style, [10], which, in addition to the AROHA style of the learner, points out the characteristics that the learning environment should involve.

Under this perspective, the BI-AROHA style considers specific expectations of the learning style that the Alpha generation requires, namely it should be:

- Adaptive: Tailoring educational content to individual needs.
- Reflective: Encouraging students to reflect on their learning experiences.
- Open: Promoting the use of open educational resources and collaborative platforms.
- Hands-on: Providing practical experiences such as haptic devices and virtual labs.
- Authentic: Connecting learning to real-world applications.

IV. Embracing haptic interaction in HEI studies

Haptic interaction, which includes haptic feedback, engages users physically through tactile sensations to draw attention to actions performed and reinforce new behaviors, [11-13]. This interaction utilizes the tactile, auditory, and visual senses through touch, enhancing user engagement and learning. By creating habits that integrate these sensory inputs, haptic interaction opens new neural possibilities, fostering a more immersive and comprehensive experience. This multisensory approach can significantly impact how users interact with digital environments, improving their understanding and retention of information.

To integrate haptic interaction effectively, HEIs should consider the following steps:

1. Incorporating Virtual Labs: Use haptic devices in virtual labs to simulate real-world experiments and environments. This is particularly useful in fields like engineering and environmental science, where tactile experience is crucial.

2. Enhancing Interactive Simulations: Develop interactive simulations that leverage haptic feedback to teach complex concepts in a more engaging and intuitive manner.

3. Training Educators: Provide training for educators to effectively use haptic technology in their teaching, ensuring they can create and manage interactive learning experiences.

4. Encouraging Active Learning: Design courses and activities that encourage students to take an active role in their learning, utilizing haptic devices to explore and experiment with course material.

Leveraging haptic technologies can dramatically enhance the learning experience in HEI's studies. By providing students with tactile feedback and immersive simulations that mimic real-life scenarios, haptic technologies empower them to grasp complex concepts more effectively. This approach not only aids in comprehension but also equips students to tackle the practical challenges they will face in their professional careers.

To adequately prepare for the Alpha generation, universities with a technological focus must move beyond the traditional STEM curriculum and embrace a STEHEAM (Science, Technology, Engineering, Humanities, Ethics, Arts, and Mathematics) framework, [14]. This expanded approach fosters a well-rounded education, equipping graduates with the critical thinking and problem-solving skills necessary to navigate the complex challenges of the modern world. Adopting a STEHEAM framework and incorporating these elements ensure that universities are preparing to receive the Alpha generation successfully in a rapidly evolving and interconnected world.

• Integrating Humanities: By incorporating courses that emphasize critical thinking, cultural awareness, and communication skills, universities can help students understand the societal context and broader implications of technological advancements. This ensures that future engineers and scientists can not only develop innovative solutions but also consider the ethical and human impact of their work.

• Emphasizing Ethics: Developing curricula that delve into the ethical considerations surrounding technology and engineering is crucial. This equips students to make responsible decisions regarding the development, use, and potential consequences of emerging technologies.

• Promoting Aesthetics: Encouraging creativity and design thinking by integrating arts into the curriculum fosters innovation and allows students to explore the aesthetic dimensions of technology and engineering. This can lead to the development of more user-centered and visually appealing technological solutions.

• Encouraging Interdisciplinary Learning: Universities should cultivate an environment that fosters interdisciplinary learning, where students can engage in projects that combine elements of all the STEHEAM disciplines. This encourages a more holistic understanding of real-world problems and allows students to develop solutions that draw on diverse perspectives and skillsets.

V. Leveraging visual and digital literacies

Digital literacy is a set of skills that allows a person to use technology and information effectively. It involves a combination of technical and cognitive abilities to find, evaluate, create, and communicate information using digital tools and platforms. Digital literacy is crucial in today's world because of the vast amount of information available online, [15]. It empowers people to be informed citizens, effective learners, and responsible users of technology. Some key aspects of digital literacy include:

• Finding Information: Being able to effectively search for information online using search engines and navigate websites to locate relevant and trustworthy sources.

• Evaluating Information: Critically analyzing information encountered online, assessing its credibility, accuracy, and potential bias.

• Creating Information: Using digital tools to create content, such as documents, presentations, or multimedia projects.

• Communicating Information: Effectively communicating ideas and information using digital tools and platforms, including email, social media, and collaboration software.

Visual and digital literacy go beyond basic digital skills, offering a powerful toolkit for navigating the complexities of the online world. This combined expertise empowers individuals to not only search for specific visuals, like infographics or data visualizations, but also to critically evaluate their credibility based on the source, context, and the information presented. Furthermore, visual literacy principles combined with technical proficiency in digital tools enable creation of impactful multimedia content. Ultimately, this comprehensive literacy fosters critical engagement with digital media, allowing users to analyze the use of visuals in social media posts, online ads, and other digital content, decipher their purpose, and identify potential biases.

To address the critical viewing skills and digital literacies of the Alpha generation, universities should, [16,17]:

1. Incorporate a variety of visual aids such as infographics, animations, interactive diagrams, and simulations to complement traditional teaching methods. This caters to the visual learning preferences of the Alpha generation and fosters stronger engagement with complex concepts.

2. Utilize digital learning platforms that offer interactive and multimedia-rich content, including simulations, gamified elements, and collaborative features. This allows students to engage with material in various formats, promoting active learning and knowledge retention.

3. Encourage students to create digital content as part of their coursework, such as infographics, presentations, or even short videos. This fosters skills in digital communication, collaboration, and storytelling. Additionally, students can explore using different digital tools to express their ideas.

4. Design projects that require students to use both visual and digital tools to solve problems and present their findings. This could involve tasks like creating data visualizations, designing interactive prototypes, or developing multimedia presentations. By applying these skills in a practical context, students solidify their understanding of visual and digital literacies.

5. Integrate dedicated courses or modules focused on critical media literacy. These should teach students how to analyze and interpret visual content, identify biases, and understand the purpose behind different media messages. This empowers students to become discerning consumers of information in the digital age.

6. Develop workshops and resources that equip students with the skills to effectively evaluate online information. This includes teaching them how to identify credible sources, verify information, and avoid falling prey to misinformation and disinformation.

7. Integrate digital citizenship education into the curriculum. This should cover topics like online safety, responsible online behavior, cyberbullying prevention, and digital privacy. By fostering responsible digital citizens, universities can prepare students to contribute positively to the online environment.

VI. Technology Integration and Adaptive Learning

The integration of technology is at the forefront of future learning methodologies, enhancing accessibility, engagement, and efficiency, [18-20]. Immersive technologies such as virtual reality and augmented reality create engaging learning experiences, particularly in disciplines where simulations can replicate real-world scenarios. Artificial intelligence further enhances this process by enabling adaptive learning systems that analyze student performance data to provide personalized instruction, real-time feedback, and automated assessments. Haptic feedback devices offer a multisensory approach to learning and are particularly relevant in STEM disciplines, allowing students to engage with virtual experiments and improve cognitive retention. The Internet of Things contributes to this transformation by facilitating smart classrooms where interconnected devices monitor student engagement and optimize learning conditions. The seamless integration of these technologies is essential in fostering a learning environment that adapts to the diverse needs of students, [21-22].

Adaptive learning leverages artificial intelligence and data analytics to customize educational experiences based on individual student needs. These systems continuously monitor progress, identifying learning gaps and tailoring content accordingly. Personalized learning paths enhance motivation and skill development, ensuring that students advance at an appropriate pace while receiving the support they need to succeed. In disciplines like environmental science and engineering, adaptive learning is particularly useful for fostering problem-solving skills and continuous skill refinement. Implementation involves establishing technological infrastructure, training educators, integrating adaptive learning into curricula, and continuously updating systems based on feedback. The effectiveness of adaptive learning is demonstrated by real-world applications such as Carnegie Mellon University's Open Learning Initiative, Arizona State University's Adaptive Learning Platform, and Knewton's Adaptive Learning Technology, which have significantly improved student engagement and retention.

VII. Multimodal Learning and Other Educational Aspects

Multimodal learning recognizes the diverse ways in which the students engage with information and incorporates various instructional methods, [23-24]:

- Blended learning combines traditional instruction with digital resources, offering flexibility and increased engagement.

- Flipped classrooms further this approach by allowing students to engage with instructional content outside the classroom while dedicating in-class time to discussions, collaborative exercises, and hands-on projects.

- Gamification introduces game elements into learning, such as rewards and challenges, to enhance motivation and participation, while competency-based education focuses on skill acquisition rather than time-based progression, ensuring mastery of a subject before students advance.

- Inquiry-based and problem-based learning encourage students to engage in real-world problem-solving activities, particularly in fields like environmental sciences and engineering.

These strategies enhance critical thinking while allowing learners to apply their knowledge to practical contexts. The evolution of learning environments supports this shift by incorporating modular classrooms, hybrid learning platforms, and interactive spaces that foster engagement and personalization.

Finally, diversity and inclusivity play a fundamental role in future learning, [25]. Inclusive education ensures that students from diverse backgrounds have equal access to learning opportunities, guided by Universal Design for Learning principles that inform the development of accessible teaching strategies.

Student engagement and motivation are closely linked to these efforts, requiring interactive assessments, collaborative projects, and real-world applications to foster intrinsic motivation. Incorporating ethics into curricula further ensures that students develop a well-rounded understanding of their disciplines' societal impacts, especially within a framework that integrates humanities and ethics alongside science and technology.

VIII. Case Study: The ERASMUS+ CBHE LESLIE Project

One of the significant CBHE projects financed by the European Education and Culture Executive Agency (EACEA) is LESLIE (Land Management, Environment & Solid Waste: Inside Education and Business in Central Asia, ERASMUS-EDU-2023-CBHE-STRAND-1). This ambitious initiative brings together 14 partners from five countries within a multidisciplinary consortium that integrates universities, research centers, and Ministries of Higher Education from Kazakhstan and Uzbekistan. The project is structured to ensure the feasibility of its outputs and the sustainability of its results, leveraging the strengths of institutions across Europe and Central Asia, including key universities in Spain, Italy, and Cyprus, alongside leading educational and research entities in Kazakhstan and Uzbekistan, [3,10].

The LESLIE project is designed to address critical educational gaps in Central Asia by developing micro-credentials and digital educational tools on Sustainable Land Management (SLM). This initiative aims to modernize the

academic offerings at both the Bachelor's and Master's levels while aligning with the most recent international standards and industry demands. By integrating contemporary pedagogical methodologies and technological innovations, LESLIE is setting a new standard for higher education in the region.

A cornerstone of LESLIE is its commitment to integrating cutting-edge educational technologies. Recognizing the importance of digital transformation, the project fosters the adoption of online learning tools, digital repositories, and interactive learning platforms. Many Central Asian universities have only recently begun implementing online education, and LESLIE seeks to accelerate this transition by equipping institutions with the necessary digital infrastructure and pedagogical expertise. Universities are developing media centers for high-quality video materials, while ministries are establishing frameworks for online and distance education through Learning Management Systems (LMS) such as Moodle and HEMIS.

The pedagogical shift facilitated by LESLIE is deeply rooted in student-centered learning. The project promotes active learning approaches such as inquiry-based learning, project-based learning, and competency-based education. By adopting a STEHEAM (Science, Technology, Engineering, Humanities, Ethics, Arts, and Mathematics) framework, LESLIE expands upon the traditional STEM model to incorporate crucial interdisciplinary components.

Ethics is emphasized as a core competency in engineering and environmental studies, ensuring that students develop a sense of responsibility and sustainability consciousness.

Humanities and aesthetics are also integrated to nurture creativity and contextual understanding of technological advancements.

The practical applications of SLM education under LESLIE are particularly relevant given the environmental and economic challenges faced by Central Asian countries. Issues such as climate change, inefficient land management, water resource depletion, and waste management necessitate innovative solutions that combine scientific knowledge with policy-driven action.

The curricular development of LESLIE incorporates case studies, simulations, and interactive projects to ensure that students acquire both theoretical knowledge and practical skills.

Moreover, the project aligns with the European Commission's Green Deal, [26] and the broader agenda of sustainable development goals (SDGs), [27], making it a transformative initiative in the region.

Beyond educational content, LESLIE fosters the creation of a Sustainable Land Management Hub, which will serve as a knowledge-sharing platform connecting universities, industry stakeholders, and regulatory bodies. This hub will support interdisciplinary collaboration, enhance research initiatives, and provide a conduit for industry-academia partnerships, ensuring that the educational advancements introduced through LESLIE translate into tangible environmental and economic benefits.

LESLIE exemplifies the principles of future learning through its integration of pedagogical innovation, digital transformation, and interdisciplinary education. The project is not only modernizing academic programs but also reinforcing institutional capacities, fostering international collaboration, and ensuring the long-term sustainability of its outcomes.

V. Conclusions and Recommendations

The integration of adaptive learning, multimodal strategies, and inclusive practices enhances educational experiences and students' outcomes. Institutions should invest in digital learning technologies and encourage cross-disciplinary collaboration to ensure effective implementation.

The LESLIE project serves as a prime example of an ERASMUS+ CBHE initiative that successfully integrates these elements, highlighting how adaptive technologies, inclusive pedagogies, and interdisciplinary collaboration prepare students for the evolving demands of higher education and the professional world.

Embracing these innovations seems the way to effectively prepare students for the challenges and opportunities of the future educational landscape.

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