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Mapping out digital skills gaps for widening integration of XR resources in healthcare education

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Abstract. Increased engagement and immediate spatial information uptake make eXtended Reality (XR) resources readily useful for a wide range of healthcare education use cases. A core obstacle for their increased uptake in healthcare higher education curricula is the lack of the necessary digital skills and institutional visibility to healthcare education stakeholders. This panel aims to initiate a structured dialogue in the immersive learning research community. Targeted at all healthcare higher education stakeholders it will map out perceptions of digital skills requirements for XR in higher healthcare education. Panelists, at the epicenter of healthcare higher education and industry will present all aspects of the digital skills gap and frameworks for digital upskilling in the context of XR technologies in healthcare. Discussions, combined with digital polling, will provide a live snapshot of the immersive learning research community, regarding digital upskilling needed for ubiquitous integration of XR resources in healthcare higher education.

Keywords: Healthcare, Education, Extended Reality, Virtual Reality, Digital Skills, Higher Education.

1 Introduction

The successful and sustained integration of XR resources into healthcare courses is a multifaceted endeavor. Contemporary healthcare education has advanced considerably, utilizing a variety of instructional methods and activities within the ICT sector [1]. This motivation arises from the need for unrestricted global access to clinical skills [2]. The implementation of virtual, augmented, and, more recently, mixed reality (VR/AR/MR) technologies has significantly influenced the domain of immersive medical education. Defining these immersive technologies might be challenging due to their occasional overlap. The medical field was among the first fields to explore the possibilities of immersive technological ecosystems. In 2019, the Royal College of Physicians acknowledged virtual reality as a "...powerful educational tool for defined learning objectives..." [3] and outlined many applications in medical education and surgery. The global virtual reality market was valued at $3.1 billion in 2019 and projected to expand to $57.55 billion by 2027. Immersive content can be utilized in healthcare education for various subjects and competencies. Nonetheless, this necessitates the comprehensive design and development of these tools to initially assess and then implement them in practice. A previous study revealed that the cost for the development and implementation of VR training programs for hospital-based healthcare professionals was around $106,387 [4]. Considering the potential for reutilization of VR resources, this was regarded as a favorable approach. Medical knowledge and training are continually evolving, and need regular revisions to ensure accuracy, adherence to evidence-based practices, and alignment with advancing clinical guidelines, technologies, and educational standards.

2 Context of the panel; Healthcare Higher Education and Immersive Technologies Uptake

2.1 Identifying the Stakeholders and Key actors

Successful and sustainable implementation of XR resources into healthcare curricula and is a multidimensional effort. Different stakeholders are involved in the development and delivery of such resources, and their complementary knowledge, competencies and understanding are vital for the effective incorporation of the resources into educational practice. While understanding of the implementation and key roles are not always clear, even within the stakeholders themselves, we identified (Table 1) the following broad roles that cover different aspects of creation and implementation of XR resources, that cover the Context/Environment, the Scientific Expertise, the Pedagogy, the Design and Development of the Content, the Digital Development of the resource and hosting platforms and the Delivery into educational practice.

Table 1. Stakeholders for XR Integration in Healthcare Higher Education.

	Context/ Environment	Scientific Expertise	Pedagogy	Content Co-Design and Development	Digital Development
Academic	X	X	X	X	
Student				X	
Learning Technologist			X	X	X
Policy Makers	X				
Software Engineers			X	X	X

Academics. Are the core stone of Higher Education who bring in scientific expertise into the digital transformation of Higher Education. These are the content experts, the tertiary institutions' educators, the people who have the duty to take subject matter knowledge and transform it to learning objectives and then achieve those learning objectives through educational activities. While there are ongoing efforts for continuing professional development on Teaching and Learning strategies there is a continuous need to upskill themselves in contemporary technologies -such as XR-, appropriate pedagogies and teaching methodologies, and co-creation approaches for the digital era of Higher Education.

Students. As the receivers of the digitalised education, are usually considered as digital natives and are expected to have a better understanding of technology and its role in their education. There is an expectation that they would be confident learners, and they would start using any technological advancements used in their education, however often they do not have the appropriate technical skills, ethical understanding for the use of specific digital tools or lack the confidence to change their learning style incorporating more digital resources. Upskilling towards the use of XR resources is crucial to embed immersive experiences into their learning.

Learning Technologists. The "third space" professionals in Higher Education are bridging the gap between technology and pedagogy. Having different professional titles across educational institutions such as education advisors, learning designers and others [5], they bring together digital and pedagogical competences leading to pedagogical implementation of technologies into the educational practice. Among other tasks they support innovation in education and act as a catalyst for the design and digitalisation of the curricula. They provide guidance to academics on how new technologies can be effectively and pedagogically sound used, they occasionally take the role of trainer to their institutions and are the content creators, converting the specialised knowledge of the academics to quality digital resources, sorting out all the "technicalities" and facilitate co-creation approaches. They usually advise on the complexities of cost vs effectiveness of the implementation of new technologies into practice and are responsible for maintaining the resources over time. As the Learning technologist be the interlink between technology and pedagogy keeping them upskilled both in terms of technological advancements and pedagogical approaches are vital for successful development and delivery of XR resources.

Policy Makers. Both at Institutional and at Professional level, in a digital transformation era for Higher Education, play a vital role in ensuring that the necessary regulatory frameworks, safety, ethics and privacy guidelines are in place. For example, quality assurance committees for the healthcare curricula should have the necessary guidelines to ensure alignments with institutional policies. Since Healthcare Education is regulated by Professional Bodies, they should detail their guidance on the role of innovative technologies both in terms of the amount of virtual against physical training, but also on the type of proficiencies that are acceptable to be acquired through XR resources. Thus, there is a need for Policy Makers to familiarise themselves with XR technologies and understand their possible uses to ensure a regulated, safe and ethical context/environment.

Software Engineers. Are the ones designing and creating digital platforms and educational software with the intention of being used in educational practice. Usually, they are part of company and rarely part of the Higher Institution. Their aim is to produce working, sustainable products usually designed with minimum involvement of workings, leading to partially disconnected educational digital products from the real educational practice. Therefore, upskilling in terms of co-design methodologies, pedagogies suitable for educational XR resources and their delivery in practice will complement their existing skills on software design and development.

2.2 Digital Skills Frameworks; Adapting for XR Integration

The nature of university educators' digital capabilities and the appropriate ways to enhance them in HE is a topic of controversy [6]. Most frameworks for digital competency were created especially for secondary education, and the field has just lately focused on HE competencies [7]. In response to this gap, the Higher Education Digital Competence (HeDiCom) framework, grounded in the comparison and integration of various international standards and frameworks for digital competence, was developed with the aim of serving as a common reference for digital competence of university educators. By doing so, HeDiCom seeks to facilitate the professional development of university educators, enhance the transparency of what is expected of them and support the development of their expertise [8], [9]. A primary distinction between HeDiCom and other digital competency frameworks, such as the European DigCompEdu Framework [10] and the ISTE Standards [11], is that most of these were published prior to COVID-19. In contrast, HeDicCom explicitly positions online and blended learning as central models of contemporary HE. Accordingly, skills required to the design, development and pedagogical orchestration of online and blended learning environments for HE is particularly emphasized, especially within the dimension of Professional Learning [12],[13]. While another relatively new digital competency covered in the HeDiCom Framework is computational thinking which has gained increasing attention in recent years [14].

Apart from the conceptual contribution, HeDiCom was also used empirically as a structuring reference in the investigation of university educators' digital educational needs in the Greek HE context [15]. In this framework, HeDiCom was treated not as a prescriptive checklist but rather as an analytical lens guiding systematic elicitation, organization, and interpretation of educators' perspectives in developing digital competence. The framework, through a consensus-oriented Delphi approach, supported the identification and thematic clustering of the digital educational needs across its four core dimensions to reach a coherent mapping of priorities without constraining participants' responses to predefined indicators. This use of HeDiCom demonstrates its applicability in needs assessment processes and the capacity to accommodate context-specific characteristics of national higher education systems such as those of Greece.

2.3 Pitfalls of XR Resources' Integration in Healthcare Education

As previously indicated, academic initiatives for immersive healthcare education are fraught with faults and challenges. The issues primarily pertain to the difference in scope between the fundamental mission of an academic institution and the essential prerequisites for sustainable and ongoing product development.

The primary problem in sustaining a consistent rate of content development in an academic setting is the justification of costs and availability to resources. Custom educational resources may be suitable; nevertheless, the expenses associated in developing and sustaining a portfolio within an academic institution exceed what operational budgets can accommodate. Financial and human resources must be purposefully allocated for development. Virtual Reality Developed resources are not reutilized throughout educational episodes and modules, necessitating ongoing committed investments. This is typically considered outside the parameters of an academic institution's allocated budget. Although it is viable to create such materials for a time-constrained project, maintaining a consistent rate of ongoing content generation across an academic institution to meet comprehensive curricular requirements is presently financially impractical.

The difficulty of unreliable development, which is essential to the character of human capital in academic institutions, is contingent upon the preceding obstacle. Academic institutions occasionally gain advantages from amateur content creators, whether they are passionate, tech-savvy educators or students eager to adopt technological advancements. Accessible content development tools, including modern game engines and XR APIs, significantly assist enthusiastic amateurs who independently generate instructional resources in an ad-hoc manner. Although these initiatives initially enhance content generation capability, they often stagnate as the demands of live software maintenance, updates, and ongoing development become apparent. These issues demonstrate that the academic sector itself lacks the capacity to ensure sufficient and constant supply of immersive healthcare training content.

3 The Panel

The panel's audience is implicitly outlined in section 2.1. Defining the digital barrier that inhibits proliferation of immersive modalities in healthcare education requires feedback from members of these stakeholder groups that are going to participate in iLRN2026. Thus, the expected audience for the panel will be:

- Higher education teachers and learners, especially healthcare oriented, provide feedback on what they are actually missing for integrating immersive modalities in the educational process.
- Educational Technologists, that can provide important feedback on the pedagogy/technology link that can make immersive resources integral in the classroom.
- Immersive content creators, that can provide best practices and experience for linking content creation from the industry to the academic sector
- Digital Industry Stakeholders that are uniquely positioned to tackle the issue of sustainable development and maintenance of digital resources and the skillset required to achieve industry academia collaboration.

3.1 Panelists

The panel will consist of Panagiotis Antoniou (PA), Stathis Konstantinidis (SK), Ioanna Dratsiou (ID), Athanasios Raikos (AR) and Panagiotis Bamidis (PB). The panel will be moderated by Panagiotis Antoniou.

Panagiotis Antoniou. Is postdoctoral research associated with a wide research portfolio. He has extensive experience in leading design and development of immersive digital content for healthcare education. He has led and contributed several enhanced healthcare education projects. He has authored more than 100 scientific publications in journals and conferences, several of which are in the field of enhanced immersive healthcare education in technology. In the panel PA will focus on identifying the necessary methodological and technological tools and means for integrating effective XR resources in healthcare education.

Stathis Konstantinidis. Is an Associate Professor in e-Learning and Health Informatics at the University of Nottingham in the UK. He serves as the Lead of the Future Health Research Group, the Global Engagement Lead in the School of Health Sciences, and as an academic member of the HELM team. His research spans several interconnected themes related to digital innovations in healthcare and education, supported by numerous EU-funded research projects in which he has acted as Project Coordinator and Principal Investigator. In the panel, he will focus on the role of stakeholders and their digital upskilling needs for integrating effective XR resources into healthcare education.

Ioanna Dratsiou. Is a research associate and a PhD candidate focusing on the professional development of university educators' through tecno-pedagogical upskilling. She has strong experience in digital pedagogy, educational innovation, and the pedagogically grounded implementation of technologies across the health and education sectors. In the panel, ID will contribute to the perspective of a Learning Technologist, identifying the usefulness of digital skills frameworks and emphasizing the digital and pedagogical prerequisites required for the effective pedagogical integration and sustainable implementation of XR resources in healthcare education.

Athanasios Raikos. Is a physician, anatomist and academic with extensive experience in anatomical sciences education, curriculum design, and technology-enhanced learning. His work focuses on the integration of immersive XR technologies, three-dimensional visualization, and clinical simulation into undergraduate and

postgraduate medical curricula, with an emphasis on aligning educational innovation with learning outcomes and clinical competencies. In parallel, he has been actively involved in entrepreneurial initiatives in the XR medical education sector, including the development of the world's first VR anatomy application, contributing to the design and delivery of scalable digital solutions for the education and clinical training market. In the panel, AR will contribute the perspective of a clinician-educator and industry innovator, focusing on curricular alignment, pedagogical value, and the role of industry in offering effective and sustainable XR solutions for healthcare education and clinical training.

Panagiotis Bamidis. AProfessor of Medical Physics, Informatics and Medical Education and Director of the Lab of Medical Physics and Digital Innovation in the School of Medicine of the Aristotle University of Thessaloniki (AUTH), Greece. He designs, implements, and evaluates Digital Health and Assistive Technologies that enhance everyday functioning, health, and quality of life for older adults and other vulnerable populations, while advancing medical and health professions education through digital technologies. He is the coordinator of more than 12 large European projects, and the principal investigator for many national and international funded projects (>100 in total, 5 of which are Joint Actions in e-Health/Digital/Integrated Heath). He is the President of the Hellenic Biomedical Technology Society, HL7 Hellas and the co-chair of Athens Digital Health Week series of events. He founded ThessAHALL, Living Lab, a member of the European Network of Living Labs (ENoLL). In the panel, PB will present a roadmap for curricular integration of XR resources in healthcare HE.

3.2 Format

The panel will be following a straightforward format for participatory dialogue between the panelists and the audience. Each panelist will focus on a specific aspect of the topic. They will open with a short presentation, no more than 5 minutes, which will set the stage for the interaction with the audience. Closing this presentation each panelist will present the audience with one or maximum two questions in a digital polling app (e.g. Mentimeter) regarding their feedback on their topic and will comment on the feedback for the next couple of minutes. Responses from the audience will be cast live through the presentation projector. After that, the floor will open for comments and discussion from the audience and between the panelists, closing the total time of each panelist to 10 minutes. Then the next panelist will continue with the same format. The order of the panelists and their themes are summarized in Table 2. The feedback gathered will be aggregated and thematically analysed by the panelists for future insights. Through this format, the panel will provide both a fertile environment for dialogue and it will extract usable data for the perceptions of the immersive learning community regarding the needs of healthcare higher education for higher uptake of XR and other immersive technology modalities for learning (Table 2).

Table 2. Panelists and Topics.

Panelist	Topic
Stathis Konstantinidis	Identifying healthcare higher education stakeholder roles in the adoption of XR.
Ioanna Dratsiou	Identifying the usefulness of digital skills frameworks in adoption of XR in healthcare education.
Athanasios Raikos	Identifying business-academia inflection points for seamless XR integration in healthcare education
Panagiotis Antoniou	Mapping the obstacles of XR resources' integration in healthcare education
Panagiotis Bamidis	Identifying a roadmap for curricular integration of XR resources in healthcare higher education

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