EXPERIENCES ON THE CREATION OF A MULTI-DISCIPLINARY COURSE IN A METAVERSE ENVIRONMENT

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ABSTRACT

COVID-19 and climate change have both influenced the way we will organize higher education in the future. Turku University of Applied Sciences has developed its own metaverse technology to be used in higher education and industrial competence training. In this paper, we will report how this technology has been adapted to the requirements of higher education in medical sciences and health technology as part of the international Erasmus+ funded Artificial intelligence, innovation & society (AIIS) project which identifies a requirement for immersive multi-user learning. The AIIS project's main objective is to provide a course for medical students and health technology engineering students, where AI, innovation, and soft skills will play a key role, promoting the integration of the course into European universities' curricula. Combining metaverse technology with students from medical and engineering disciplines will allow us to simulate real-life problem-solving very closely while offering participants the unique possibility to deepen their professional understanding and multidisciplinary knowledge. The project´s goals support CDIO's idea on providing integrated learning experiences (standard 7) and active learning (standard 8). This paper outlines our pedagogy considerations based on a sound theoretical framework and how we translated these considerations to suit the constraints and opportunities afforded by a metaverse environment that should be appropriate for both desktop and virtual reality headset users. Moreover, we examine content formatting, course pacing, assessment, and knowledge origin as the key elements of a typical learning landscape and how to adapt these for a metaverse setting. Additionally, to confirm the design choices for content and task presentation in a metaverse, this paper briefly gives the headline results of a large-scale pilot that was run at the time of this writing. Our paper contributes a comprehensive first draft pedagogy model for a metaverse collaborative learning environment, providing a practical contribution for educators venturing into metaverse-based teaching and a theoretical springboard for researchers to further enhance the body of knowledge concerning contemporary education technologies.

KEYWORDS
Metaverse, Collaborative learning, Virtual learning environment, Artificial Intelligence, Standards: 7, 8

INTRODUCTION

Notwithstanding the influence COVID-19 and global warming have had on how higher education institutions organize their teaching practices, we cannot lose sight of the fact that today's learners are highly digitized members of a knowledge-based society where information lies at a click of the mouse, a stroke of the keyboard, or tap of the finger (Karakas, Manisaligil, & Sarigollu, 2015). However, with an abundance of available knowledge, there comes a real risk for information overload. As such, today's learners are drawn to concise information sources (Newman, 2010) Our learners do not mind rapidly diverting their attention to satisfy their acute curiosities and will easily skip over sources that place unnecessary cognitive strain through, for example, long-winded explanations, tedious context establishment, or elaborate analysis breakdowns (Molyneux, 2018) Turku University of Applied Sciences has developed own metaverse technology to be used in higher education, and industrial competence training. We have defined metaverse to be a combination of social communication, hands-on-training, and real-life integration (Luimula, 2022).

Virtual reality (VR) has both advantages and disadvantages versus a simple 2D graphics or other approaches. For example there is no overall task-workload difference between traditional visualizations and visualizations in VR, but there are differences in the accuracy and depth of insights that users gain (Millais, Jones, & Kelly, 2018). In addition, when analyzing whether and how the delivery mode of an identical video game in either 2D, 3D, or virtual reality (VR) impacts players' game evaluation as well as the brands that are placed in the game, presence was highest in the VR video game and lowest in the 2D video game. The results indicate that 3D and VR lead to higher presence, i.e. to a pronounced feeling of "being in the game", but game evaluation did not differ between the 2D, 3D, and VR version (Roettl J, 2018). Furthermore, previous studies (Banos et al., 2008; Bartsch, Mangold, Viehoff, & Vorderer, 2006; Gorini, Capideville, De Leo, Mantovani, & Riva, 2011; Marín-Morales, Llinares, Guixeres, & Alcañiz, 2020) have suggested that VR can elicit emotions in different visual modes using 2D or 3D headsets. Tian et al. research finds that the emotional stimulus in the stereo vision environment would affect people's perception and presence of the virtual reality environment to a greater extent, which would thereby generate greater emotional arousal (Tian, 2021).

This paper explores the metaverse potential in the context of teaching basic artificial intelligence concepts and soft skills to medical students. This study is done under the banner of the Erasmus+ funded Artificial Intelligence, Innovation and Society (AIIS) project. The AIIS project comprises five European universities (University of Salamanca, Turku University of Applied Sciences, University of Turku, University of Mons, and the University of Thesaly) and three industrial partners (MEUS, SciFy, and GoDataDriven), and a national research network (CIBER).

In preparation for the AIIS project, it was found that medical professionals and researchers alike have identified that basic concepts of data science or machine learning are not covered in medicine curriculums due to the absence of AI professionals involved in medicine faculties. Moreover, medical professionals felt that current education is insufficient in preparing medical students to rapidly adapt to the constant stream of AI development (Wartman & Combs, 2018). Furthermore, the University of Salamanca (USAL) and their respective university hospital professionals also identified a key need to integrate soft skills training into medical curricula. USAL is the coordinating partner of the AIIS project, and Turku University of Applied Sciences (TUAS) is the lead technical partner for creating an online collaborative learning interface, using their own metaverse technology, for medical and health tech students in AI and soft skills.

When it comes to distance (or online) education, there are several key facets that we as educators must consider. Online education has: (a) learners, who; (b) engage with content through; (c) a varied supply of technological solutions to show; (d) their proficiency in a specific area of study (Nam & Jung, 2021) Educators today are targeting learners who expect and demand flexible learning options. We must attempt to provide courses that are not rigid or linear. Courses should offer relevant content tasks (Deloitte, 2018) that learners can do at will and in any order they wish during the period of their program. In addition to flexible learning content, technology and technological innovation is a natural part of our learner's world. Our learners don't mind and even expect, to use innovative devices and interfaces—provided we use them sensibly, consistently and to their learning benefit. The fourth facet of pedagogy that cannot be overlooked is assessment. With online learning, we should leave traditional summative assessments behind. Online courses should look toward new forms of assessment that harness the power of digital breadcrumbs our learners leave behind as they navigate through their courses. In essence, this paper explores how a metaverse-driven pedagogy can meet the anytime, anywhere, and any amount of content today's learners demand (de Reuver, Nikou, & Bouwman, 2016).

To address these contemporary learning habits within the need of the AIIS context, TUAS has created a learning interface that works with their metaverse technology. The AIIS interface is infused with a constructivist pedagogy centered on increased learner autonomy and a sense of competence as the primary learning motivators. The pedagogy was a co-design effort among the consortium university partners and steers toward an anywhere, anytime, and any size learning experience that will suitably engage modern learners.

This paper serves to illustrate how we applied the pedagogy considerations outlined earlier to suit the constraints and opportunities afforded by the TUAS built metaverse technology, in a way that is appropriate for both desktop and virtual reality headset users. Moreover, we examine content formatting, course pacing, assessment, and knowledge origin as the key elements of a typical learning landscape and how to adapt these for a metaverse setting. Additionally, to confirm the design choices for content and task presentation in a metaverse, this paper will briefly report the headline results of a first pilot implementation of the AIIS learning interface.

THE AIIS LEARNING INTERFACE

The AIIS project's main objective is to provide a comprehensive program for medical and health technology students, where AI, innovation, and soft skills play a key role, promoting the integration of the program into European universities' curricula. Using metaverse technology to facilitate collaboration between students from medical and engineering disciplines will allow us to simulate real life problem solving very closely. This in turn offers participants unique possibilities to deepen their professional understanding and multi-disciplinary knowledge. The project´s goals support CDIO approaches on providing integrated learning experiences (standard 7) and active learning (standard 8) (Crawley, 2014).

The AIIS learning program has a theory and a practical component. The practical component makes up a third of the work and is done outside the learning interface with mentors in the form of a machine learning task with real medical data. The theory makes up the remaining two-thirds of the workload and is studied autonomously within the metaverse AIIS learning interface. Students can access all theory material in the learning interface either through regular desktop mode or a VR headset. The theory content is offered to the students in short (maximum 15 minute) videos which are linked to interactive tasks where deeper learning of the topics occurs. There are several different task types that allow various pedagogical learning methods to be used.

The AIIS Learning Program content

The AI and soft skill modules are divided into six topics each. Every topic within the modules has between three and five theory videos coupled to tasks that students must solve. In total, there are 56 theory tasks (26 AI and 30 soft skills) that students must complete.

The AI topics include: (a) Intro to AI; (b) Expert systems and their role in the healthcare sector; (c) Intro to machine learning; (d) Machine learning in the healthcare sector; (e) Intro to machine vision; and (f) Image recognition in the healthcare sector. The AI module intends to provide participants with a high-level understanding of the AI currently prevalent in the healthcare sector. Upon completing the AI module, students will be able to:

- Critically assess the contribution various AI solutions make to their work environments.
- Have meaningful deliberation on AI propositions for the healthcare sector.
- Adapt their working practices to facilitate the integration of AI into their workplace.
- Propose new use cases within the healthcare sector for existing AI techniques.

Although the AI module does not teach the skill for developing and applying relevant AI techniques, some essential knowledge of underlying architecture, applied mathematics and programming algorithmics is introduced. This will give learners the foundational building blocks for a well-rounded understanding of the AI techniques utilized within the healthcare sector.

The soft skills topics include: (a) Self-knowledge and initiative; (b) Capacity to adapt to different situations; (c) Communication; (d) Teamwork; (e) Work organization; and (f) Work ethics. The soft skills module objectives are to make students aware of the importance of soft skills in the employment of their profession. Completing these topics will allow students to develop and put into practice the most valued skills in the sector. In completing this module, students:

- Will become aware of their thought patterns and learn some internal self-regulation mechanisms that allow them greater personal well-being.
- Learn techniques that allow them to better connect with people both verbally and in writing in two-way interactions, in small work groups, and in large audiences.
- Recognize and apply strategies to improve concentration at work, better use of time and organizational planning.
- Will become aware and reflect on medical ethics, especially within the scope of applied artificial intelligence.

As part of the certificate criteria for completing the AIIS theory component, students are required to work on at least 10 of the 56 theory tasks in collaboration with other students.

In addition to the theory topics and tasks, students also work on a specific practice related challenge. There are several challenges to choose from, each one linked to a different subject area. Every student is required to select one challenge. Each challenge requires students to apply their foundational AI knowledge from the AIIS theory component to solving a basic machine learning problem, utilizing a given real-world data set. Every challenge group ideally consists of 10 students and in working together to solve the challenge, under the guidance of a mentor, students are expected to directly apply the soft skills they acquire from the theory in the AIIS learning interface.

A walkthrough of the AIIS Learning Interface

Students who enroll for the AIIS course receive a welcome email that includes a link where they can download the local client as well as a student authentication token that permits them into the learning interface and grants them access to the modules and challenge selection area. Other token types include teachers and visitors, each with their own set of access rights.

Once a student has downloaded the client, installed it, and registered themselves with their token, they can enter the collaborative virtual learning environment (CVLE) where they are represented by an avatar. Students can choose and switch between using a first- or third-person view of the CVLE. Furthermore, students can communicate with other students in the CVLE by means of a push-to-talk mechanic when they are withing close enough proximity of those they wish to talk to.

Upon entering the environment for the first time, students find themselves in a tutorial room where they get to practice the mechanics of accessing and completing a topic task. When students complete (or skip, if they so choose) the tutorial they gain access to the main floor of the CVLE. Figure 1 shows a first- and third-person view of the AIIS CVLE bottom floor.

Figure 1: AIIS virtual learning environment first- and third-person views

The CVLE comprises three floors. The ground floor contains the AI learning material, the next floor has the soft skills material, and the rooftop is where students can select the challenge they wish to participate in. However, the challenge selection rooftop area is inaccessible for the first three weeks of the course. This gives students enough time to build some prior AI knowledge before making a challenge selection.

AI and soft skills knowledge is gained by doing tasks that students can access through tablets from dispensing machines. Each AI and soft skills topic has its own tablet dispenser and these are scattered throughout their respective module floors. That is, the six AI dispensers are on the ground floor and the six soft skills dispensers are on the floor above. Students can do any task from any dispenser at any time. In other words, the virtual learning environment pedagogy does not have a forced linear learning structure. Every topic task has a theory content video lecture with a related accompanying activity.

The only compulsory mechanic students have is that every dispenser has an unlock task students must complete before the rest of the tasks for that specific dispenser become available. Students do not have to successfully complete the unlock task, they must merely submit an effort. Furthermore, the unlock attempt is done without any theory content. The rationale behind this is that students will have an opportunity to self-assess their prior knowledge of a given topic before encountering the rest of that topic's theory content. Once an unlock task is submitted, the rest of the tasks with their respective theory content, as well as the unlock task's theory become available. The unlock task theory now serves as the content to enable students to successfully complete the unlock task.

Figure 2 shows the tablet dispenser for the Intro to AI topic, which has three tasks that students must complete. Students approach the dispenser and select the task they wish to do. The dispenser then releases a tablet students can pick up and move around with freely. The interactive tablet has a theory video for students to watch and an activity to complete that is related to the video content. The AIIS learning content currently contains 11 different activity types, including among others, crossword puzzles, diagram labelling, match the columns, concept mapping, synonym bingo, and more.

Figure 2: Tablet dispenser and tablet for the Intro to AI topic

Every task (theory + activity) has a certain number of micro-credentials attached to it, based on how long a task is expected to take to complete. In the AIIS CVLE, one micro-credential is equivalent to approximately 30 minutes of work. To complete the CVLE theory material (i.e., not including the practical challenge), a student must collect 102 micro-credentials from the 56 available tasks. Students can repeat a tasks as often as they like until a successful submission is made that earns the set micro-credentials for that specific task.

Students can track their micro-credential progress by means of a dashboard that is pervasively available while they are active in the CVLE. The dashboard contains a general view (Figure 3) that provides summary information about the learning progress on a per-module level, as well as detailed views for the AI (figure 4) and soft skills modules that present the student's progress on a per-task level. The dashboard also contains explanatory videos to guide students with the mechanics of the AIIS CVLE, as well as introductory videos for each module.

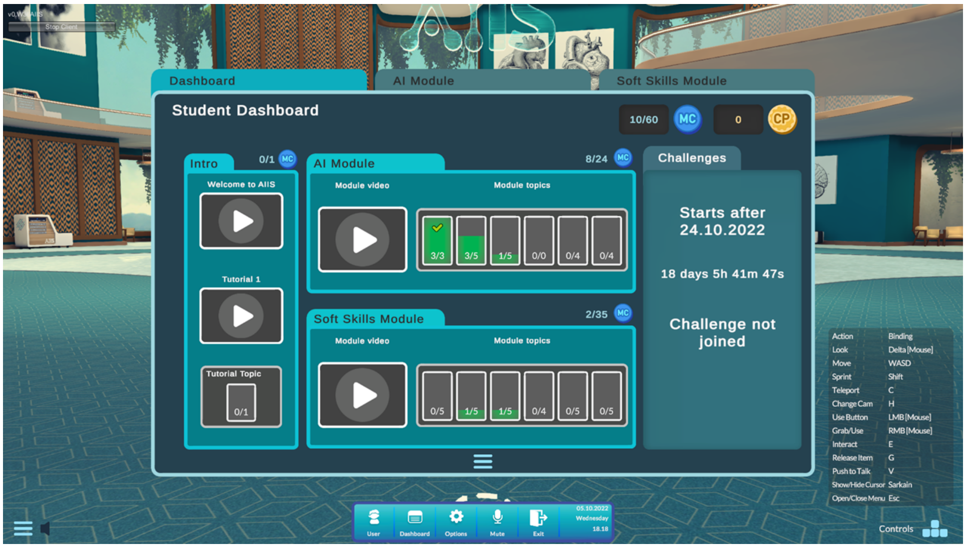

Figure 3: General view from the student dashboard

Figure 4: Detailed AI module view from the student dashboard

In addition to completing 102 micro-credentials, students must also collect at least 10 collaborator points. Students gain one collaborator point when they join a task initiated by another student. When a task is initiated, other students in the CVLE will see an indicator pole that a task has been started in that specific location with information on how many collaborator seats are available for that task. There are two collaborator seats available when a task is initiated (i.e., when the initiating student starts to interact with a task tablet). If a student wishes to collaborate, they enter the task area (indicated by a dashed circular line in the CVLE) and select the option to collaborate. Communication between the collaborators and task initiator continues with the same push-to-talk mechanic as in the rest of the CVLE, but only those within the collaborator circle can hear this conversation. The collaborator point is granted to the collaborator if they are in collaboration mode when the initiating student submits a correct solution to the task. If students exit the collaboration before the submission, they do not gain a collaborator point. Students cannot get multiple collaborator points for the same task. Only the student who initiates the task will gain micro-credentials for that task and does not gain any collaborator points, irrespective of whether there were collaborators.

The AIIS CVLE also contains reflection zones that appear next to the task dispenser of a topic for which the student has successfully completed all tasks. The reflection zones are typically a poster with additional information, latest developments, or some newsworthy content regarding the completed topic. Students are not expected to perform any activities in these reflection zones—they serve purely as points of interest for students to read and reflect on.

FIRST ITERATION PILOT PHASE

At the time of writing this paper, the AIIS collaborative virtual learning environment was piloted among 115 medical students from four of the partner universities and 10 health technology engineering students from Turku University of Applied Sciences. The engineering students were evenly divided among the challenges so that there was at least one technically experienced person in each of the challenges to ensure a smooth setup and utilisation of the architecture required to complete the machine learning challenge tasks. The engineering students also completed the CVLE theory material.

Of the 125 students who started the pilot, 96 received certificates for completing the course (a completion rate of roughly 77%). We conducted a usability and user experience survey with those who enrolled for the course and the consensus was that the AIIS collaborative virtual learning environment was an overall positive experience. A detailed analysis of the pilot and user experience survey will be published once their respective data sets have been fully analysed.

DISCUSSION

The aim of this paper was to describe the outlines of our pedagogy considerations based on a sound theoretical framework and how we translated these considerations to suit the constraints and opportunities afforded by a metaverse environment. We also examined content formatting, course pacing, assessment, and knowledge origin as the key elements of a typical learning landscape and how to adapt these for a metaverse setting. Moreover, we showed that a collaborative learning environment can be more than a simultaneous user experience. With the AIIS collaborative virtual learning environment pilot, we showed how an interdisciplinary student cohort (medical and engineering) can meaningfully collaborate to successfully complete a diversified subject set (AI and soft skills) in a virtual environment underpinned by metaverse technology.

Our paper contributes a first draft pedagogy model for a metaverse-driven virtual learning environment. This provides a practical contribution for educators venturing into metaverse-based teaching and a theoretical springboard for researchers to further enhance the body of knowledge concerning contemporary education technologies, both in general terms and more specifically under the CDIO framework. The work we presented in this paper particularly embraces CDIO standards 7 and 8. The fundamental cooperation opportunity the TUAS metaverse technology grants and the AIIS CVLE requirement for students to collect collaborator points across two distinctly different subject groups (AI and soft skills), clearly shows an integrated learning experience with a pedagogical approach that fosters the learning of disciplinary knowledge simultaneously with personal and interpersonal skills (CDIO Standard 7) (Brodeur & Crawley, 2009). The practical and continuously engaging nature of the non-linear AIIS learning experience squarely addresses the CDIO framework standard 8, whereby it is stated that active learning methods should engage students directly in thinking and problem-solving activities. Not just are the AIIS metaverse-driven theory tasks practically engaging in their own rights, but they encourage reflection, group discussion, and direct application in the practical challenge component of the AIIS learning program.

CONCLUSION

Implementing the CDIO model to metaverse technology allows for novel ways to educate. Student communication and collaboration are now possible on a level that cannot be achieved using present learning platforms. This more natural interaction enables immersive and deeper collaborative learning experiences across subjects by multiple study disciplines. In summary, virtual reality can provide added value compared to a simple 2D environment through increased immersion, spatial understanding, interactivity, presence, empathy, realism, visualization, and novel experiences. These benefits make VR an increasingly popular technology for a wide range of applications across different education domains.

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