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European Space University for Earth and Humanity

UNIVERSEH is an alliance of five European universities established to develop a new way of collaboration in the field of Space, within the "European Universities" initiative.

The alliance aims to create new higher education interactive experiences for the university community, teachers and students, and for the benefit of society as a whole. Such initiatives will enable broadminded, informed and conscientious European citizens to capture and create new knowledge and become smart actors of European innovation, valorisation and societal dissemination within the Space sector, from science, engineering, liberal arts to culture.

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4.14 Report describing different reality processing concepts impact and usability in learning

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Introduction

The aim of this report is to describe different reality processing concepts impact and usability in learning. Open education gives everyone access to high-quality educational experiences and resources. UNIVERSEH will work on eliminating barriers to this goal. by developing openly shared educational resources (WP4), while harnessing today's collaborative spirit to develop educational approaches that are more responsive to learner's needs.

Task 4.5 will build the technical foundation to achieve consortia-wide hybrid learning and virtual classroom functionality, both of which set high requirements on technical, logistical, and digital solutions. All members of the Alliance are currently with high priority exploring these innovative approaches, and the task will bring our efforts together in this area.

To deal with the need for more flexible learning and to provide a richer, more engaging remote learning experience, the creation of the synchronous hybrid virtual classroom is of importance. The concept of the hybrid virtual classroom comprises one group of learners who participates in the course on campus, and simultaneously other individual learners participate in the course remotely from a location of their own choice by connecting to the same platform (cf. Raes et al., 2020).

Our definition of hybrid and virtual classrooms is in accordance with above definition, but it also comprises that different digital tool can support both the synchronous learning processes as well as asynchronous activities. In addition, establishing social presence, or the ability of students to project their personal characteristics into a so-called community of inquiry, has proven to be very important for student satisfaction (Greenhow & Gleason, 2017).

The outline of this report is as following: first, we briefly present our method for identifying digital technical solutions. Secondly, we describe identified innovative digital technical solutions in higher education. Lastly, we give some conclusions and a brief description of future work in task 4.5.

Method

To identify different reality processing concepts impact and usability in learning we have within T4.5 hold seminars where six different concepts have been presented and discussed in relation to impact and usability in learning. Secondly, in webinars, partners in the Universeh-project have presented some different innovative digital technical solutions in higher education. These solutions will be input to WP3, the design of Universeh-courses.

Hybrid education and learning

Hybrid education is in the literature described in various ways, describing synchronous and asynchronous learning.

- Blended learning: Asynchronous online learning is used to enhance student learning between face-to-face sessions. Online instruction does not replace face-to-face time.
- Flipped learning: A type of blended learning in which students receive content, usually through recorded lectures accessed asynchronously, then use face-to-face time for active learning.
- Online education: All instruction occurs online, synchronously or asynchronously.
- Distance learning: Defined as “providing education to students who are separated by distance (i.e., who are not physically present in the same space) and in which the pedagogical material is planned and prepared by an educational institution” (Kaplan and Haenlein, 2016, p.443)
- Hybrid learning: Utilizes both online and face-to-face learning strategies in an effort to maximize both learning environments. Online learning may be synchronous or asynchronous and may replace face-to-face time.

However, hybrid learning and blended learning are two terms usually referring to one concept. Abdelrahman and Irby (2016) state that blended or hybrid learning can be seen as the use of “mixed mode of instruction”, combining traditional face-to-face instruction and pure online learning. It is observed that the online learning approach has increased, and sometimes it replaces the traditional method of learning (F2F) (Abdelrazeq et al., 2019).

We argue that hybrid education is more that replacing some course activities with digital ones. Hybrid learning is an educational model where some students attend class in-person, while others join the class virtually from home. Lecturers teach both remote and in-person students at the same time using tools like video conferencing hardware and software. Hybrid education can include asynchronous learning elements, like online exercises and pre-recorded video instruction, to support face-to-face classroom sessions. Studies shows that hybrid pedagogy is viewed as a method of teaching that utilizes technology to create a variety of learning environments for students, i.e. incorporation of technology tools both to enhance student learning and to respond to a wide range of learning preferences (Linder, 2017). A study by Olapiriyakul and Scher (2006) suggests the need for a creative balance between pedagogy and technology in designing, delivering, and providing support for hybrid courses. The concept of Technological Pedagogical Content Knowledge, or TPACK, has been offered as a framework to assist instructors in understanding how best to plan technology integration into the classroom (http://tpack.org/).

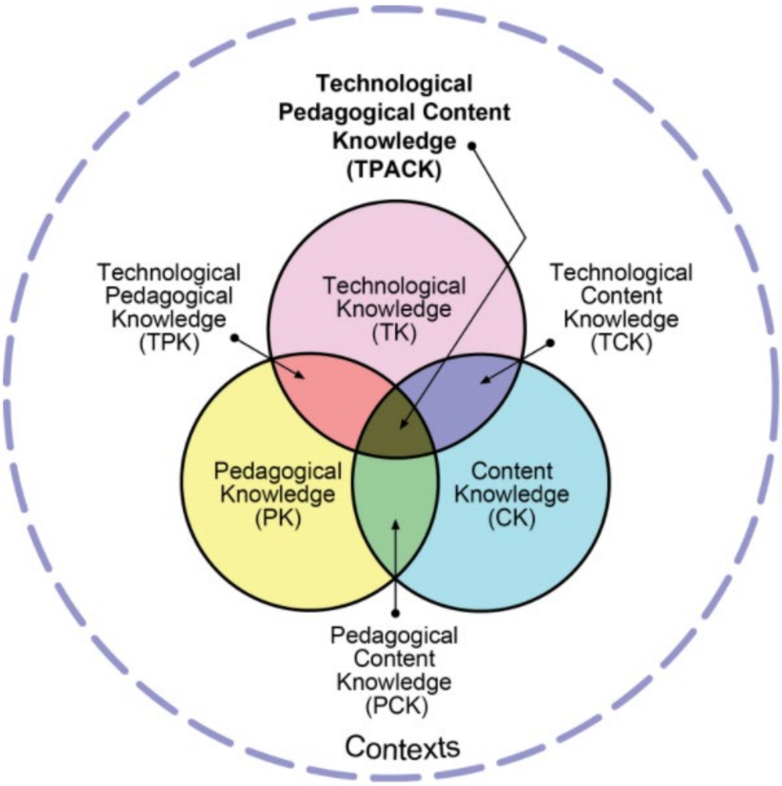

Figure 1. The TPACK framework (http://tpack.org).

The TPACK framework illustrates the complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK). It also emphasizing the type of knowledge that lie at the intersections between three primary forms: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK).

In hybrid education, technology plays an essential part, effective technology integration is needed for developing sensitivity to the dynamic, transactional relationship between these components of knowledge situated in unique learning contexts, i.e. no single combination of content, technology, and pedagogy will apply for every teacher, every course, or every view of teaching. For instance, video conferencing in general is a live video-based meeting between two or more remote parties over the internet that simulates a face-to-face meeting. Video conferencing allows multiple people to meet, interact and collaborate face-to-face long distance in real-time by transmitting audio, video, text and presentations. In higher education, and among the partners in T4.5, following systems have been used: Zoom, Teams, Hyflex, Webex, and BBB.

A study by Olapiriyakul and Scher (2006) suggests the need for a creative balance between pedagogy and technology as faculty members make decisions about how to design, deliver, and provide support for hybrid courses.

Zoom is the most frequently used system among the partners in T4.5. The system is used in distributed teaching for seminars, project meetings, team meeting. Zoom is a cloud-based video conferencing service for virtual meetings with others, either by video or audio-only or both, all while conducting live chats and sharing documents and whiteboard. It is also possible to record those sessions to view later (https://zoom.us/).

BigBlueButton (BBB) is a free software web conferencing system for Linux servers. Its intended use is online learning (https://bigbluebutton.org).

Learning Management Systems (LMSs) have gained popularity among both the educational institutes and students as a software application used for planning, implementing, and examining the whole education process (Almaiah et al., 2020). Moodle and Canvas are the well-known LMS software solutions used for not only online learning but also for organizing course material. These systems have features including student enrolment, exams, quizzes, assignments, course management, messaging, uploading course material, etc.

Among the partners in the Universeh-project, digital systems and tools for communication are mainly through the LMS, Rochetchat, e-mail, and Google workspace (for sharing documents). Different LMS are used for information and reaching a large group of students.

The opportunity for users to collaborate and explore different perspectives is an important element in the design of university courses, especially for participants who are learning or working at a distance (Herrington and Herrington 2006). Any platform used for creative online collaboration has to support a collaborative communication model at its core. However, the standard LMS have some shortcomings that often discourage their teachers from using them for courses based on intense collaboration due to strong hierarchic model and the weak tools LMS is not used for e.g. complex online project collaboration at all (Stockleben et al., 2016). Therefore, other digital tools to support collaboration and getting students to actively discuss with each other can be used, e.g. digital whiteboards like Mural, Miro, and Padlet, and chat in Microsoft's Teams.

Various technologies that enable active learning, and more specifically inquiry or experiential learning, are increasing in education. These technologies can relate to simulations or online labs, games, and modelling tools (with which students create runnable models themselves) at different levels of interactivity (also including virtual reality) (de Jong et al., 2018). However, the technologies need to be combined with other instructional approaches and assignments, scaffolds, and prompts.

Videoconferencing systems have been used since the 1970s, and researchers, developers, and designers have tried to bring video-mediated communication closer to face-to-face interaction, in an effort to simulate the feeling of actually "being there" (Choi et al., 2017). By enhancing the feeling of "being there" at a remote location, a feeling of being "presence", robotic telepresence systems offer some benefits that come from being physically present. Telepresence robots are developed in order to help a remote sender instil his or her presence more vividly for the receiver, enhancing interpersonal communication at a distance (Choi et al., 2017). One example of these telepresence robots (tried out by one of the partners in Universeh) is the so-called Kubis with the ability to pan up to 300 degrees and to tilt (up or down) up to 45 degrees. The Kubi will work with any tablet and any video conferencing platform to make video calls simpler and more engaging in business, telemedicine, and education (ww.kubiconnect.com).

Figure 2. Example of a teleprecence robot, Kubi (photo by Linda Alfredsson, Luleå university of technology).

Innovative and creative technical solutions

In T4.5 we have identified some future-oriented technical solutions for higher education and for hybrid and virtual classes supporting synchronous and asynchronous activities. These technical solutions are; Virtual Reality, AI in learning and simulation, GatherTown, Walkabout, and LUNA-lab.

Virtual Reality

Related to virtual reality (VR), there is a virtual reality educational tool in the context of mining engineering that has been tested in the mining education at Luleå University of Technology. This tool creates a vision of a reality study visit (though it is virtual) in a mining environment. Within the recent years, mixed reality (MR) technologies and devices have experienced remarkable improvements. Primarily, head mounted displays (HMD), offering different virtual reality (VR) experiences, are became increasingly popular in various domains. VR has already proven to be effective in simulating interest, improving skills acquisitions and learning in diverse fields of study; the application of VR enriches didactic approaches used in different learning and teaching setups (Abdelrazeq et al., 2019).

As an example, in a studio, it is possible to create lifelike environments for areas such as in construction, architecture, ore geology and mining and rock engineering (www.ltu.se/org/sbn/Verksamhet/Laboratorium-och-utrustning).

Figure 3. The Virtual Reality Lab at Luleå University of Technology (https://www.ltu.se/org/sbn/Verksamhet/Laboratorium-och-utrustning).

Another example of Virtual lab is related to task 4.7 and it is named IREAL (https://ireal.isae-supaero.fr/www/). IREAL stands for "Interactive Remote Experimentation for Active Learning", and it is an ongoing project whose aim is to facilitate the implementation of scientific lab experiments in an educational context, and accessible from anywhere, see figure 1. In addition, some Bring-Your-On-Device (BYOD) is used related to aerospace software.

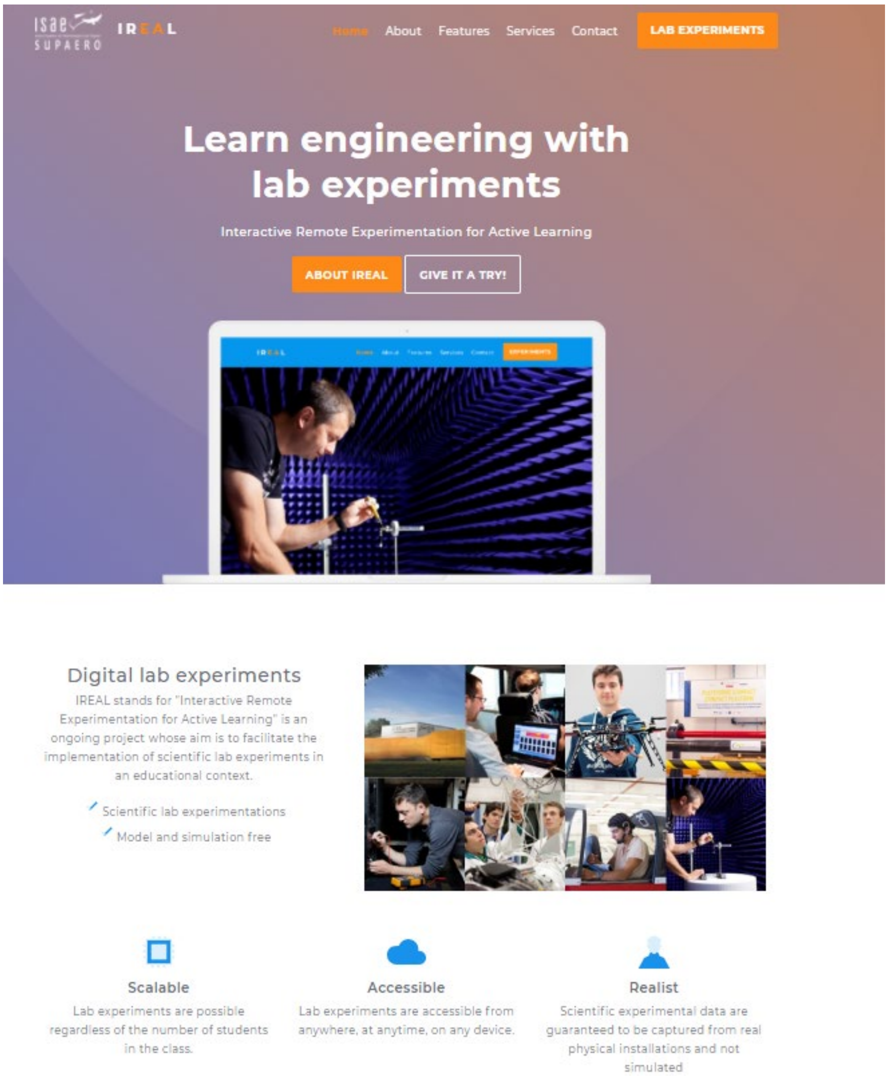

Figure 4. IREAL (https://ireal.isae-supaero.fr/www/)

AI for space simulation

Another identified tool related to virtual environments is a virtual physics-based realistic simulation environment for education in AI for Space Autonomy. It is an open-source space autonomy simulating environment with a high-performance physics engine that the Robotics and AI team at Luleå University of Technology has developed for evaluating future space autonomy concepts e.g. satellites GNC, rovers and aerial vehicles operating into other planets. This simulator can provide a super-realistic rendering of an environment in terms of physics, lighting, shadows, and textures. At the same time, it can integrate CAD models of robots, satellites, asteroids, etc. to create a realistic space mission scenario. This simulator can also model sensors that can provide observations of the simulation environment, such as monocular cameras, laser range finders, etc.

Some examples of simulations are presented in a webinar held by Sumeet Gajanan Satpute, Post Doc in Robotics and Artificial Intelligence at the Department of Computer Science, Electrical and Space Engineering at Luleå University of Technology, and the PhD-student Vignesh Kottayam Viswanathan.

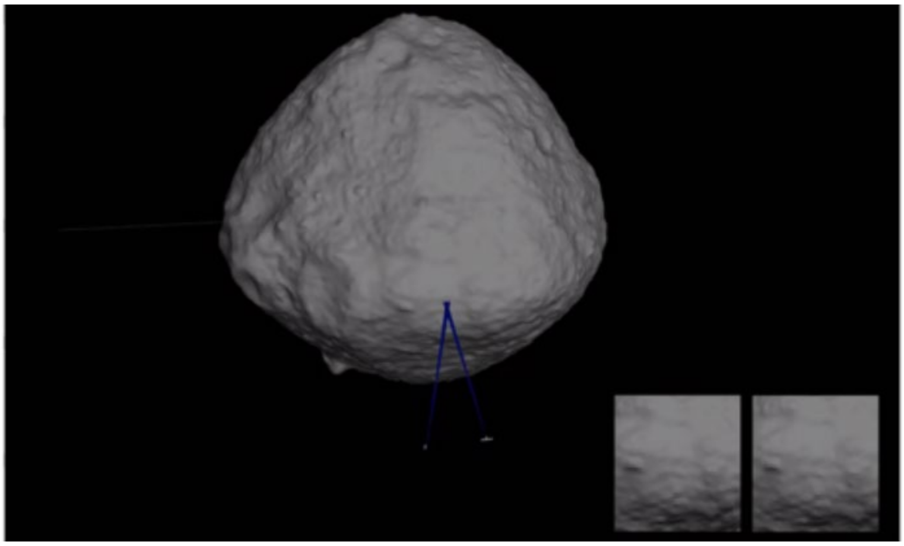

Figure 5. Stereo imaging of asteroid (Satpute and Viswanathan, 2022).

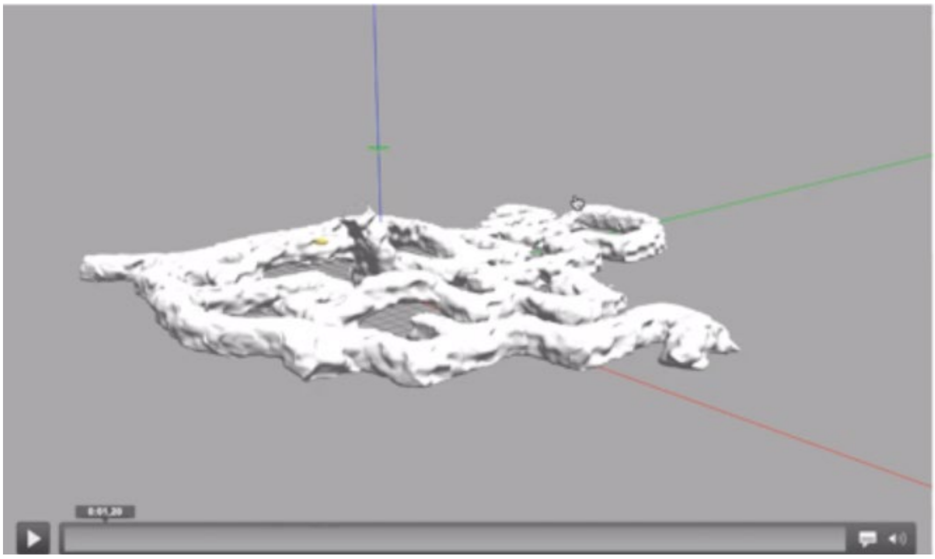

Figure 6. Lava/skylight environment (Satpute and Viswanathan, 2022).

AI in learning

Artificial Intelligence (AI) can be used in various ways in education. Hamam Mokayed, Senior Lecturer in Machine Learning at the Department of Computer Science, Electrical and Space Engineering at Luleå University of Technology, has presented in a webinar some examples of different research and implementation of AI in the learning process and education in general. Two different projects were demonstrated: iMusica and ChatPal.

For example, iMuSciCA is a pioneering approach using music for fostering creativity and deeper learning. The project adds the ability of problem solving in STEM sciences using AI. Problem-solving is one of the key skills for the 21st-century job market. STEM (Science, Technology, Engineering and Mathematics) teaching rely on the left half of the brain and thus is logic driven. Artistic activities, which uses the right side of the brain fosters creative problem-solving. STEM education is necessary but it is not sufficient, iMusica plays the role to make the learning process easier by linking the scientific concepts with the arts (STEAM).

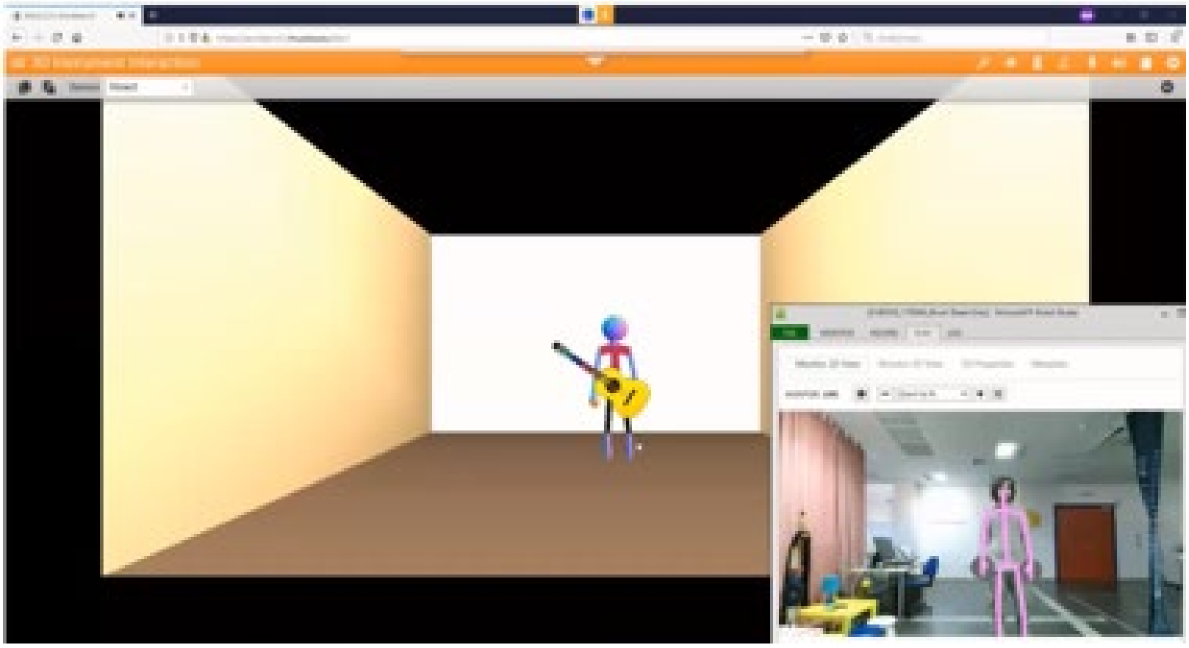

Figure 7. Using AI power to play music (Mokayed, 2022).

Another example, ChatPal is a project that helps in answering queries students generally ask like lesson plans, course modules, assignments, and their deadlines. With more advanced features, ChatPal is able to Identify the areas that students are lacking and requires efforts, then it will provide the teacher with an opportunity to figure out areas they can improve their teaching abilities as well, see example of chat below.

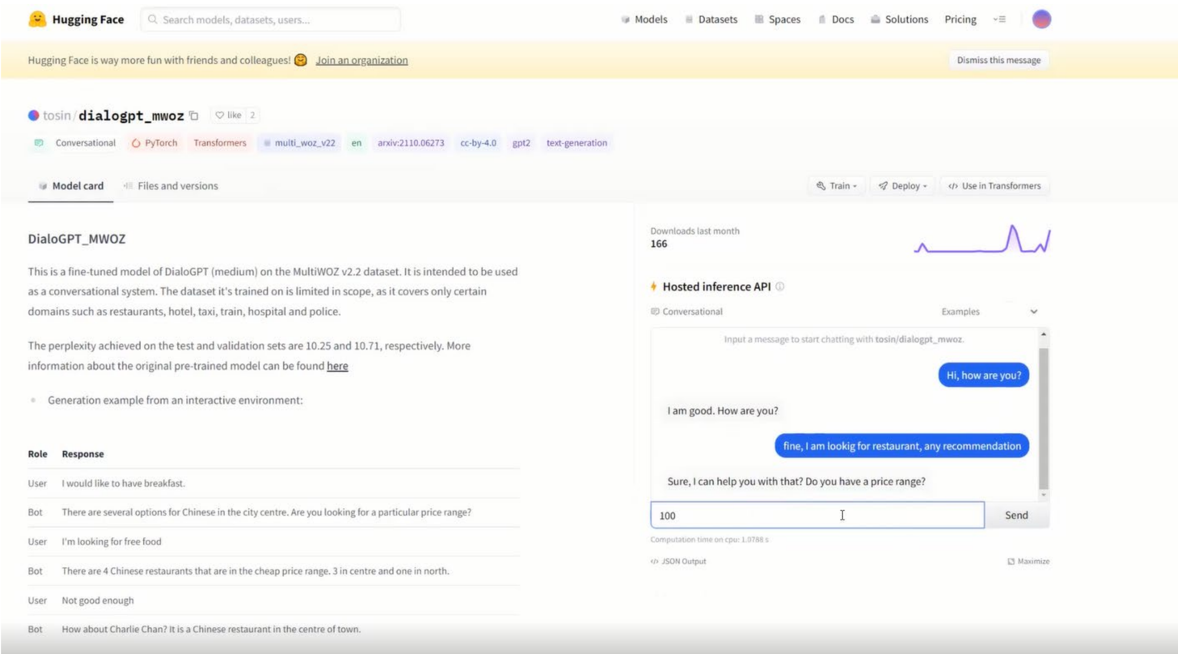

Figure 8. ChatPal is a project that helps in answering queries (Mokayed, 2022).

Mokayed (2022) summarizes that AI can be used as:

- Learner: Regular chat conversation with a student, but it is based on the lecture material. Recommended students more relevant learning content by analysing their learning skills and lackings.
- Teacher assistant; helping in answering queries students generally asked like lesson plans, course modules, assignments, and their deadlines.
- Providing feedback: identifying the areas that students are lacking and requires efforts

AI can also provide the teacher with an opportunity to figure out areas they can improve their teaching abilities as well.

Figure 9. AI in learning (Mokayed, 2022).

GatherTown

Virtual classes have now become commonplace during the COVID-19 pandemic. New learning environment like distance learning often taking a blended approach with both synchronous, i.e., learners engaged at the same time, usually via synchronous video-conferencing, and asynchronous sessions to support students' learning. Distance/online learning is related to teaching students in the virtual classroom. To teach in the virtual classroom, educators/teachers must go beyond what have been called traditional pedagogy styles, which mostly include lecturers, and into modern and more facilitative approaches. A virtual classroom is used to facilitate peer-to-peer meetings and discussions, social learning, a variety of training, and collaborative work on professional and academic projects (Fitria, 2021).

GatherTown (GT), from Gather, is an intuitive, online, proximity-based video-conferencing software which offers participants the ability to move freely within a 2-D, pre-designed space where users can access private 'rooms', interact with different shared documents, files, pre-recorded videos etc. in order to co-create in projects. GT is suitable in for instance project courses. GT offers educators the ability to pre-design learning spaces specific to their audience, to communicate effortlessly between entire spaces and small groups and to provide tailored support to students and/or student groups as they progress through the activities in a DL synchronous environment. GT can present an opportunity for students to derive the benefits of synchronous sessions, which provide opportunities for peer-peer communication and development of a sense of identity within their learning community (Themeli, 2016).

GatherTown is a web-conferencing software like Zoom, but with the added component of seeing the virtual "room" you and others are occupying, and with the ability to move around and interact with other participants based on your locations in the room, just like real life Virtual project rooms for effective teams. Users easily start and end side conversations and chats or return to a main speaker just as at a real-world conference or other gathering. Rather than being moved to a Zoom breakout room, in GatherTown, you can simply walk your online-self to tables and chairs, sit down, and start a conversation.

Figure 10. GatherTown, a visual project view.

WalkAbout

WalkAbout is a multi-user 3D-environment built with computer game technologies where students and teachers can express themselves using different avatars, animations, and text and voice chat in different graphical environments. The tool is under development, and can be tested in a learning environment (www.ltu.se/research/subjects/Distribuerade-datorsystem). The idea is that teachers bring in web screens and 3D-objects to enhance the learning environment as well as control the students in the environment, i.e., automatically gather them in one place or show current interesting places using light beacons. The students and teachers can create natural group conversations by how they place themselves in the 3D-world. The

WalkAbout environment can also be used to cross language barriers through real-time text chat translation and text-to-voice generation in different languages.

WalkAbout gives teachers and students an alternative to traditional online education where they can interact and be engaged in an enriched learning environment. In this online learning environment, the students are encourage to take an active part in their own learning, i.e. to be an active learner. The users of WalkAbout can either create a new room or join an existing room from a room overview. Further, they can see how many users are currently in each room and how many seats are available in that specific room (Parnes et al., 2021).

The goal of the WalkAbout-project is to create an open learning environment for teachers and students that complements learning tools that exist today, both in the classroom and online. The idea to WalkAbout is to stimulate online students to interact and to be visible by using avatars and animations that they can control in different virtual 3D-environments, similar to open world games. Various game elements can be used to enhance the learning and in WalkAbout through e.g. missions, points and challenges. This virtual learning world is based on the idea of active learning where the students can actively participate in tasks, and solve problems, but also participate in more passive learning activities such as just listening to a classical lecture. To create motivation is an important part of learning and the idea of gamification for motivating learners to learn more in the context of WalkAbout must be further investigated (Parnes et al., 2021).

Figure 11. Interaction in WalkAbout on a mobile device (picture from Parnes et al., 2021).

The Luna Lab

The International Space Master's LunaLab is one of the few facilities across the globe that simulates lunar conditions for testing applications such as autonomous navigation of lunar robots, multi-robot interaction, lunar surface extraction, manipulation and transportation, additive manufacturing and regolith analysis (https://researchluxembourg.lu).

The Luna Lab is an analogue lunar environment that simulates the visual appearance of the surface of the Moon. This Lab was designed and constructed at the University of Luxembourg by Prof. Miguel Olivares-Mendez. It is a closed environment of 80m^2 that contains 20 tons of basalt. It is equipped with a motion capture system of 13 cameras to evaluate and validate developed algorithms with under millimetre precision and 3 IP cameras to record and monitor experiments and project-based exams. A single light spot installed in 6 meters rails simulates the illumination of the Sun at different latitudes of the Moon, from equatorial regions to the South pole. This Lab will be equipped with the most advanced system for hybrid classes and direct access to lunar rovers and sensors.

Other technical solutions

Micro learning platform with a direct access to Aeroplace digital nuggets (ADN) (https://adn.isae-supaero.fr). Other digital tools, used by some of partners in Universeh, are briefly described here. Microlearning is the practice of breaking information down into easily-absorbed bite-sized chunks. Creating and distributing these lessons require software platforms called authoring tools and Learning Management Systems (LMS). A modern micro learning platform will often have a rapid authoring tool integrated into the LMS. This makes the creation of eLearning courseware simple and effective (www.edapp.com).

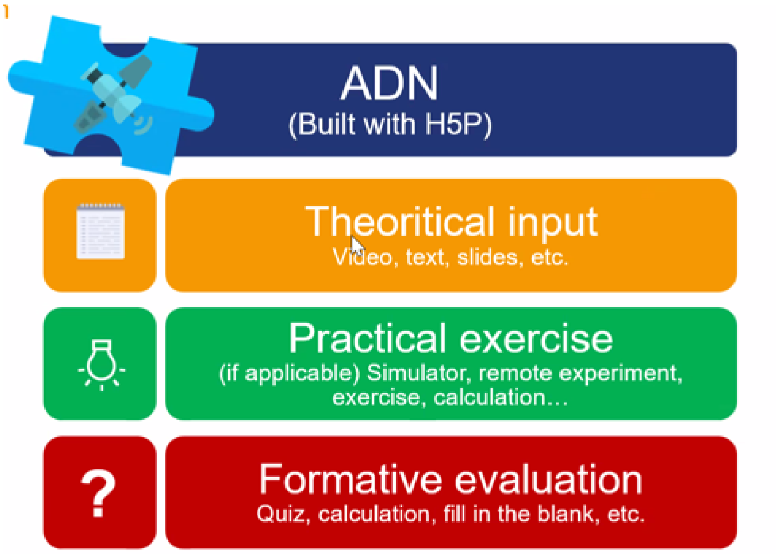

Figure12. From Anne-Lise Luga - ADN Factory

Conclusion and future work

Digital technology can be used to create a feeling of social presence (belonging to a community), support interaction between the different student groups, simulation in laboratory work, or support specific activities as project work. We will now continue working with different innovative technical solutions in the pilot courses developed within the Universeh-project and investigate the possibilities and challenges with each solution. These innovative technical solutions now need to be duly evaluated form a pedagogical perspective and students' experiences. A main task is to identify which type of course and design can be compatible with which hybrid solutions. Universeh-courses vary in level of flexibility and geographical target group which means a span of degrees of hybridization; from having mix classes, i.e. student in the classroom as well as online, to having just online students.

The evaluation needs to take into consideration the experiences made and most importantly how these aspects will become in the hands and the knowledge of teachers. Reflections also need to be dedicated to, for example, how to deal with very specific systems as Walkabout in the overall perspective of hybridization combined with ideas concerning competence development of teachers. There are also issues to solve around licenses and user rights concerning some of the developed platforms.

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