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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D4.6 Prerequisites for hybrid learning and virtual classroom

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Introduction

Method

In order to identify the use of current digital technical solutions, all partners involved in task 4.5 were asked to fill in an excel-sheet of their use technical solutions in their education. Some pre-defined categories were given, technical solutions for video conferencing, learning management systems, communication, collaboration, virtual labs, simulations, robot-mediated communication, and other digital technical solutions. In addition, two workshops were held to show and discuss the content future digital tools as GatherTown, WalbAbout, Virtual Labs etc.

Current digital technical solutions

Technical solutions were divided into 8 categories: Video Conference, Learning Management Systems (LMS), Communication, Collaboration, Virtual Lab, Simulations, Robot Mediated Communication, and others.

Video conference

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. At its simplest, video conferencing provides transmission of static images and text between two locations. At its most sophisticated, it provides transmission of full-motion video images and high-quality audio between multiple locations. In higher education, and among the partners in T4.5, following systems have been used: Zoom, Teams, Hyflex, Webex, and BBB.

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/).

Teams is mainly not used in teaching with students but in other occasions as between teachers or in projects. Microsoft Teams is a chat-based collaboration platform for online meetings with document sharing, and chat function (www.microsoft.com).

HyFlex@isae-supaero system is an integrated French homemade solution (ISEA-Supaero) build from various software components (Zoom, planning, streaming, and storage) and physical components (webcam, tablet, streamdeck, mic, etc.) to provide hybrid real time and 72h replay (https://online.isae-supaero.fr/resources/HyFlex/index-en.html).

BigBlueButton (BBB) is a free software web conferencing system for Linux servers. Its intended use is online learning. BBB is a global teaching platform. BBB was developed by the Technology Innovation Management (TIM) program at Carleton University's Institute for Technology Entrepreneurship and Commercialization in Ottawa, Canada, in 2007. It includes tools that make it easier for teachers to focus students on the lesson. Features like screen sharing, a multi-user whiteboard, breakout rooms, easy group polling, etc. that foster collaboration and keep students engaged. BBB has been embedded into major learning management systems used world-wide. It has been adopted by Canvas, Moodle Cloud, Sakai, Jenzabar, D2L, and Schoology as their default virtual classroom (https://bigbluebutton.org/).

Learning Management System (LMS)

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..

A learning management system (LMS) is an online education hub that provides a large and indispensable set of features to support educational activities such as classroom learning, distance education and continuing education (www.neolms.com). An LMS is used for structuring and managing educational activities, such as

- Creating and delivering educational content.
- Assessing students and analyzing their results.
- Tracking student progress.
- Collaborating on projects.
- Making learning more interactive and engaging.

The different partners in T4.5 use following LSM: **Canvas**, **Moodle**, **Coursea** and **ILIAS** for structuring learning material, communicating with students, and organising assignments and tests.

Communication

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. Since LMSs are an e-learning online system in the form of a portal, students and lecturers can perform or share many of the classroom activities using the Internet; lecturers and students are able to interact outside the classroom through online forums and discussions more easily. However, currently, most learning facilities utilize the LMS as a tool for instruction delivery in traditional classroom setups. Communication between lecturer and students; students-students can be achieved via an integrated e-mail function, chat or discussion forum.

Collaboration

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. As seen above, offering a number of different communication tools from messaging over chat to wiki, it might seem an easy requirement to fulfil for any learning management system. 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.

Nextcloud is used for sharing documents, and contains multi edition tools. It is a suite of client-server software for creating and using file hosting services. It is enterprise-ready with comprehensive support options. Being free and open-source software, anyone is allowed to install and operate it on their own private server devices, though it is not integrated with LMS.

Another collaborative tool is Yopad/Etherpad, which is a Collaborative Online-Editor for students to work and write together. Etherpad (previously known as EtherPad) is an open-source, web-based collaborative real-time editor, allowing authors to simultaneously edit a text document, and see all of the participants' edits in real-time, with the ability to display each author's text in their own color.

Microsoft Teams is also reported by the Universeh partners to be of used for collaboration. Microsoft Teams is a collaboration app that helps your team stay organized and have conversations. In Teams, there are different channels that you can create or belong to. In these channels, you can hold on-the-spot meetings, have conversations, and share files.

Virtual lab

Currently, there are not many examples of Virtual labs used by the partners in Universeh. One example is related to task 4.7 and it is named IREAL. 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.

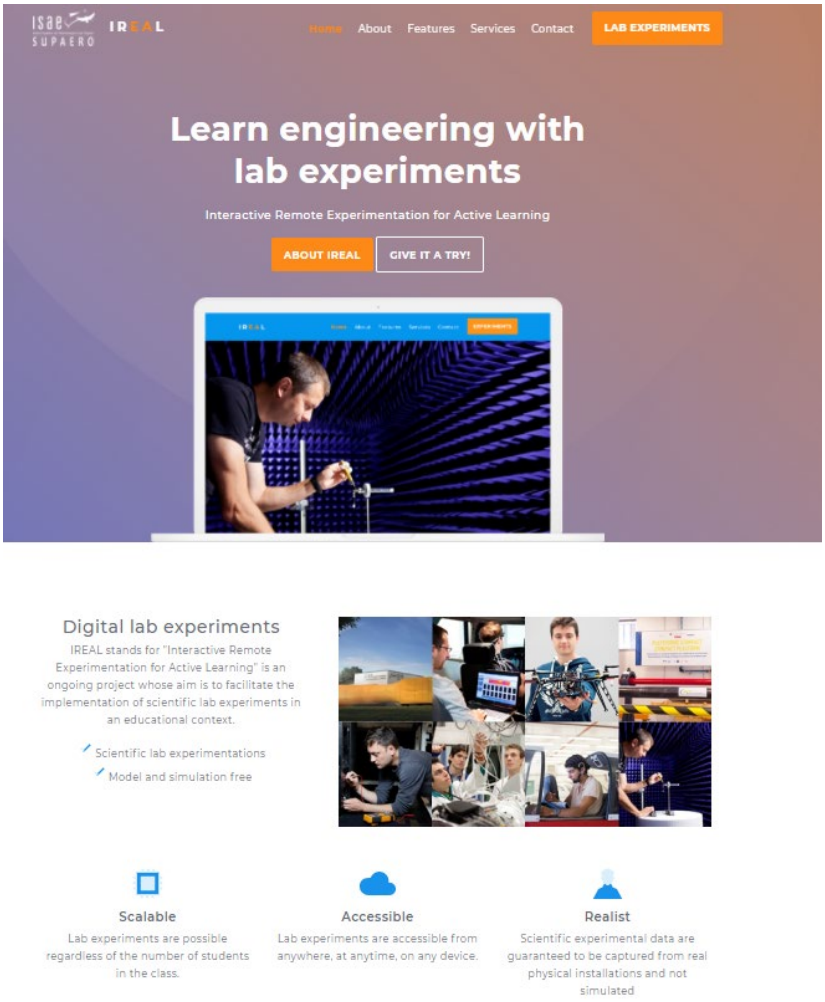


Figure 1. IREAL (https://ireal.isae-supaero.fr/www/)

Simulations

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.

Examples of technologies used by the partners in Universeh are: Notebook Python, Matlab (as local software or integrated into Moodle, specific plugin), and GeoGebra.

Python notebook is a web application that allows you to create and share documents that contain live code, equations, visualizations, and explanatory text. The Notebook has support for multiple programming languages, sharing, and interactive widgets.

MATLAB® combines a desktop environment tuned for iterative analysis and design processes with a programming language that expresses matrix and array mathematics directly. It includes the Live Editor for creating scripts that combine code, output, and formatted text in an executable notebook (www.mathworks.com).

GeoGebra is an interactive, dynamic mathematics software for all levels of education that brings together geometry, algebra, spreadsheets, graphing, statistics and calculus in one easy-to-use package. Constructions can be made with points, vectors, segments, lines, polygons, conic sections, inequalities, implicit polynomials and functions, all of which can be edited dynamically later (www.geogebra.org).

Robot mediated communication

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).

However, the user need to download an application to run the Kubi, it is no longer integrated with e.g. Zoom. A Kubi can be used in smaller groups with distance students, to create social presence and facilitate communications. Distance students can manoeuvre the Kubi with a panel and can look around in the physical classroom.

Figure 2. Example of a teleprecence robot, Kubi.

Other technical solutions

Other digital tools, used by the partners in Universeh, are briefly described here.

Micro learning platform with a direct access to ADN. 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).

https://iquiz.univ-toulouse.fr/en.html). IQuiz offers a simple and agile way to implement ongoing interactions with closed and open questions.

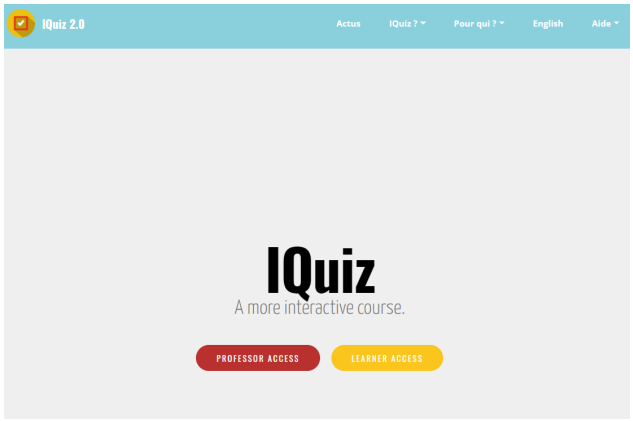


Figure 3. IQuiz, free UFTMIP homemade solution (https://iquiz.univ-toulouse.fr/en.html).

Different antipplagiate solutions linked to LMS are used, e.g. Compilatio connected to local Moodle, Ouriginal linked to Canvas, JSA, a uniform Anti-plagiarism System used at universities in Poland, etc.

Kahoot can be used to create quizzes to measure for instance students' progress. Kahoot is a game-based learning platform that makes it easy to create, share and play learning games or trivia quizzes in minutes (https://kahoot.com).

UPeL (in Moodle) is a university e-learning platform created especially for the needs of AGH University of Science and Technology in Poland. It has all the functionalities of Moodle and fully integrates the resources of these types of platforms. It is used to conduct classes, including lectures, seminars, exercises and workshops. After obtaining a special certificate, AGH UST employees can convert ECTS points from a stationary form to a remote form, so UPeL is an equivalent method of conducting classes, fully recognizable by the didactic system.

The main challenge is the legibility of the layout and user-friendliness, especially for those unfamiliar with the basics of e-learning. To take full advantage of UPeL's capabilities, you need to undergo specialized training, and then use the tool many times to gain skill. Sometimes there are problems with logging in and difficulties with transferring the course content outside the university. UPeL is not rated best by students who prefer MS Teams (based on anecdotal evidence).

Clickmeeting is a tool for conducting virtual classes and webinars, fully integrated in UPeL at AGH. It has functionalities similar to popular tools, such as Teams, Zoom, Meet, etc. It is distinguished by a user-friendly layout and the possibility of direct streaming to YouTube and Facebook. It is a tool rarely used in remote education and poorly recognized by users. Therefore, it requires training and practical application to acquire the right skills. The challenge is poor accessibility and problems with participation in virtual classes for people from outside the university.

MS Teams MS Teams is an equal tool to Clickmeeting, it can be used after signing an agreement between Microsoft and AGH during the pandemic. It is a universal tool, which can be a challenge as it is not directly related to UPeL (like Clickmeeting). In particular, it lacks tools supporting student activity, workshop approach and poor possibilities of using interactive techniques (e.g. a whiteboard). It is a good tool for webinars and communication, but weak in terms of activating and interactive methods.

Future innovative and creative technical solutions

In T.4.5 we have started to identify more future-oriented technical solutions for higher education and for hybrid and virtual classes. These technical solutions are: Gather Town, Walkabout, LUNA-lab, VR-lab etc.

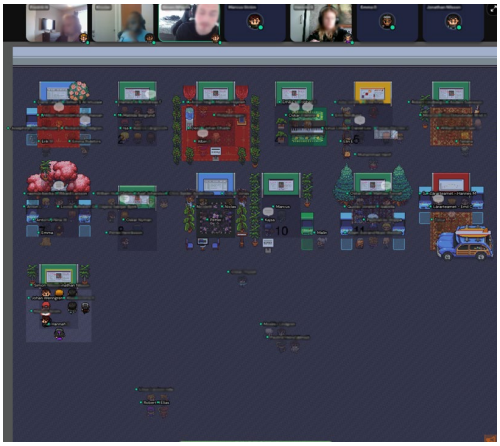
Related to VR, there is a **virtual reality educational tool** in the context of mining engineering that has been tested in the mining education. This tool creates a vision of a reality study visit (though it is virtual) in a mining environment. Within the recent years, mixed reality (MR) technologies 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).

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 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.

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.



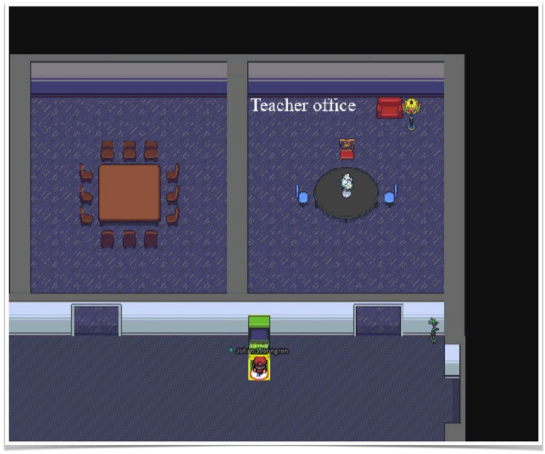


Figure 4. GatherTown, a visual project view.

WalkAbout is a net-based interactive multiuser 3D-environment for enhanced and engaging learning using gamification to enhance the learning using missions, points and challenges. Using WalkAbout, teachers and learners can engage in active learning using different 3D-environments online. The environment allows learners to represent themselves using many different avatars, animations, expressions paired with traditional voice communication. Further, classical presentations are done using one or several virtual web screens that allow users to bring outside content into the virtual world.

Figure 5. Interaction in WalkAbout on a mobile device (picture from Parnes et al., 2021).

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.

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Conclusion and future work

We will now continue working with our innovative technical solutions, VR, AI-simulation, virtual classrooms and virtual labs, use them in pilots in Universeh courses and investigate the possibilities and challenges with each solution. These solutions will be presented in our next report.We will compare virtual vs hybrid solutions in the context of teaching and learning.

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