



# University campus as a smart technology-supported active learning arena



UiT The Arctic University of Norway  
Septentrio Academic Publishing  
<https://septentrio.uit.no/>  
Septentrio Reports, No 1, 2023  
<https://doi.org/10.7557/7.7222>\*

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\* Link corrected 21 December 2023

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## Preface

This report was initiated by Professor Gunnar Hartvigsen at the Department of Computer Science, UiT the Arctic University of Norway (UiT). Hartvigsen invited fellow colleagues at UiT and collaborators from other universities to contribute to the report. In a series of online meetings, held in 2022, the authors discussed and drafted the topics presented in the report. The report is mostly based on experiences from Norwegian Universities, particularly in terms of available (or not available) technological solutions for online teaching and supervision.

The COVID-19 pandemic has accelerated the usage of technology in teaching and supervision. But it has also shown for whom, when, and for what physical meetings, teaching and supervision are superior. In this vein, the report is meant to stimulate a synergy/symbiosis between the advantages of a physical campus and the inclusions and outreach made possible by technology.

Technological development is fast and specific technological details or tools might be outdated. However, this same fast development is the reason why this report got initiated. Universities, and education more generally, now have tools at their hand that opens possibilities our ancestors with just paper and pencil could only dream off. At the same time, the core function, that of facilitating learning in the student, remains. In this sense, technological tools and functionality need to be matched to their pedagogical task.

The report is not meant to be exhaustive. The report solely reflects the views of the authors, which may not represent the view of all faculty members. We also do not claim to speak in the name of our current and future students. The report does not address pedagogical software or AI in teaching (Cowley et al., 2022), but rather focuses more on the hardware-side of technology.

Instead, we see the report as a tool to reflect on how one can design a good learning arena in the 21<sup>st</sup> century. Technology is not everything. A campus must provide physical meeting arenas, places to eat and drink, clean bathrooms, quiet areas, and not least green spaces like parks. All these facilities will contribute to a lively, welcoming, and inspiring learning arena.

It should be mentioned that the use of machine learning, deep learning and chatbots have entered the scene of education. Even though some of the results are amazing when it comes to compiling text, answering difficult questions, providing new perspectives and analyses, we still don't understand how and in which way this might influence on teaching and learning. In this report, we have not addressed this technology since we don't have much experience in higher education with this technology.

We hope this report can inspire discussions and reflections regarding university campus as a smart technology-supported active learning arena.

*Tromsø/Grimstad/Kristiansand/Trondheim/Halden/Bergen/Aalborg/  
Stockholm/Valencia/Pisa/Chicago*

*December 2023*

## Summary

Universities are facing many challenges as they are expected to prepare their students in the best possible way to contribute to sustainable societal- and industrial development. Students will become researchers, innovators, entrepreneurs, and role models, and should be able to contribute in the transition to a greener and smarter future. The task is almost impossible. It requires full attention from both students and their teachers. To successfully complete this task, universities explore different approaches, including developing smart technology-supported active learning arenas.

This report provides an insight into the technological development of the learning environment and presents wish lists for organizing a smart technology-supported learning environment, both in the physical and in the virtual environment, on campus and online (virtual). In addition, the report presents possibilities for appropriate development of competencies. The infrastructure for teaching, research, and administration must be as good as possible. Universities and other educational institutions around the world are experimenting with various technological solutions to establish a learning and working environment that is adapted to increased expectations and demands from students, employees, and society in general.

An active learning arena must consider both physical, hybrid and virtual aspects and might address design and organization of physical and hybrid classrooms on campus, offices on campus, home offices, meeting places on campus, lounges and meeting rooms on campus, collaboration opportunities on campus, virtual rooms and virtual campuses, laboratories, social media, and biophilic areas.

## Table of content

Authors	iii
Preface	iv
Summary	v
Table of content	vi
1. Introduction	1
2. Universities are changing	4
3. Forming smart learning environments based on learning theory and university pedagogy research	6
3.1. Behavioristic, cognitive, and social cognitive theories	6
3.2. Information processing theory	6
3.3. Experiential learning and reflection in/on action	7
3.4. From theories to practice	7
4. Developments in technology-based learning and working environment on a physical or virtual campus	9
4.1. Physical and hybrid classrooms on campus	9
4.2. Office on campus	11
4.3. Home office	13
4.4. Meeting places on campus	13
4.5. Lounges and meeting rooms on campus	19
4.6. Simulation as a pedagogical method	20
4.7. Professional education and follow-up of students off-campus	21
4.8. Virtual rooms and virtual campus	23
4.9. Biophilic design	28
4.10. Social media	30
4.11. Project participation - benefits and challenges for educational institutions	31
5. Our "wish lists" for organizing a smart technology-based learning environment on a physical, hybrid and virtual campus	32
5.1. Our "wish list" for physical and hybrid classrooms on campus	32
5.2. Our "wish list" for offices on campus	33
5.3. Our "wish list" for home offices	34
5.4. Our "wish list" for meeting places on campus	35
5.5. Our "wish list" for lounges and meeting rooms on campus	36
5.6. Our "wish list" for virtual rooms and virtual campus	36
5.7. Our "wish list" for laboratories	38
5.8. Our "wish list" for curriculum and teaching materials	39

5.9. Our "wish list" for social media use	39
5.10. Our "wish list" on behalf of our students	40
5.11. Our "wish list" for academic development	41
6. Universities in the 21 <sup>st</sup> century - where are we heading?	42
References	45

## 1. Introduction

Campus-based teaching must be renewed and revitalized. It needs to be reconsidered and perhaps even radically changed. The challenges are many and our educational buildings and infrastructure in general are modestly equipped to meet new requirements of teaching, supervision, and research. Nevertheless, we are expected to deliver flexible and research-based, high-quality teaching that is tailored to the wishes and needs of different student groups, possibly at different locations. There is an expectation that university teachers in an almost magical way are superusers of all new teaching tools and self-service administrative tools, and that all these tools are there to make more efficient use of time for all user groups involved – teachers, students, technical and administrative staff. As faculty members and university teachers, we shall also be active researchers, communicators, public debaters, and we are encouraged to facilitate, and in some cases also take part in, entrepreneurship. Students at all levels of education should be involved in our own research as much as possible, and the education shall be relevant for the working place.

Teaching, throughout history, takes place on an extended campus (and not just in classrooms, seminar rooms and laboratories). Today's students have grown up with, and to some extent also on, continuously evolving social media. However, the variability in technological knowledge is large between different student groups. Some are advanced, self-directed users, while others are lacking basic skills and need strong support (Hartvigsen, 2012). They also acquire knowledge in a multitude of ways. Students have high expectations of the learning environment – it should be flexible, engaging and stimulating and offer learning settings that challenge them.

We as faculty members and university teachers can provide engaging, stimulating learning settings, e.g., field work or walk-and-talks. However, as university teachers we cannot always satisfy students' wishes and requirements for a smart technology-supported learning arena. In many cases, the common teaching equipment on campus and the personal teaching equipment of many university teachers are obsolete. Some teachers put 7-to-8-year-old computers and outdated monitors in the office and lab. The medium that students almost continuously use to acquire knowledge and to communicate with fellow students and teachers – their smartphones – is not defined as teaching equipment and consequently not available to university teachers. In many cases, tablets are not available to university teachers either. This is even though much of today's teaching does not take place in the teaching rooms, but in the office, in the lab, around the campus, in the home office, and online. For securing these heterogeneous environments against data privacy and integrity breaches, IT departments of universities are making computers/laptops restricted when it comes to installing new software. For the students, the usual tool for consuming information is the smartphone, while the common tool for producing information appears to be the laptop (Watanabe et al., 1990).

An important part of the work as a university teacher consists of supervising Ph.D. candidates and undergraduate students (at bachelor and master level). This often takes more than 25-30% of working time. Most students have two or more supervisors. The supervision often takes place in the office of one of the supervisors, while others use meeting rooms with varying facilities. Co-supervisors might be present, either physically or via video conferencing



(Teams, Zoom, Chat, Meet, or the like). The students typically give status reports or presentations, or one discusses drafts of articles, text for the dissertation or master's thesis, etc. This, in turn, requires suitable equipment.

We also want the conditions for spontaneous academic discussions, both between colleagues and between supervisor(s) and student(s), and between students, to be as favorable as possible. We must therefore think of the campus as an (inter)active learning arena.

Our starting point is that we teach and research experimental subjects, or subjects that include laboratory activities, or we carry out practical exercises. We are responsible for teaching at bachelor, master, and Ph.D. level, as well as for providing lifelong education to employees. Learning takes place in several different arenas:

- Classroom
- Office, campus, and home
- Corridor (coffee machine, canteen, coffee bar, ad-hoc)
- Break-/coffee-room/area
- Laboratory
- Virtual room
- Social media
- Traveling

As faculty members and university teachers, we must have *sufficient time* to and have *access to* a suitable infrastructure to facilitate these activities:

- Plan teaching, supervision, and research.
- Implement teaching, supervision, and research.
- Competency development.
- Contact (international) guest lecturers, examiners, opponents.
- Keep in contact with students for teaching, supervision, and research.
- Include students as partners in teaching and learning.
- Conduct high quality research – together with students, staff, and international colleagues, on and off campus.
- Disseminate own (and others') research.
- Take part in the operation of the institution, faculty, department, and group.
- Engage in creating a culture of collegiality.

We should also have time for and suitable infrastructure for:

- Community contact including dissemination to general audiences.
- Workplace contact for students learning in work placements.
- Entrepreneurship.

The infrastructure must give us the opportunity to take care of our work tasks in the best possible way. And – we must bear in mind that "without students, no university". This has implications for all employees. This report provides an insight into the technological development of the learning environment and presents wish lists for organizing a technology-

based learning environment both in the physical and in the virtual environment, on campus and on the net as well as possibilities for appropriate development of competencies.

## 2. Universities are changing

Universities are experiencing increasing pressure from the surrounding community:

- *The social mission:* Universities should serve society and communicate research to the public.
- *The relevance criterion:* The study programs should be relevant in relation to the actual demands that society has in terms of knowledge and skills of their citizens to support its development.
- *Flexible education:* Universities should organize their teaching in such a way that as many people as possible can study.
- *Continuing and further education:* Universities should provide continuing and further education that supports lifelong learning for a dynamic work life.
- *Research:* Universities should conduct independent and high-quality research.
- *Business development:* Universities should, through research and new educational offerings, contribute to innovations and development of new industries.
- *The climate crisis and sustainability goals:* Universities should support the green shift and the UN's sustainability goals.
- *Democracy and human rights:* Universities should be champions of democratic thinking and the protection of fundamental human rights.
- *Internationalization:* Universities should promote international cooperation in research and education.
- *Formal teaching competence:* Universities should offer academic development initiatives (for example in university pedagogy) to ensure development of pedagogical expertise. Diversity in the student body, the above-mentioned changes in expectations, and new technologies, challenge existing teaching methods and call for implementation of more modern teaching methods.
- *Artificial intelligence:* Universities should provide training in co-working with intelligent systems, educate for responsible use of AI.

Scientific staff are experiencing increasing pressure internally because of streamlining:

- Administrative tasks such as publishing syllabus lists, timetables, exam papers, reporting etc. have been transferred to academic staff.
- Demand to use internal quality systems and self-service administrative tools.
- Open access requirements (open data, open material).
- More students per university teacher while the students are to be followed up more closely.
- Artificial intelligence tools assisting with writing of papers.

At the same time, the universities must manage existing knowledge in a responsible manner. For centuries, universities have also been responsible for the management of collections and so-called "useless" knowledge, i.e., knowledge that we do not currently see the usefulness of. E.g., libraries and University Museums serve also as dissemination areas to the public.

The European University Association (EUA) discusses in its report "Universities without walls. A vision for 2030" (Murphy & Crowfoot, 2021) what tomorrow's universities can/should look like and what challenges we are facing. The report states:

*"Technological developments are changing lives and disrupting labor markets. Universities produce knowledge for new technologies and social innovation. The development and promotion of such innovation is a central element of their activities. Universities also ensure that the impact of new technologies on our societies is studied and evaluated and that graduates are equipped for labor markets that are changing due to digitalization and new technologies, in particular artificial intelligence. These will also change the way universities and their partners work." (Murphy & Crowfoot, 2021) (p.4).*

EUA further argues that flexible forms of education will be necessary to be able to offer higher education to a larger group of today's young people (Murphy & Crowfoot, 2021). The report states that "higher education continues to be a major motor for socio-economic mobility". The pandemic has also forced changes in the way we organize education. The EUA argues that "this is leading to a rapid expansion in digital provision and research capacity to solve major societal challenges" (Murphy & Crowfoot, 2021).

EUA's vision for the future towards 2030 for European universities is "universities without walls", that means "universities that are open and engaged in society while retaining their core values." Universities must be organized in such a way that they are "open, transformative and transnational" (Murphy & Crowfoot, 2021). Universities should be the primary institutions for testing new ideas and identifying new knowledge.

It must be arranged for a hybrid life where the activity takes place partly on campus and partly virtually:

*"The nature and structure of universities will be hybrid. They will be open as physical and virtual spaces and will work to cultivate both when engaging with society. In the future, this will entail that physical and digital learning and research environments must be designed in a holistic way to accommodate the different needs of a diverse university community and allow for flexible and blended approaches. The physical campus will continue to be crucial as a place for social interaction and dialogue: a place that will host encounters that challenge and inspire, but will also offer quiet spaces for focused learning and research. The virtual campus will make the university ubiquitous. It will be developed to improve access for all to participate in research and learning, enhance cooperation, and explore new, innovative ways of pursuing university missions." (Murphy & Crowfoot, 2021) (p.5-6).*

With increasing international cooperation, there is a need for technological solutions that promote international cooperation (Murphy & Crowfoot, 2021). Universities must work together on a worldwide basis. As the EUA report shows (Murphy & Crowfoot, 2021), universities face major challenges if they are to be able to maintain their position and role as knowledge communicators, managers, and innovators by and for society.

### 3. Forming smart learning environments based on learning theory and university pedagogy research

What do we know about how students learn? Before we go further into the specific suggestions for infrastructure, tools, and facilities, we need to look at what psychology and pedagogy can tell us about learning. The theoretical models and empirical research on learning lays the premise for how a university campus should be designed. We will briefly discuss some central learning theories and their consequences for forming flourishing learning environments.

#### 3.1. Behavioristic, cognitive, and social cognitive theories

Behaviorist learning theories are characterized by objective truths and measurements and by behaviors which can be observed (Bearman et al., 2017). Learning occurs when a stimulus is followed by a given response, which is, in turn, followed by an increased stimulus (i.e., learning by doing) (Schunk, 2019). Practice is a core element in behavioristic instruction because practice strengthens the link between a stimulus and a response. To aid transfer - the use of acquired knowledge and skills in new contexts - teachers must let students practice applying their knowledge and skills in diverse situations and with different content. Behavioristic theories are easily recognized in learning outcome descriptions in higher education: Learning outcomes need to be formulated in a specific way that makes them possible to test through behavior of some kind (oral, in writing or as a demonstration).

As a reaction to behaviorism, cognitivist learning theories elaborate the mental processes involved in learning. Within the cognitivism paradigm, the learner is viewed as someone also with metacognitive abilities, that is, abilities to reflect on and evaluate their own learning process. In addition, problem solving, reasoning, critical thinking, and creativity are part of the more complex cognitive processes involved in learning (Schunk, 2019). This opens for flexible and engaging teaching methods. Cognitive theories suggest that we use examples in our teaching that are similar to what the students will meet themselves, that we use multiple examples on different types of problems, encourage self-explanation of problems and concepts and give students opportunities to practice their skills.

Social cognitive theory emphasizes that learning occurs in the interaction between the person, the person's behavior and the environment, either vicariously by observing, reading, or listening, or inactively by doing (Bandura, 1986). Model learning is regarded highly effective. Self-efficacy - the belief that one is capable of performing a given action - is also a central concept for learning. A student may be perceived in a certain way by the environment (teachers, peers), and adopt that perception about themselves, and as such, the environment has the power of both reducing and enhancing a student's learning capabilities (Schunk, 2019). This interaction between person, behavior and environment may be exploited by teachers who wish to increase a student's self-efficacy.

#### 3.2. Information processing theory

Information processing theory deals with attention and encoding and retrieval of knowledge (Schunk, 2019). We perceive the world through our senses and receive input to the sensory memory. If we do not pay attention to the input, it will be lost, but if we do attend to it, it

transfers to the working memory. The working memory has limited capacity (*cognitive load*), and the input will again risk being lost, if not rehearsed, thought about and integrated with previous knowledge somehow. Rehearsed input that are strengthening, adapting, or forming neural networks may transfer further into the long-term memory. Learning happens through actively selecting the right information, organizing, and integrating it with existing information, skills that we as teachers need to help the students acquire and understand.

The dual-channel principle tells us that sensory input enters the sensory and working memory through either the auditory or visual channel (Baddeley, 1992). If matching (not competing) inputs are received through both channels simultaneously, learning is enhanced (Mayer, 2019). This is called dual coding. When teaching, we should use this knowledge to better structure multimedia presentations (talks, books, other resources using both pictures/video and spoken word) with illustrations that are coherent to the topic and helps students organize the information and reduce cognitive load.

### 3.3. Experiential learning and reflection in/on action

The term “Learning by doing and reflection” was coined by philosopher John Dewey. The work of other influential learning theories was combined by David Kolb into “Experiential learning theory” in 1971, where he defined learning as “a process whereby knowledge is developed through a combination of a grasping and transforming experience” (Kolb, 1983). He describes an experiential learning cycle with four related parts of concrete experience, reflective observation, abstract conceptualization and active experimentation (Kolb, 1983). Kolb (1983) elaborate that the experience is the major source of learning, but both doing and thinking are required. The model is often used as a pedagogical basis for learning through virtual classrooms (de Freitas & Oliver, 2006).

Schön (Schon, 1984) also elaborate the importance of reflection, and he describes both reflection-in-action, and reflection-on-action. Reflection-in-action occurs when participating in an experience, using knowledge from past experiences into an unfamiliar situation. Reflection-on-action is reflection after participating in an experience, with the goal to get new understandings and knowledge to apply to future similar situations.

### 3.4. From theories to practice

What does this mean for our quest towards changing the campus arena? From both behaviorism and cognitive theory, we know that *practice* is needed to learn something, and that students need to practice applying their skills in different situations to be able to generalize them and utilize them in new settings. From information processing theory, we know that students learn best when they are *active participants* in their learning process, that learning happens through both *visual and auditory channels*, and that *cognitive load* should not be too large.

We need to design our university campuses with all this in mind. Students are not passive listeners to lectures in auditoriums, but active participants in a social learning environment, who need to practice and use their skills under different conditions. They need rooms and tools to help them be just that. Academic staff and technology should be seen as facilitators.

As a university, research is a crucial part of our mission, and this needs to be reflected also in teaching. Four aspects are important:

*Research quality.* To be able to teach in a research-based way, high quality research needs to be of the essence. In today's economic environment, that includes having enough time and resources to apply for funding and establish international networks. Without research, teaching quality will suffer.

*Faculty development.* Both because we as teachers need to reflect on our teaching, improve our toolbox and learn from each other, but also because of increasing demands of formal competencies.

*Scholarship of Teaching and Learning (SoTL)* (Felten, 2013). Involves faculty taking a scholarly approach to teaching to enhance and perhaps even transform teaching and learning in higher education.

*Including students as partners* (Bovill, 2019). This is important for several reasons. Being able to conduct research is a skill that requires practice and that involves the students in active learning. In addition, this is an important way of integrating students academically, helping them build a professional and academic identity.

The aim of higher education is to educate students into being independent, critical, skilled professionals and reflecting, active members of the society. We have discussed how learning theory lays the groundwork for different teaching methods to achieve this and will now look more closely into how technology can help us in this task.

## 4. Developments in technology-based learning and working environment on a physical or virtual campus

### 4.1. Physical and hybrid classrooms on campus

Physical teaching rooms are typically divided into auditoriums, classrooms/seminar rooms and group rooms. The former is suitable for traditional lectures for large groups of students, but less suitable for activities and collaboration. Classrooms and group rooms are more flexibly furnished with flat floors and suitable for activities and collaboration, but often have less capacity. Rooms that take care of both aspects at the same time are difficult to find on many campuses.

In addition, the technology available in the rooms is most often linked to the teacher, in the form of a PC, projector, camera, microphone and the possibility of recording and streaming. Very few rooms have technology available for the students present to support active participation, for example to facilitate sharing of content between laptop- or smartphone-screens and a larger screen. Several campuses have begun to build active-learning classrooms with group screens and more advanced opportunities for collaboration, but our impression is that these are often inaccessible and little known amongst students and faculty members. There is also a shortage of classrooms that are adapted for hybrid teaching, where some students are present physically and some digitally, perhaps especially in smaller campuses. Rooms are also typically not properly available for students with different disabilities.

Many solutions are hybrid where it is possible to combine teaching for on- and off-campus students. Several companies are developing and selling technology-based learning environments. For example X2O Media (X2O Media, 2022b), headquartered in Montreal, Canada. The company works with solutions for digital communication, including collaboration technology and digital workplace solutions for several industries, including educational institutions (Figure 1). The goal of the technology that X2O Media offers is "to maximize engagement and communication", and describes its solutions by (X2O Media, 2022a):

*"X2O OneRoom is an online collaboration environment with real-time engagement and provides unique immersive learning and training experiences for remote and in-room participants. X2O Media also provides unified communication solutions with the cloud-based X2O Platform helping connect and communicate with users on both desktop and mobile devices. The X2O Platform also supports dynamic data visualization and business intelligence dashboards which enable a dynamic, engaging way of communicating with dispersed/distributed workforce. Meeting room scheduling solutions also support the digital workplace by improving space utilization and streamlining the meeting room booking process." (X2O Media, 2022a).*



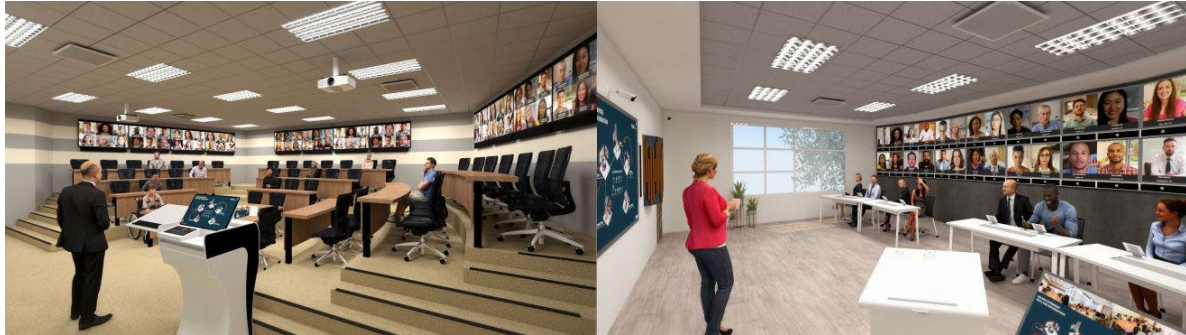


Figure 1 Examples of X2O Medias classroom solutions (X2O Media, 2022c).

The College of Pharmacy at the University of Louisiana Monroe (ULM) has installed a far cheaper and simpler solution than what X2O Media offers. In collaboration with the company Trox, ULM has installed what they describe as a hybrid teaching room where students sit together in groups supported by different types of digital aids. Figure 2 gives an illustration of a hybrid teaching room. In a news article at ULM, Glenn Anderson, dean of the College of Pharmacy, describes the goal of the learning space: “We wanted to create a learning environment that goes beyond memory. Students will learn more here” (Henderson, 2021). The article continues (Henderson, 2021):

*“In a traditional classroom, students all face the instructor with their backs to their fellow students. A teacher shares expertise: students take notes, memorize those notes, and then state those facts when test time comes.*

*‘That’s really the lowest form of learning, the regurgitation of facts’, Anderson said, referencing Bloom’s Taxonomy (Bloom et al., 1956), a classification system used to define and distinguish different levels of human cognition. [...] It doesn’t encourage students to think for themselves.*

*‘We want our students to move to the highest level of Bloom’s Taxonomy, creative thinking. We want them to be able to build a treatment plan.’*

*In the center of the studio-style classroom is the instructor, usually a professor, and a workstation with an interactive smartboard. The students sit all around the instructor at 14 tables.*

*Each table features a 360-degree microphone, plug-ins for laptops, and a large multi-screen monitor. The technology enables professors and students to wirelessly share notes, presentations, project materials, and other content from any laptop, smartphone, or tablet between the instructor station and the tables where students collaborate as a team.” (Henderson, 2021)*

Anderson continues:

*“The idea is if you sit here in the classroom, you should always see content from the learners and from the instructor. Students will learn faster and deeper through group learning.” (Henderson, 2021).*



Figure 2 Illustration of hybrid teaching room (AI generated).

#### 4.2. Office on campus

In step with the growing need for online teaching, supervision and research, the demand for technological office solutions that support and streamline work is increasing. Pre-Covid-19, many of the solutions seem to be adapted to open office landscapes. But the pandemic has demonstrated that such solutions do not work for infection control reasons.

The Economist summarizes the situation of the office in a Post-Covid existence in the article "The office of the future" (The Economist, 2021):

*"The office used to be a place people went because they had to. Meetings happened in conference rooms and in person. Desks took up the bulk of the space. (...) The pandemic has exposed the office to competition from remote working and brought up a host of questions about how it should be designed in the future."*

The pandemic has forced us to reconsider the role of the office (The Economist, 2021):

*"In the past it was a place for employees to get their work done, whatever form that took. Now other conceptions of its role jostle for attention. Some think of the office as the new offsite. Its purpose is to get people together in person so they can do the things that remote working makes harder: forging deeper relationships or collaborating in real time on specific projects. Others talk of the office as a destination, a place that must make the idea of getting out of bed earlier, in order to mingle with people who may have covid-19, seem attractive." (The Economist, 2021).*

Close cooperation over a long period of time with the same people "feels very 2019", according to the article in The Economist (The Economist, 2021). What now applies is reduced physical attendance. When you are physically present, it happens in "shared areas, or neighborhoods, where people in a team can work together in a flexible way" (The Economist,

2021). Since much of the activity will still take place online, one must establish arenas where employees can meet and build bridges between the teams. We must expect “that more space will be set aside for socializing and events. Bars in offices are apparently going to be a thing” (The Economist, 2021).

Another key word according to The Economist is hybrid work (The Economist, 2021). The post-Covid office must be designed so that hybrid work where some are physically present, while others participate online, must work for all participants. An example that is mentioned is the New York offices of the architectural firm Gensler: “Gensler's New York offices feature mini-meeting rooms that have a monitor and a half-table jutting out from the wall below it, with seating for four or five people arranged to face the screen, not each other.” (The Economist, 2021)

Post-Covid life will also be characterized by variation in work tasks. Employees need solutions that are adapted to different forms of work, such as group work and quiet rooms where you can work concentrated over a longer period.

In order to meet requirements for varied forms of work, the office furniture must be flexible (The Economist, 2021). In addition to docking stations for portable workstations, workbenches should have wheels and cabling be so flexible that you can easily reorganize the premises. The same requirements for flexibility apply to meeting rooms where walls on rails can change the size and decor of the meeting rooms.

The article in The Economist (The Economist, 2021) also describes how usage data will play a role in organizing work in the office:

*“If socializing and flexibility are two of the themes of the post-pandemic office, a third is data. Property and HR managers alike will want more data in order to understand how facilities are being used, and on which days and times people are bunching in the office. Workers will demand more data on health risks: the quality of ventilation within meeting rooms, say, or proper contact-tracing if a colleague tests positive for the latest covid-19 variant.” (The Economist, 2021).*

The office of the future will require registration of data to understand how the premises are used, what days and times employees are present, how the indoor climate is, and what the individual health risk of being present is.

All of these place demand on how this data is handled (The Economist, 2021):

*“And data will flow more copiously (...): from sensors in desks and lighting but also from desk-booking tools and visitor-management apps. The question of who owns data on office occupants and what consent mechanisms are needed to gather this information is about to become more pressing.” (The Economist, 2021).*

The article in The Economist (The Economist, 2021) concludes: "Whatever happens, the office won't be what it was."

### 4.3. Home office

Professor David Patterson at UC Berkeley presented in 1997 "Patterson's Rules for New Computer Science and Engineering Professors" (Patterson, 2016). One of his advice reads as follows: "Use startup funds/personal funds to have office at home as nice as office nice desk/chair, fast modem ( $\geq$ ISDN), printer, big screen, ...[sic]" Maybe except for the recommendation for modems with ISDN speed, this is still a very good advice. The home office should be so well equipped that all the work tasks that do not require a physical presence on campus can be done from home.

There are many providers of home office equipment. In August 2021, The Strategist published an article with advice on everything one needs in the home office in addition to the obvious things like computer, webcam, wireless network and printer (Cheslaw, 2021). These include adjustable desk, office chair, lighting (table lamp), wireless ergonomic keyboard and ergonomic mouse, access to good tea/coffee (coffee machine), wireless headphones with noise reduction, external microphone, large high-resolution computer screen, wireless speakers, stand for Pad and phone, heat shield for laptop so that it can be held on the lap for a long time and computer glasses (terminal glasses). Some of the more curious things mentioned in the article are rice cooker, carbonated water machine, warm blanket, warm slippers, humidifier, air purifier and acupuncture mat to name a few of the "special equipment".

When it comes to office chairs, The Strategist's recommendation is clear: you should give your office chair the same thorough care as you would for choosing a mattress for your bed. It is especially important that it is comfortable to sit in for a long time, as the chances are high that you will sit in it for a minimum of eight hours every day.

In November 2021, Wired Magazine (Chokkattu, 2023) presented a list of equipment you need for your home office: a laptop or desktop PC, desk, chair(s), laptop stand, computer monitor(s), monitor mount(s), Multi-Port Hubs, cables, charging adapters, keyboards, mice, mouse pads, portable storage device, headphones, PC speakers, webcam(s), microphone(s), VPN connection, password manager, Wi-Fi. A more comprehensive list of everything you did not know you needed in the home office is e.g., made by the company Home Stratosphere (Dykstra, 2023).

### 4.4. Meeting places on campus

The first principle of the European Pillar of Social Rights (European Commission, 2017a, 2017b) is that "everyone has the right to quality and inclusive education, training, and lifelong learning in order to maintain and acquire skills that enable them to participate fully in society and successfully manage transitions in the labor market". The role of the social environment as a mediator of learning (Walberg, 1969) underpins the importance of social interaction in the context of inclusive education, especially relevant in times where such type of interaction has been drastically reduced (e.g., COVID-19 pandemic) between peers, and between peers and the teaching community.

From the perspective of active learning, social cognitive theory, and community of practice, learning in a social environment is desirable. The goal of the learning environment and

infrastructure on campus must be as good as possible and perceived as attractive by the students in that they see the campus as their preferred place of residence. This requires that the campus be adapted in a flexible way so that as many students as possible experience added value by spending time on campus.

Although many students have less favorable conditions for studying at home and therefore will prefer campus, there are also some who have acceptable work environments in their homes. This might include:

- Worktable with custom lighting
- Office chair (which is often a "Gaming chair")
- Laptop
- 1-2 additional computer screens with good resolution
- Wireless keyboard
- Wireless mouse
- Webcam
- Extra microphone
- Headphones, often with microphone and noise reduction
- High speed internet connection

Many have tablets and smartphones integrated with the solution above. Some have access to a printer and scanner. In addition to this, students have access to all the home's basic facilities such as kitchen, toilet, etc.

Except for laboratories and equipment that are only available on campus, most of the software and learning materials are available online. This applies to library services, digital learning platforms (Learning Management Systems), teaching that is available digitally, YouTube, etc.

Some students also take e-learning courses in the form of MOOCs (Massive open online courses) at other educational institutions, often international. Several of the world's best universities and international companies are behind some of these. This applies to e.g., Coursera (Coursera, 2023) and edX (edX, 2022). Participation in this type of teaching usually takes place from the home/home office. It can also be mentioned that the offer of online teaching is also increasing at Norwegian educational institutions. This applies to both traditional education programs and continuing education programs. In general, these programs do not offer much support for continuous campus-based activity and teaching. Online teaching also opens new ways of organizing teaching in e.g., using multimedia, interactive e-learning modules, short videos, etc.

Academic and social integration and belonging to the university are important aspects to ensure that students continue their studies. Affiliation is an important prerequisite for ensuring good learning conditions and results. Since most of the learning process is not dependent on physical presence on campus, the educational institutions must facilitate and make visible the added value for the students in such a presence. This added value can e.g., be:

*Academic integration:* An important result of higher education is to be integrated into the academic field, including networking between students and employees at the institution. This aspect is not as easy to take care of in a digital learning environment.

*Universal design:* Given the larger diversity in the student population, which also includes students with different disabilities and challenges, learning activities and learning environment that are flexible and accessible will promote learning for all. This will also help students without such challenges learn better (Capp, 2017).

*High-quality physical infrastructure:* An attractive physical infrastructure for learning and interaction in the form of contemporary architecture and high-quality surroundings could contribute to the campus being preferred.

*High-quality technological infrastructure:* The educational institution's attractiveness will also be assessed based on the added value of the technological infrastructure. By offering access to advanced technology that promotes learning and interaction, this can also lead to students preferring to meet on campus.

*New forms of learning:* By using pedagogical models such as "flipped classroom", or reverse classroom in Norwegian. This means that students are introduced to the topic that is covered in a home environment via a short video presentation (typically 20-25 minutes) with subsequent campus-based discussion and group work.

*Social integration:* Canteens, coffee bars, cafes, break rooms, break facilities, etc., should also be part of the offer on campus. All catering offers should be adapted to the students' financial situation. It must not be the case that the students, relatively speaking in relation to income/personal finances, have the most expensive food offers. Students must also be given the opportunity to run their own social meeting places on campus.

*Welfare services:* Access on campus to fitness facilities, organized leisure activities, health and social assistance will also lead students to campus. The same applies to proximity to grocery stores, pharmacies, restaurants, cafes, bars, etc.

*Housing:* Student housing on campus will help make it easier for students to choose campus as a place of learning.

Many companies offer solutions that can contribute to attractive learning environments. One of these is the English company Warwick Conferences. In the advertisement for the meeting room "The Studio" (Figure 3, (Warwick Conferences, 2022)) Warwick Conferences writes among other things "Write on the walls and get creative in comfort. Perfect for idea-generation and interaction."

Since a lot of teaching and learning takes place in formal and informal student groups, opportunities for ad-hoc sharing of documents, teaching materials, etc., on large computer screens will be attractive. The company Smith Systems is one of many suppliers of this type of solution (Smith System, 2022).



Figure 3 The company Warwick conferences rents out various meeting rooms. Picture shows "The Studio" (Warwick Conferences, 2022).

Many universities have established environments that invite collaboration and group work. One of these is Australian Bond University which has established an innovative multimedia learning center (MLC):

*“The MLC is a self-directed learning center, as well as a digital gallery for the presentation of multimedia high art and for the use of computer gaming technology. The MLC space comprises a number of specific zones, including social learning and interactive lounges, group oriented study booths, collaborative study desks and enclosed Collaborative Learning Rooms, with extensive AV and technology support for film, tv and computer gaming courses presently offered to Bond University students.” (Wilson Architects, 2021).*

The company Steelcase (Steelcase, 2022b) delivers a wide range of products for the working environment for a number of different industries. One of the products is “media:scape”, which according to Steelcase: “... integrates technology and furniture to bring people, space and information together for a collaborative work environment and more productivity than ever before” (Steelcase, 2022a). Steelcase's ambition is to transform “classrooms, libraries or social spaces, connecting students, and sharing information seamlessly in dynamic new ways.” Steelcase argues that:

*“Most collaborative spaces today support leader-led presentations where information is controlled and shared by one person at a time. “media:scape” removes these barriers and democratizes how people access and share information by allowing all participants to contribute their ideas – equally, quickly and seamlessly.” (Office snapshots, 2022) .*

The company OFS is another supplier of equipment for e.g., teaching purposes. OFS states that:

*“Heya was designed to foster smaller touchdown spaces within an environment. Heya collaborative in particular creates opportunities for human connection and respite amidst the larger office.” (OFS, 2022).*

Access to large "digital whiteboards" can also help increase the attractiveness of the campus. An example of this type of technology is provided by Samsung. Samsung Flip monitors are well-suited for group collaboration. The active screen can also display meeting participants participating online while the screen is actively used by the participants in the room (Samsung, 2022a, 2022b).

Samsung Flip can be connected directly to the web or display screenshots from the participants in the group (Figure 4). The screen itself can be controlled by direct interaction with the screen or using Bluetooth connected equipment (keyboard, mouse, etc.)

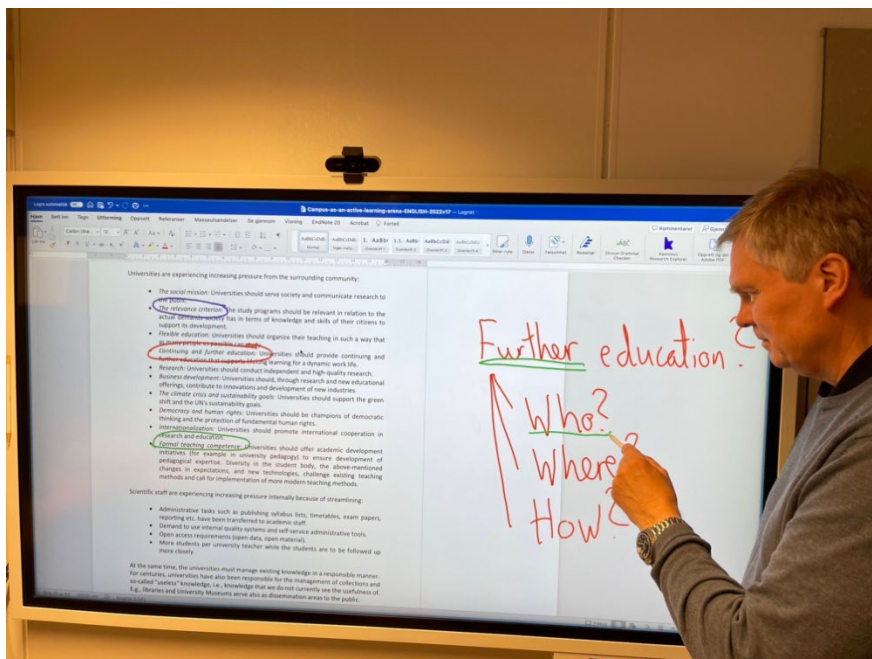


Figure 4 Illustration of Samsung Flip being used (Photo: André Henriksen).

Table 1 presents a comparison of products for meeting places on campus (these vendors have not been involved in the creation of this report). It appears that the information about prices or costs is not public, and this aspect could hinder initial estimates of the investment.



Table 1. Examples of products for meeting places on campus

#	Company	Product name	Product type	Description	For achieving intended learning outcomes, such as	Figure, citation
1	Warwick Conferences (UK)	"The Studio"	Warwick Conferences	Meeting room	<ol style="list-style-type: none"> <li>1. Demonstrate the ability in speech and writing about a specific topic.</li> <li>2. Describe common sources of information for a specific topic.</li> <li>3. Analyze, discuss, and reflect on a specific topic.</li> </ol>	Figure 3, (Warwick Conferences, 2022)
2	Smith Systems, TX, USA	"Multi-media Cafe Tables"	multimedia tables	for ad-hoc sharing of documents, teaching materials	<ol style="list-style-type: none"> <li>1. Demonstrate the ability in speech and writing about a specific topic.</li> <li>2. Describe common sources of information for a specific topic.</li> <li>3. Analyze, discuss, and reflect on a specific topic.</li> </ol>	(Smith System, 2022)
3	Bond University, Australia	Multi-media Learning Center	multimedia learning center	Collaboration and group work	<ol style="list-style-type: none"> <li>1. Demonstrate the ability in speech and writing about a specific topic.</li> <li>2. Describe common sources of information for a specific topic.</li> <li>3. Analyze, discuss, and reflect on a specific topic.</li> </ol>	(Wilson Architects, 2021)
4	Steelcase, USA	"media:space"	"Technology and furniture to bring people, space and information together"	Collaborative work environment	<ol style="list-style-type: none"> <li>1. Demonstrate the ability in speech and writing about a specific topic.</li> <li>2. Describe common sources of information for a specific topic.</li> <li>3. Analyze, discuss, and reflect on a specific topic.</li> </ol>	(Office snapshots, 2022)
5	OFS, USA	"Heya collaborative"	Bring people together	Collaborative work environment	<ol style="list-style-type: none"> <li>1. Demonstrate the ability in speech and writing about a specific topic.</li> <li>2. Describe common sources of information for a specific topic.</li> <li>3. Analyze, discuss, and reflect on a specific topic.</li> </ol>	(OFS, 2022)

#### 4.5. Lounges and meeting rooms on campus

Both break rooms and meeting rooms are important facilities on a campus. Ideally, these should be equipped with appropriate solutions for group work and collaboration. This can help make the campus attractive to students and staff.

Meeting rooms should be equipped with opportunities to include participants online. Examples of such hybrid solutions for meeting rooms are offered by the company X2O Media. The company's OneRoom solution allows both local and external participants in the same meeting (Figure 5). They advertise that the interactive solution helps to promote real-time engagement with integrated collaboration tools, including high-resolution interactive whiteboards and group groups (X2O Media, 2022c). It offers e.g., dynamic configuration of the meeting room, high-quality audio and video, directional sound to focus the camera on the speaker, several types of camera views, including perspective camera for each external participant.



Figure 5 Example of X2O media's OneRoom solution for flexible rooms (X2O Media, 2022c).

Many useful professional discussions arise in connection with break areas, coffee machines, kettles, water dispensers, etc. Sometimes the need arises to bring students or employees into the discussion. The X2O Media's video wall solution offers an overview of employees and students at strategic places, which could be a possible solution for more easily getting to know the staff (Figure 5).

The example in Figure 6 is realized by placing several 55-inch high-resolution displays (1920x1080) together in a 5x2 configuration. In the figure we see photos of all employees in the company Marco, Inc., sorted by date of employment. The pictures on the wall are re-sorted when hiring or leaving the company.



Figure 6 X2O Media's video wall in St. Cloud, Minnesota, headquartered in Marco, Inc (AVNetwork, 2015).

Solutions like this could be facilitated for traditional break areas, where technology usually is not emphasized. In an article in the New York Times (Marcus, 2020), William Zemp, Southern New Hampshire University's Director of Strategy and Innovation, stated: "One of the most important things we do here is disprove and dismantle ideas."

Many employees find it useful and stimulating to be able to meet their colleagues in an informal environment on campus. It is important to maintain such meeting places, even in an online environment. We could therefore establish more of these online break rooms where we can seek out online contact, in those cases where you cannot be physically present on campus.

#### 4.6. Simulation as a pedagogical method

"Experiential learning such as simulation has been promoted to challenge student's misconceptions, which encourages higher-order learning and promotes critical thinking abilities and self-directed learning" (Caniglia, 2019). "Students involved in experiential learning have a greater understanding of their subject matter than students in a traditional lecture-only class" (Hakeem, 2001), and students perceive themselves as more competent practitioners when subjected to experiential learning methods (Rocha, 2000)

One form of experiential learning is simulations. Simulation can be defined as "an experiential instructional method that teachers create to imitate or replicate actual events, problems, procedures, or skills to achieve the desired instructional outcome" (Sabus & Macauley, 2016). "Students may be given a role to play or asked to complete a task in a simulated environment. The goal is for students to experience the situation from a realistic perspective, apply or practice new skills and knowledge, think critically, and gather meaning from the scenario" (Jones & Barrett, 2017). Various simulation methods can be adapted according to specific learning outcomes and educational levels, but the required learning outcomes must govern the choice of simulation method (Dieckmann, 2009).

In healthcare, simulation learning can be defined as “the process where trainees practice a procedure or routine in a simulated learning environment before treating actual patients” (Department of Health, 2014). It has been used systematically since the 18<sup>th</sup> century (Owen, 2012), for instance by performing medical procedures and practicing on mock or real patients. It refers to more than just handling mannequins, but also a variety of activities using patient simulators, including devices, trained persons, lifelike virtual environments, and role-playing (Kim et al., 2016). In 2013, the World Health Organization (WHO) stated that “Health professionals’ education and training institutions should use simulation methods ... of contextually appropriate fidelity levels in the education of health professionals” (World Health Organization, 2013)

Simulations are also applied in other professional fields. For example, “in business-related classes, simulations have been used to model international trade and the development of business enterprises. In family life education, they have been used to illustrate divorced and remarried families and interactions between partners. Social science courses studying institutions and individuals have simulated life in mental hospitals, and in prison” (Caniglia, 2019).

Researchers agree that *“Simulation can be a highly effective instruction tool, but it is resource and time consuming. To realize positive, experiential learning through simulation, proven, evidence-based strategies can be tailored to the practice context. Simulation opens the door for rich learning experiences that have potential to achieve the highest quality, safe, and inter-professional practice”* (Sabus & Macauley, 2016). As simulations often are time consuming, and some designed to take place over several class periods (Sharifi et al., 2017), it may be challenging to find time for educators to plan, conduct and evaluate simulation activities. This may be especially challenging when the activity depends upon collaboration between different professions and study programs, i.e., in interprofessional educational activities. This is important to have in mind when developing curricula at educational institutions. According to Caniglia, preparation is together with active student participation, and post-simulation debrief one of the three necessary elements for effective simulations (Caniglia, 2019).

#### 4.7. Professional education and follow-up of students off-campus

Professional education is an education at a college or university that qualifies for specific professions. A common feature of these programs is the close ties between profession and field of practice. In many professional studies, practical training is an important part of the program. Fifty per cent of the bachelor's degree program in nursing consists of clinical practical training. The university lecturer must then have close follow-up and supervision of the students off-campus that may entail various challenges. These challenges can involve fragmented working hours, a lot of off-campus time, as well as challenges in balancing tasks in both education, supervision, and research. This, in turn, requires a special focus on technological solutions.

The students' learning is largely influenced by the quality of the supervision they receive along the way, and the practice supervisors' supervisory competence (Haddeland & Söderhamn, 2013). Digital solutions such as TOPP-N (Technology Optimized Practice Process – Nursing) can help provide support in the learning processes and a good collaboration between the student, the practice supervisor, and the teacher during the clinical practice periods (Nes et al., 2023).

Technological solutions during the practical training period can work well as a supplement to face-to-face supervision for the students. The Ministry of Education and Research in Norway encourage more use of digital tools and flexibility in higher education (Ministry of Education and Research, 2018). A major advantage of detaching supervision, assessment and communication from time and place is that teachers can follow up the students regardless of physical location. This means, among other things, that internships from a larger geographical area can be used. It is a known challenge that a lack of local internships limits the current educational capacity.

There is a need for multicampus or decentralized education, i.e., study programs or courses that can be taken by students in more than one location at the same time. A driving factor is the trend to merge universities and/or colleges into larger organizational units. This is also motivated by a need for higher education to be available in all parts of the country, not only in the biggest cities. This need is documented e.g., in the Norwegian demography report from 2020 and the structure of education has been a hot political issue in Norway.

Education's social mission also means that there is an expectation of close cooperation between society, cultural life, and business. Among other things, the Coordination reform ("Samhandlingsreformen") (Ministry of Health and Care Services, 2009) places greater emphasis on educating for instance health personnel who are adapted to future municipal tasks that also involve scattered settlements and long distances. This means that several educational institutions offer decentralized or what is also called district-friendly education. This is seen especially in nursing and teacher education, but other education areas are also relevant. Such studies should therefore be suitable for students who live far away from the university main campus and then provide the opportunity to take a higher education. The teaching may be session-based either at the university main campus or in more remote locations (or smaller campuses), it can be given through streaming of lectures or a combination of these. To support such distributed teaching patterns, we need high-quality and innovative technology-based solutions that facilitate and encourage active involvement by students. Experience shows that it is not always effective teaching that students are sitting at home in front of their computers; it is desirable that they can go to a campus location and participate together with other students (and faculty) on different campuses. The value of being a part of an informal group shouldn't be underestimated.

Global societal challenges require international cooperation. The Government's goal is therefore for half of students who take a degree in Norwegian higher education to have a period of study abroad (Meld St. 7 (2020-2021) (Ministry of Education and Research, 2020). This can place great demands on educational institutions in the form of, among other things, tailored follow-up of students where the university teacher is still present on campus, while the student is abroad. This requires good technology-based solutions that not only work on campus, but also where the student is located. This can present challenges, as many countries do not have as good technical solutions such as, for example, internet access as Norwegian educational institutions have. Even though the university teacher is physically present on campus, this becomes a form of off-campus situation that can be technically demanding. Here it can often be experienced that there is little technical support. A paradox is that there is a strong focus on student mobility, but at the same time little focus on facilitation for university teachers.

#### 4.8. Virtual rooms and virtual campus

The development has for a long time been in the direction of increasing use of virtual classrooms where teachers and students meet in real time in a digital learning environment. Teachers use video conferencing systems for real-time lectures where screen sharing, digital whiteboards, special programs for surveys, quizzes, comments, discussions are often used. Virtual classrooms are basically traditional classrooms moved into a digital environment. In addition, virtual classrooms provide extended opportunities for recording meetings and lectures, sharing files and other types of teaching materials, discussion in plenary or groups, and feedback at various levels.

One of the educational institutions that has used virtual teaching rooms is Harvard University, which in 2016 used its high-tech classroom HBX (GineersNow, 2016; Harvard Business School online, 2022; Raffaelli, 2017). HBX is also Harvard Business School's digital learning initiative. HBX allows the teacher to interact with students worldwide.

One of the HBX participants in 2016 described his experience as a participant in one of HBS 'seminars in the following way (Gans, 2016):

*“HBX has a studio complete with multiple cameras (one moving around with an expert camera-person). This was a labor-intensive operation — especially for a research seminar which normally requires little in the way of labor. As a participant, what I could see was the feed from the seminar and I could also control whether the ‘boards’ (which were either chalk like or PowerPoints) were larger than the person talking. There was a chat feed allowing participants to chat with one another. There was a polling feature that allowed the presenter to gauge the audience. I won’t say it was like “being there” but it was certainly a great experience relative to other online forums I have experienced.*

*As this was a research seminar, audience interaction was key. The presenter could see a wall of video feeds with all participants — there were around 30 but it can support as much as 90. I imagine the presenter could then sense what the mood of the room was to some degree. Participants could interact by putting up their hand (highlighting something) and then could be called upon. There was also some feature that allowed the presenter and two or three participants to converse. These videos were highlighted on everyone’s main feed.”*

It is common to use different types of learning platforms (LMS - Learning Management System) where teachers and students can communicate both synchronously and asynchronously. Such systems are flexible and offer support for different types of teaching and learning. This gives students opportunities to work with the learning content in different ways adapted to the individual's skills and level.

The next step from virtual classrooms will be to establish a virtual campus where students have access to different types of learning platforms and learning environments, formal and informal meeting and break facilities, non-fiction, multimedia libraries, resource persons, etc.

Virtual reality represents the next step for virtual environments. Here, a "real" world is recreated using 3D techniques that provide a spatial perception of the outside world. In the

fall of 2021, students at Fisk University, Nashville, Tennessee, could participate in in-person classes in what is referred to as one of the first virtual reality (VR) campuses in the United States. One of the teaching options was an interactive 5G-powered VR human cadaver lab for students in pre-med and biology-related majors. The virtual lab is a collaboration between Fisk University, HTC Vive, T-Mobile and VictoryXR (Fisk University, 2021):

*“This new model of learning combines the in-person classroom experience with 5G-powered VR technology, enabling students to explore the complete skeletal structure, muscle structure and the eleven human organ systems while still engaging in-person with their classmates and instructors.” (Fisk University, 2021).*

The laboratory is organized as much as possible like a real lab. Students are given the opportunity to examine the human internal organs. The teacher also has the opportunity to choose an organ and "send" this to the students, who can then keep the organ, open it and possibly also enlarge it.

Such a virtual organ laboratory gives students at Fisk University access to a state-of-the-art scientific learning environment that, compared to acquiring real carcasses, is both affordable to purchase and easy to maintain. Such virtual models also allow for expansions in the form of surgical procedures and studies at the cellular level.

A VR environment, in the form of virtual/serious games and/or the use of VR glasses, gives students the opportunity to virtually visit places, environments and situations where it is otherwise difficult to access, and experience these in a more natural way than through descriptions with text and images. Such an environment can also allow students to participate with their own avatar.

Using Serious games (SGs) and VR glasses gives students the opportunity for situational and experience-based learning, in that they can practice critical thinking and make decisions in realistic situations. SGs also consist of various game components, such as interactive solutions, multimedia and a score, which can further stimulate students' motivation and learning. Using SGs and VR glasses represents a flexible form of learning that can be used anytime and anywhere by the students (Hamilton et al., 2021; Zhonggen, 2019).

By using telepresence, it is possible for the teacher – or students – to be present in the room. Already in 2013, Cisco presented a solution where the teacher was present using telepresence (Fisk University, 2021).

Figure 7 shows an illustration of Cisco's Professor Avatar (Profesor Avatar, 2022), a telepresence model that combines the use of Real Time Holographic Projections and Telepresence Robots. With this solution, the teachers can both see and hear the students so that they can have an ongoing dialogue with the students. This form of "humanizing distance learning" gives students a completely different perception of the teacher and creates a sense of closeness that traditional video teaching does not achieve. Professor Avatar was also presented in an article from the Futurist forum (Schwartz, 2013).



Figure 7 Illustration of Professor Avatar (AI generated) [67]

Table 2 presents a comparison of products for virtual rooms on campus. It appears that the information about prices or costs is not public, and this aspect could obstacle initial estimates of the investment.

In 2020, the New York Times published the article ‘How Technology Is Changing the Future of Higher Education’ (Marcus, 2020). The article talks about how researchers are now testing artificial intelligence (AI), virtual reality (VR), and innovative solutions that can improve learning and at the same time reduce the teaching costs for Generation Z and subsequent generations.

The article (Marcus, 2020) talks about the activity at Sandbox COLLABorative at Southern New Hampshire University, which is one of several laboratories:

*“... where experts are testing new ideas that will shape the future of a college education, using everything from blockchain networks to computer simulations to artificial intelligence, or AI. There is not a future of falling enrollment, financial challenges and closing campuses. It’s a brighter world in which students subscribe to rather than enroll in college, learn languages in virtual reality foreign streetscapes with avatars for conversation partners, have their questions answered day or night by AI teaching assistants and control their own digital transcripts that record every life achievement.” (Marcus, 2020).*



The article in New York Times presents several examples of technological innovations in higher education (Marcus, 2020):

*“S.N.H.U. [Southern New Hampshire University], in a collaboration with the education company Pearson, is testing AI grading. Barnes & Noble Education already has an AI writing tool called bartleby write, named for the clerk in the Herman Melville short story, that corrects grammar, punctuation and spelling, searches for plagiarism and helps create citations.”*

Table 2 Examples of virtual rooms on campus

#	Company	Product name	Product type	Description	For achieving Intended Learning Outcomes, such as	Figure and citation
1	Harvard University/Harvard Business School	virtual reality Lab	High tech classroom HBX	Meeting and Conference room,	1. Demonstrate the ability in speech about a specific topic. 2. Describe common sources of information for a specific topic. 3. Analyze, discuss, and reflect on a specific topic.	(Raffaelli, 2017)
2	Fisk University's	VR lab	Simulator, virtual 3D Human Body Atlas	in-person classroom experience with 5G-powered VR technology	1. Demonstrate the ability in speech about human anatomy. 2. Describe common sources of information for human anatomy. 3. Analyze, discuss, and reflect on human anatomy.	(Fisk University, 2021)
3	CISCO	Professor Avatar	Telepresence model that combines the use of Real Time Holographic Projections and Telepresence Robots	Telepresence classroom experience	1. Demonstrate the ability in speech about a specific topic. 2. Describe common sources of information for a specific topic. 3. Analyze, discuss, and reflect on a specific topic.	Figure 7, (Professor Avatar, 2022; Schwartz, 2013)

One of the negative aspects of online studies is greater dropout among students. An example cited in the NYT article is how Arizona State University has adopted an AI-based system that is able to recognize signs that the university's online students are struggling. Students who are identified are next contacted by one of the university's advisers (Marcus, 2020).

Another example that is mentioned is the Rensselaer Polytechnic Institute in New York which has established a language laboratory. The laboratory, which with its 4.5 meter high walls and

360-degree projection system, brings language students from the Rensselaer Polytechnic Institute to China for all practical purposes (Marcus, 2020):

*“The students learn Mandarin Chinese by conversing with AI avatars that can recognize not only what they say but their gestures and expressions, all against a computer-generated backdrop of Chinese street markets, restaurants, and other scenes.*

*Julian Wong, a mechanical engineering major in the first group of students to go through the program, “thought it would be cheesy.” In fact, he said, “It’s definitely more engaging, because you’re actively involved with what’s going on.”*

*Students in the immersion lab mastered Mandarin about twice as fast as their counterparts in conventional classrooms, said Shirley Ann Jackson, the president of Rensselaer.*

*Dr. Jackson, a physicist, was not surprised. The students enrolling in college now “grew up in a digital environment,” she said. “Why not use that to actually engage them?”*

*Slightly less sophisticated simulations are being used in schools of education, where trainee teachers practice coping with simulated schoolchildren. Engineering students at the University of Michigan use an augmented reality track to test autonomous vehicles in simulated traffic.”*

The article goes on to describe how Georgia Tech has experimented with a virtual teaching assistant (TA) named Jill Watson (Goel & Polepeddi, 2016). The technology is based on IBM's Watson supercomputer platform. Among other things, Jill Watson is used together with human teaching assistants to answer questions from students in a discussion forum. The experience from this is that many students do not know if it is Jill Watson or a human TA who answers their question.

In 2020, the website OnlineEducation (OnlineEducation, 2020) presented an article on "AI Powered Adaptive Learning". Here, the introduction of AI in teaching is referred to as a revolution:

*“The structures and traditions of education are often slow to change. While it may adopt some of the innovations of mainstream society (laptops in the classroom, online delivery of services, etc.), the core system of education is largely retained. The last truly disruptive shift to the way we teach and learn came during the advent of the Industrial Revolution, when standardized curriculums that focused on math and reading were introduced to better prepare students for factory-level jobs.*

*Artificial intelligence may bring about yet another revolution to the way we live and work. While AI won’t be replacing the jobs of teachers just yet, it may be joining them as a colleague quite soon. The intervention is likely to be welcome. According to a recent McKinsey survey, (Bryant et al., 2020) teachers are working an average of 50 hours a week, and further research estimates that 20 to 40*

*percent of those hours are spent on activities that could be automated using existing technology.*

*By taking over a teacher's mundane, burnout-inducing tasks, it can give educators more time to focus on the student experience. At the same time, AI can drive innovations within education itself by making it smarter, faster, and more personalized. The concept of adaptive learning, which seeks to personalize education to each individual learner, has gotten a jolt of new energy thanks to the power of AI. For a historically stubborn field, education appears to be growing up." (OnlineEducation, 2020)*

One of the examples cited in the article is Jill Watson:

*"Jill Watson has the potential to be every teacher's new best friend. A cousin of IBM's Jeopardy-winning Watson, Jill is an AI-enabled teaching assistant who can answer student questions about a particular class and curriculum." (OnlineEducation, 2020)*

Professor Ashok K. Goel of the Georgia Institute of Technology and creator of Jill Watson told OnlineEducation that: "We continue to build more powerful versions of Jill Watson every semester." He goes on to say: "By now, Jill Watson has been run in about 17 classes, including graduate, undergraduate, online, and residential. Next, we want to take her outside Georgia Tech."

The team behind Jill Watson spent somewhere between 1000-1500 hours developing the first version of Jill Watson, which is far too long to use this technology for an ordinary teacher. They are therefore working to reduce the adaptation time. Professor Goel says in the article that: "Now we can build a Jill Watson in less than ten hours":

*"That reduction in build time is thanks to Agent Smith, a new creation by Goel and his team. All the Agent Smith system needs to create a personalized Jill Watson is a course syllabus and a one-on-one Q&A session with the person teaching it. Named after the self-replicating character in The Matrix, the Agent Smith program clones Jill Watson, but makes her a specialist in the area of need. Teachers from any grade level or subject domain can have a deployable, AI-powered teaching assistant for their class with minimal set-up."*

Professor Goel explains that: "In a sense, it's using AI to create AI, which is what you want in the long term, because if humans keep on creating AI, it's going to take a long time."

#### 4.9. Biophilic design

An emerging concept in design and interior design is so-called biophilic design (Wikipedia, 2022):

*"Biophilic design is a concept used within the building industry to increase occupant connectivity to the natural environment through the use of direct nature, indirect nature, and space and place conditions. Used at both the building and city-scale, it is argued that this idea has health, environmental, and*

*economic benefits for building occupants and urban environments, with few drawbacks. Although its name was coined in recent history, indicators of biophilic design have been seen in architecture from as far back as the Hanging Gardens of Babylon.”*

Kellert (Kellert, 2015) argues that since we in our "natural habitat" (in urban areas) spend 90% of the time in (artificially) built environment so “biophilic design seeks to satisfy our innate need to affiliate with nature in modern buildings and cities”. With this as a starting point, Kellert claims that:

*“... the fundamental goal of biophilic design is to create good habitat for people as biological organisms inhabiting modern structures, landscapes, and communities. Accomplishing this objective depends on meeting certain conditions. First, because biophilia is essentially about evolved human tendencies, biophilic design focuses on those aspects of nature that, over evolutionary time, have contributed to our health and wellbeing. Let us be clear on this point: Any occurrence of nature in the built environment cannot be called biophilic design if it has no bearing on our species’ inborn tendencies that have advanced our fitness and survival.*

*Simply put, biophilic design focuses on those aspects of the natural world that have contributed to human health and productivity in the age-old struggle to be fit and survive. Thus, desert or deep-sea habitats or microorganisms or alien or extinct species or other obscure aspects of nature are largely irrelevant as aspects of biophilic design because they offer little if anything in the way of sustained benefits to people.” (Kellert, 2015)*

Kellert states that “*the fundamental challenge of biophilic design is to address these deficiencies in the modern built environment by initiating a new framework for the beneficial occurrence of nature.*” According to Kellert, this can be realized through both a direct and indirect experience of nature (Kellert, 2015):

*“Direct experience of nature: Light, Air, Water, Plants, Animals, Natural Landscapes and Ecosystems, and Weather.*

*Indirect experience of nature: Images of Nature, Natural Materials, Natural Colors, Mobility and Wayfinding, Cultural and Ecological Attachment to Place, Simulating Natural Light and Air, Naturalistic Shapes and Forms, Evoking Nature, Information Richness, Age, Change, and the Patina of Time, Natural Geometries, and Biomimicry.”*

In their book “The Practice of Biophilic Design” (Kellert & Calabrese, 2015), Kellert and Calabrese argue that:

*“The successful application of biophilic design should also result in a wide spectrum of physical, mental and behavioral benefits. Physical outcomes include enhanced physical fitness, lower blood pressure, increased comfort and satisfaction, fewer illness symptoms, and improved health. Mental benefits range*

*from increased satisfaction and motivation, less stress and anxiety, to improved problem solving and creativity. Positive behavioral change includes better coping and mastery skills, enhanced attention, and concentration, improved social interaction, and less hostility and aggression (p.8).”*

#### 4.10. Social media

Social media is everywhere and part of our daily life. These continuously evolving channels are defined as democratized web based or Internet-based services that allow their users to generate content and to connect and interact with other users. When we talk about social media, we refer to online networking platforms such as Facebook, Instagram, YouTube, Twitter (now X), Mastodon, WhatsApp, or TikTok, but we also refer to other file-sharing sites, blogs, and wikis, where generating and sharing contents and interacting with other users is allowed.

The most recent statistics show that there are more than 4.7 billion social media users worldwide (Datareportal, 2023). Both public and private institutions, companies, and citizens (including students and scholars) are using these channels. People use these media to interact with other users, to search and to share any kind of content, also covering educational contents (e.g., academic Twitter/X).

But how can we as faculty members incorporate social media in higher education? Are we even allowed to do it? As teachers in higher education, we should have the possibility of using these media as part of our teaching. Currently, using social media is not perceived by many higher education institutions as an academic activity, and learning how to use these channels is not part of universities or university colleges curriculum. As a result, many scholars do not use these channels for higher education beyond uploading conference talks on video platforms. Therefore, they are missing opportunities to actively involve and engage students, and to connect and exchange knowledge with other scholars. Teachers who want to use social media for their teaching typically need to learn how to use these continuously evolving channels by themselves and use social media in their free time.

Students on the other hand, are actively using social media for many purposes, such as communicating with their peers, and looking for and sharing information, and they are positive about expanding the use of these channels in higher education.

Incorporating social media in higher education is linked to multiple benefits. Research shows that incorporating social media to higher education as part of the learning arena brings several benefits for both students, educators and even to improve the university image. Social media in higher education promotes active learning and meaningful learning. As exemplified, students that use social media to supplement their studies have improved learning, higher assignment scores and grade points averages, higher retention of learned contents, communicate better, and they are also more motivated, engaged and satisfied with their studies (Malik et al., 2019; River et al., 2016).

Using social media as part of our teaching is also connected to several benefits for us as faculty members: it enhances our professional development and learning (Chugh et al., 2021; Luo et al., 2020; Malik et al., 2019), improves our networking and communication with peers and

students (Chugh et al., 2021), gives us access to more research opportunities (Chugh et al., 2021), increases our willingness to publish (Chugh et al., 2021), and professors whose social media profiles feature educative posts are perceived by their students as more credible (Malik et al., 2019).

The incorporation of social media in higher education means incorporating and promoting students and community participation and collaboration for the creation of new knowledge.

Furthermore, early, and continued training in social media will facilitate dissemination to a broader audience, and dissemination has become a criterion for advancement and grants.

#### 4.11. Project participation - benefits and challenges for educational institutions

Employees at educational institutions are increasingly encouraged to apply for and take part in externally funded projects. Especially EU-projects are economically beneficial, and therefore focused on.

However, participation in projects steals time from our other academic tasks, but also represents an opportunity to identify relevant student projects and theses. Through participation in such projects, students might get updated state of the art, collaboration with other researchers and staff at other institutions, and practical and/or commercial examples of use of technology, routines, procedures, etc., since industrial partners often take part in EU and NFR research projects.

We wish there were more clear strategies from our universities about the following, among other things:

- How to include examples and state of the art from the projects as part of the assignments in courses?
- How to include Capstone projects, Master projects and Ph.D. projects as part of such projects?
- How project participation can be compensated timewise?
- Which safe sharing platforms should be used when writing joined grant applications, as well as mandatory contracts to be made and followed by all partners when students are involved in the external funded research projects?
- How are privacy, security and ethical aspects handled when collaborating in projects with many partners, often from different countries and cultures?

## 5. Our "wish lists" for organizing a smart technology-based learning environment on a physical, hybrid and virtual campus

We will divide the "wish lists" into the following topics, which we will describe in the following pages:

- Physical and hybrid classrooms on campus
- Office on campus
- Home offices
- Meeting places on campus
- Lounges and meeting rooms on campus
- Virtual rooms and virtual campus
- Laboratories
- Curriculum and teaching materials
- Social media use
- What do we want, on behalf of our students?
- Academic development

### 5.1. Our "wish list" for physical and hybrid classrooms on campus

For most university teachers, teaching is equivalent to (classical) lectures in auditoriums and seminars in classrooms and group rooms. We also expect that this form of teaching will continue, even though the teaching also takes place in virtual and hybrid environments, and the students' roles are changing.

Classrooms on campus should be equipped with various technological solutions, including:

- Possibility of multiple data streams on multiple surfaces (e.g. large monitors).
- Active (smartboard) and passive (whiteboard) walls/panels.
- Presentations using various media types.
- Possibility to see students participating from different campuses.
- Comment and question channel/display (Twitter/X stream, Curipod etc.) that everyone can see and respond to.
- Camera(s) for streaming lectures, voice controlled, or motion controlled.
- Microphones that together cover the entire room.
- Easy for everyone in the room to start a presentation using materials on their laptops/pads/phone, etc.

In addition, the classrooms must be equipped with ergonomic and comfortable chairs that make it possible to sit down for a minimum of 45 minutes without this being experienced as uncomfortable. Both chairs and tables should be easy to move, preferably with wheels, and the room should be fully accessible for students with disabilities. Students must be able to connect power for use/charging of brought equipment. Students should also be able to easily share their own presentations with those who are present in the room or follow the teaching online.

Note: Although our wishes are primarily about digital adaptation, we would prefer that this is not at the expense of the possibilities for a more analog teaching; a completely ordinary whiteboard/blackboard is still a basic tool that must not be thrown out of the classroom. The key is that all teaching rooms are as flexible as possible and allow for a variety of teaching methods, instead of limiting the possibilities.

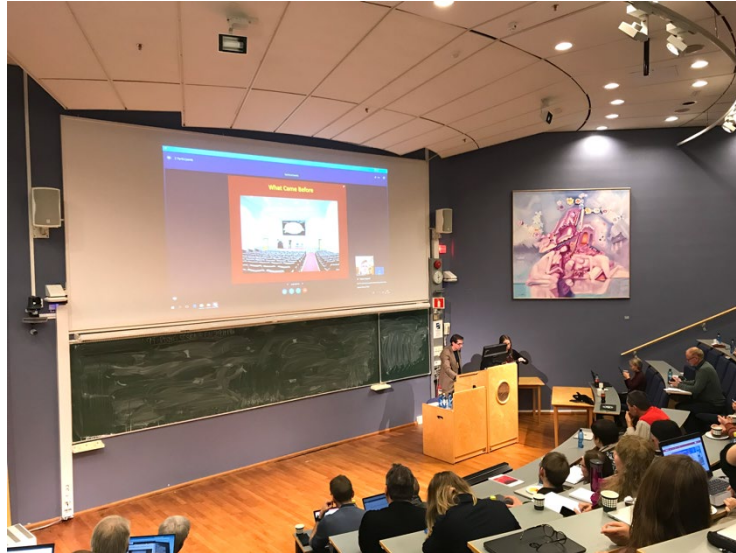


Figure 8 Example of an auditorium in the MH building at UiT. (Photo: Gunnar Hartvigsen)

Figure 8 shows a traditional auditorium where the teacher has access to the blackboard and projector. In addition, this auditorium is equipped with opportunities for video conferencing and streaming of lectures.

## 5.2. Our "wish list" for offices on campus

Most university teachers want their own offices (Figure 9) where they can work undisturbed for a long time, supervise students, have planned and spontaneous meetings with one or more colleagues and students, etc. For all these examples of meetings, it must be possible to have participants online. Most of this activity is not compatible with open landscape solutions. On the other hand, offices should have windows next to the door to create a community feeling, both from the offices and from the corridor.

The campus office should be equipped with various technological solutions, including:

- Basic equipment such as PC and or laptop connection, computer monitor(s), camera (for video calls), microphone(s), speaker(s), digital tablet(s) with recording function, high speed network (both cable and wireless), etc.
- Large monitor(s), possibly smartboard and whiteboard where supervisors and/or student(s) can seamlessly present their work.
- Opportunities for supervision where student and/or co-supervisors participate via Teams, Zoom or other online collaboration tools – for this we must also have large monitors and the speakers/microphone must be of good quality.





Figure 9 Example of a "classic" university teacher's office. (Photo: Gunnar Hartvigsen)

It is of course important that the equipment is also of good quality in terms of ergonomics and functionality. It should preferably be the case that you want to spend as much time as possible on campus and in your own office because there you have the best working conditions.

### 5.3. Our "wish list" for home offices

For most University teachers, it is important to be able to work from home (Figure 10) from time to time, not least outside ordinary working hours. Professor Toril Moi at Duke University, USA, told the magazine *Forskning* (Jakobsen, 1998) that:

*"... I have the impression that working conditions for academics are poor. There are several aspects of university life in Norway that make it difficult to have enough time to do research, to read and write new things, and that is the most important thing for me as an intellectual. The Duke professor thinks back on the three years she worked as a research leader at the Center for Humanities Studies at the University of Bergen as quite unfree in relation to what she is used to until now.*

*You had to be in the office during normal office hours, as long as you did not have a good reason to stay somewhere else. At Duke, I'm only in the office when I have an appointment or meetings. Otherwise, I work at home, like most other American academics. - If I had regular office hours, I would always be available to students and talkative colleagues. How then should I have time to write?"*

Most of us probably share the same perception from time to time that campus office time is not always the most productive. At the same time, it is important that we as university teachers are present on campus so that we can fulfill our obligations to students and the college.

However, when it comes to the home office, this should be equipped with some of the same technological solutions as the campus office, i.e.,:

- Basic equipment such as PC and or laptop connection, computer monitor(s), camera (for video calls), microphone(s), speaker(s), digital tablet with recording function, high-speed network, etc.
- Ergonomic office furniture.
- Access to campus network and library services.



Figure 10 A university teacher works in his home office. (Photo: Gunnar Hartvigsen)

#### 5.4. Our "wish list" for meeting places on campus

We need to facilitate collaboration (ad-hoc, planned) everywhere on campus, and not just where we have established seating areas, meeting room furniture, etc. Some of the infrastructure should be installed outdoors in those parts of the year where weather and climate allow this. This will typically be arranged for shorter meetings that can be held standing. To promote collaboration on campus, we should have access to various technological solutions, including:

- Large active monitor(s) where student(s) and staff can seamlessly project their screens (PC, mobile), share their ideas, present learning materials, retrieve information from the web, etc. (Figure 11)
- Active and passive board(s)/panel(s)/wall(s)/ comment function.
- Opportunities to ad-hoc invite fellow students and/or staff into online conversations.

The simplest solution would be to place large active monitors located "everywhere" on campus.

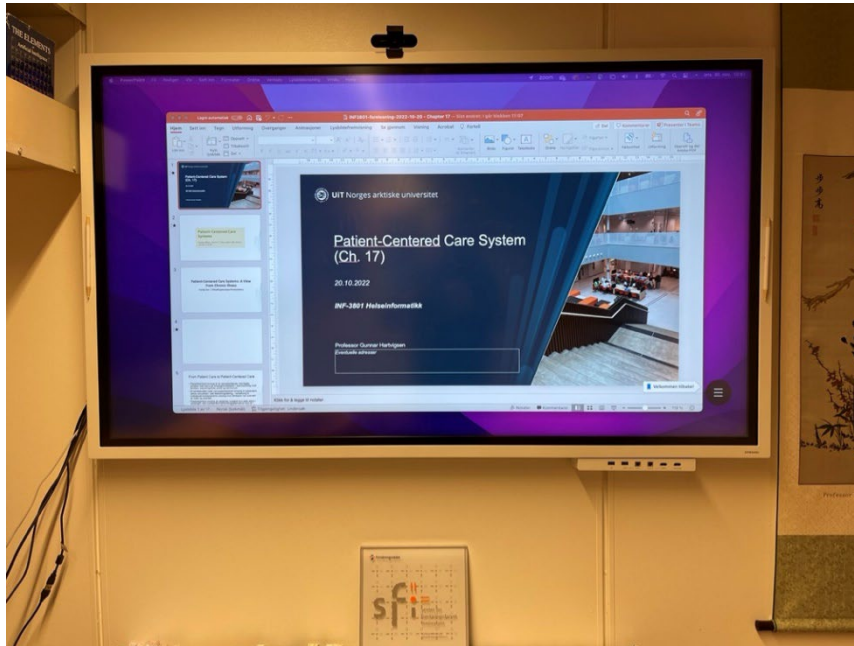


Figure 11 Example of a large active monitor (65") in a university teacher's office. (Photo: Gunnar Hartvigsen)

## 5.5. Our "wish list" for lounges and meeting rooms on campus

In connection with lounges and meeting rooms (Figure 12, Figure 13) on campus, we should have access to various technological solutions that promote collaboration and learning, including:

- Large active monitor(s) where student(s) and staff can seamlessly share their ideas, present learning materials, etc.
- Active and passive board(s)/panel(s)/wall(s)/comment function.
- Opportunities to ad-hoc invite fellow students and/or staff into online conversations.
- Audio/video equipment with high quality ready for use.

The remaining infrastructure in the form of ergonomically designed seating groups, meeting room facilities, etc., must also be in place.

## 5.6. Our "wish list" for virtual rooms and virtual campus

Although our primary goal is for all students and staff to spend as much time as possible on campus, there will be a need to be able to offer flexible studies in connection with continuing and further education. The pandemic (Sars-CoV-2) has also given us valuable experience with online teaching.

In connection with virtual classrooms and virtual campuses, we need various technological solutions, including equipment that offers:

- Virtual rooms for meetings and discussions (ad-hoc, planned).
- Virtual (digital) seminars, workshops, etc.
- Virtual lounges/break out rooms.
- Effective co-writing and co-creation.

- Easy access to Teaching materials.
- Advanced search features.

Access to the virtual world must be possible from as many platforms as possible, including smartphones, tablets, PCs, smart TVs, etc.



Figure 12 Example of a lounge at university department. (Photo: Gunnar Hartvigsen)



Figure 13 A university department's "secret weapon" – a good coffee machine. (Photo: Gunnar Hartvigsen)

## 5.7. Our "wish list" for laboratories

We have so far made little mention of laboratories (Figure 14, Figure 15) in our discussion of digital teaching. But unless the laboratory is already virtual (digital), then digital solutions must be facilitated also for these.



Figure 14 Example of a student/research laboratory at UiT. (Photo: Gunnar Hartvigsen)

In connection with campus-based laboratories, we should have access to various technological solutions, including:

- Large monitor/projector where supervisors and/or student(s) can present their results, show lectures, etc.
- Active whiteboard/comment function
- Equipment for project meetings and supervision where researchers, students and/or co-supervisors participate via video conferencing solutions.

We should/must facilitate that external actors of all "denominations" can participate "in the lab".



Figure 15 Project meeting in a research laboratory at UiT. (Photo: Gunnar Hartvigsen)

## 5.8. Our "wish list" for curriculum and teaching materials

Another topic that we have not touched on to any particular degree is the digitization of the curriculum and teaching materials. In step with an increasing degree of digital teaching, it is desirable that all teaching materials are digitally available to students. This will also align with the Open education agenda from the EU (Heckeberg, 2015). This includes:

- All teaching materials, including textbooks, must be digitally accessible (All-in-all).
- Students work with the same textbooks in such a way that they can have joint comments, questions, initiate discussions (real-time, off-line) based on different parts of the book, tip functions, references, etc.
- It should be possible to expand the teaching material in the form of a local version.
- Video lectures are available and can also be included as part of the syllabus.

We primarily do not want recordings of lectures. This is because lectures are "fresh" and interactive. This is also our strength in relation to those who offer sell admissions - we must therefore strengthen the dialogue with the participants/students. Students must experience the "added value" of interactive lectures where the dialogue depends on the interests and participation of those present. If recordings are nevertheless made, such recordings should only be used to a lesser extent over a longer period.

## 5.9. Our "wish list" for social media use

Universities and university colleges need to incorporate innovative technology-based educational methods to cover different student learning styles. Social media is undoubtedly one of those technologies that needs to be incorporated in higher education to facilitate transformative learning.

Incorporating social media in universities and university colleges means incorporating democratic values to our education, which supports innovation, collaboration and empowerment. The incorporation of social media promotes collaborative production of knowledge and stimulates creative learning through interaction and makes our universities more inclusive.

However, incorporating social media in our teaching requires extra time, and that is often not recognized by universities as part of the teaching. To incorporate, promote social media use, or facilitate its use among the ones that are interested in incorporating it in our teaching, we need:

- Incorporating social media education as part of the curriculum in all studies. Higher education students need to have sufficient literacy to understand the benefits and risks of using these channels and know how to use them efficiently.
- Institutional support (at all levels, including sufficient funds) to learn and understand how to best use these continuously evolving channels in higher education, to both promote active and meaningful learning, and to disseminate knowledge to society.
- That our social media activity is recognized and incorporated as qualification for academic promotions.

- That social media is integrated with our learning management systems.

### 5.10. Our “wish list” on behalf of our students

Although we as university teachers are not the right people to respond to what the students want, we still believe that, based on our experience, we can contribute with suggestions for student-adapted digital learning environments, including:

- Large active monitors everywhere (for smaller student groups).
- Access to campus 24/7.
- Access to all classrooms 24/7.
- Access to laboratories 24/7.
- Many meeting areas.
- "Learning café": The city's cheapest cafes must be on campus (almost free, and with extended opening hours and with appropriate infrastructure for learning sessions).

The campus must be made so attractive that the students primarily want to stay on campus.

When challenged with the question “How to improve the learning environment”, students at the Department of Physics, University of Bergen, reported that (Interviews performed by Erlend Hartvigsen, student at University of Bergen)<sup>1</sup>:

*“We are interested in a university that facilitates both learning and the social. A university that arouses interest and commitment. We want more dedicated rooms for learning, where you can sit in groups or read alone. In the rooms dedicated to learning, we think it would be beneficial to have electronic whiteboards that we can connect to our tablets and PCs. We believe that universities have a lot to learn from large commercial companies such as Facebook, Google, TikTok, etc. These companies have large open landscapes, with a lot of biodiversity, such as trees, plants and aquariums.”*

The Bergen students also emphasize social aspects on campus life:

*“We want a social space for a break from reading. Here we will be able to get to know fellow students better, and be able to meet the staff at the university. The rooms can contain activities such as ping pong tables, card games, chess boards and electronic activities such as the Nintendo Wii.”*

When it comes to teaching, students have several wishes, including use of more technology in teaching (when appropriated). The students also report that: *“For students who cannot attend the lecture, we want a recording of the teaching, with high-quality image and sound.”* The students specifically mention that they want: dedicated open landscapes for learning, dedicated rooms to socialize, and biodiversity on campus.

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<sup>1</sup> Interviews performed by Erlend Hartvigsen, student at University of Bergen.

It should be emphasized here that further interactions with students are needed to get a good overview of how students consider the learning environments on and off campus. Thus, we would like to stimulate studies to gather data for what makes a good learning arena:

- What do students need to graduate on time?
- Are there any features of the learning arenas that can mitigate student's mental health issues?
- What is the best learning arena for different groups of students?

These are also questions that must be answered in connection with the development of a technology-based learning arena.

Furthermore, a 24/7 campus does not imply that faculty members need to be available 24/7.

### 5.11. Our "wish list" for academic development

Digitalization, increased requirements of pedagogical competencies by legislation, and political initiatives for continuous innovations in higher education, challenge faculty members' competencies as well as development of professional identity. To be able to drive these changes there is a need for academic development to improve faculty members knowledge, skills and behaviors as teachers and educators and we therefore need:

- Organizational structures that can contribute to legitimizing education as a valued field of scholarship:
  - Formalized structures for peer learning, reflections, and knowledge development in teaching & learning.
  - Informal arenas for collaboration, peer learning and promotion of scholarship in teaching and learning.
- Formal and informal faculty development initiatives that support:
  - Faculty members (professional identity, leadership, team building and collaboration etc.)
  - Teaching (evidence-informed educational designs, content, learning, supervision, feedback and reflection, educational projects etc.)
  - Career & promotion



## 6. Universities in the 21<sup>st</sup> century - where are we heading?

The starting point for this report was to identify how we can revitalize the campus as the preferred learning arena for students and staff after the experience made during the COVID-19 pandemic and the sudden necessity for online and remote teaching. This experience resulted in the wish of being able to combine the best of campus and online learning arenas.

We experience too often that students don't find it convenient to show up on campus. NTNU's internal Universitetsavisa (Mæle, 2023) published in February 2023 an article that described that of 600 registered students, only 60 were present in the auditorium during the lecture. It should be added that the lecture was both streamed and recorded. According to the lecturer Børge Haugset, 60 students represented an increase from 10-12 students who were present at the first lecture. On the other hand, the number of student present in the auditorium has decreased from when the lecturer first was teaching the course in 2018 (Mæle, 2023).

Haugset says in the article that:

*"He finds it difficult to know what is the right thing to do when it comes to teaching methods, but admits that it is tiresome to teach when so few show up. Teaching is the best part of his job, but his joy cannot control the best solution, according to him.*

*"We're competing against ourselves, whether it's live recording or 'going to take it when it's getting closer.' We strive to deliver the best possible product to our customers – the students, but I sometimes wonder if we have made too much. Too many different sources of knowledge. And they end up whining through the syllabus. Lectures of two times 45 minutes feel too long for those who have grown up scrolling through."*

We must take advantage of the benefits that a technology-based learning environment gives us. Korsberg et al. (Korseberg et al., 2022) summarized it:

*"... the data sources refer to three overall benefits of using digital technology in higher education. In such a setting, digital technology can contribute to (1) more student-activating forms of teaching, to (2) pedagogical development, especially in practical subjects, and to (3) increased accessibility in higher education. On the other hand, this presupposes that the use of digital technology is an integral part of a holistic learning and teaching design, and that faculty members and students have both an understanding of and competence in the use of digital tools for a pedagogical purpose" (Korseberg et al., 2022).*

A key point here is the teachers' digital competence when it comes to the use of online learning arenas. Korsberg et al. conclude with:

*"In order to make the best possible use of the pedagogical potential of digital technology, it is required that employees have access to a combination of technical competence, knowledge of the possibilities and limitations of the technology, access to relevant equipment and not least a pedagogical foundation for how digital technology can be used. It is also important that the professional*

*employees have enough time to familiarize themselves with the technology to be used, so that the use can be as "seamless" as possible. They should also have access to relevant support functions, especially ICT expertise, but here there is great variation between the institutions" (Korseberg et al., 2022).*

As we see it, both a technology-based learning arena on campus and cafes and meeting arenas for social interaction are needed to keep students on campus.

In this report, we have taken for granted that most university faculty members want to use different technological/digital systems in their teaching. We also implicitly assume faculty members want to teach or at least see the value in teaching. There has been an increasing focus on recognizing and rewarding good teaching from both a political point of view and in higher education. Pedagogical competency is required by legislation for employment and formal development as teachers, not just as researchers are expected when applying for promotion. Merit schemes also act as incentives for such development. In step with the formal requirements, we are experiencing an increased awareness of teaching quality among university teachers. Nevertheless, research is still considered the primary concern for many faculty members, and there is still a way to go before the *quality of teaching* is equivalent to *research quality*.

Well-designed, flexible and technologically up-to-date teaching and learning environments on campus are absolutely essential to highlight the importance of education as the universities' social mission. In addition, Shorey et al. (Shorey et al., 2022) proposes having policies in place to support both students and faculty. For example, they propose 'humanizing' remote learning technologies to improve undergraduate-faculty relationships, providing adequate psychosocial support for undergraduate students and faculty members, which include "encouraging online faculty development activities to enhance receptiveness to blended learning pedagogies". Together with the right incentives for faculty members one can avoid teaching being described as a burden or "the elephant in the room" as Copeland (Copeland, 2022) put it.

Mega-universities primarily offer their services online in the form of online education and they are growing rapidly as a result of extensive marketing of the study programs (Gardner, 2019). It is expected that they will soon educate a significant proportion of American students. However, there are several challenges with these newcomers. Online teaching has a greater drop-out rate than campus-based offers (Gardner, 2019) and online-only universities have to counteract this with "calling a student to check in if the copious data collected on him or her shows unfinished assignments or missed sessions." (Gardner, 2019). Also, Mega-universities follow the market, i.e., they are under pressure to deliver the teaching to as many people as possible at the lowest possible costs. This means more students per faculty member, which in turn gives less time to each individual student. More associate professors are employed with a larger teaching share and less time for research and professional specialization. It is expected that digitalization of teaching will lead to more efficient teaching in terms of resources. Mega-universities are governed by students' preferences. Popular studies provide better earnings than study programs with few students, and studies with few students are put under pressure to increase the "earnings".

This report does not discuss mega-universities in detail (Gardner, 2019), we still think it is important to be aware of and learn from international trends, failures and initiatives for quality in higher education. The driving force for teaching should always be students learning with a scholarly approach for combining online and campus learning. Infrastructure, up-to-date technologies and possibilities for continuous development of competencies are important prerequisites for sustainable and innovative universities. At the same time, universities should also be a home for small study programs, not for profit, and a home for the few but bright scholars going against the mainstream.

Another emerging trend is using Metaverse in higher education. University of Tokyo has open a Metaverse School of Engineering (Shimbun, 2022). Several universities world-wide are active in Metaverse (Coinscapture, 2022). The pedagogical goal is to make learning fun, establish a good environment for problem-solving and interaction with teachers of all forms and fellow students (Arti, 2022).

Whether teaching is online, at campus or a hybrid solution, “education should be viewed as a relational term where education and teaching fall into the three different but overlapping domains: qualification, socialization and subjectification” (Biesta, 2012; Biesta, 2013). “Qualification encompasses acquisition of different knowledge and skills, and to a certain extent values and dispositions. Socialization refers to the way in which individuals become part of existing traditions and practices. Subjectification includes the way in which education contributes to the formation of certain qualities of the individual person” (Johnsen, 2018). Independent of the tools, we need to find the right balance among these three dimensions (Biesta, 2012; Biesta, 2013).

## References

- Arti. (2022). Top 10 Universities offering Metaverse Related Research, Courses & More. *Analytics Insight*.
- AVNetwork. (2015, 2015-11-19T01:41:00Z). *X2O Media Platform Operates Employee Photo Video Wall*. Retrieved 06-12 from <https://www.avnetwork.com/avnetwork/x2o-media-platform-operates-employee-photo-video-wall>
- Baddeley, A. (1992). Working memory. *Science*, 255(5044), 556-559. <https://doi.org/10.1126/science.1736359>
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc.
- Bearman, M., Nestel, D., & McNaughton, N. (2017). Theories informing healthcare simulation practice. In *Healthcare Simulation Education* (pp. 7-15). John Wiley & Sons, Ltd.
- Biesta, G. (2012, 2012-07-04). *Philosophy of Education for the Public Good: Five challenges and an agenda - BIESTA - 2012 - Educational Philosophy and Theory - Wiley Online Library*.
- Biesta, G. J. J. (2013). Giving Teaching Back to Education: Responding to the Disappearance of the Teacher. *Phenomenology & Practice*, 6 (2), 35-49. <https://doi.org/10.29173/pandpr19860>
- Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals* (Vol. Handbook I: Cognitive domain). David McKay Company.
- Bovill, C. (2019). Student-staff partnerships in learning and teaching: an overview of current practice and discourse. *Journal of Geography in Higher Education*, 43(4), 385-398. <https://doi.org/10.1080/03098265.2019.1660628>
- Bryant, J., Heitz, C., Sanghvi, S., & Wagle, D. (2020). *Artificial intelligence in education: How will it impact K-12 teachers* | McKinsey. Retrieved 06-26 from <https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers>
- Caniglia. (2019, 2019). *Simulation as a Teaching Strategy* | Kent State University. Retrieved 06-12 from <https://www.kent.edu/ctl/simulation-teaching-strategy>
- Capp, M. J. (2017). The effectiveness of universal design for learning: a meta-analysis of literature between 2013 and 2016. *International Journal of Inclusive Education*, 21(8), 791-807. <https://doi.org/10.1080/13603116.2017.1325074>
- Cheslaw, L. (2021, 2021-08-18T16:30:00.000-04:00). *Everything You Need to Work From Home, According to People Who Do It Everyday*. Retrieved 02-17 from <https://nymag.com/strategist/article/best-work-from-home-essentials.html>
- Chokkattu, J. (2023, 2023-03-02). Everything You Need to Work From Home Like a Pro. *Wired*. <https://www.wired.com/story/work-from-home-home-office-gear-guide/>
- Chugh, R., Grose, R., & Macht, S. A. (2021). Social media usage by higher education academics: A scoping review of the literature. *Education and Information Technologies*, 26(1), 983-999. <https://doi.org/10.1007/s10639-020-10288-z>
- Coinscapture. (2022). 10 Leading Universities For Metaverse Research And Courses. *CoinsCapture*.
- Copeland, P. (2022). Stop describing academic teaching as a 'load'. *Nature*. <https://doi.org/10.1038/d41586-022-00145-z>
- Coursera. (2023). *Online Courses & Credentials From Top Educators. Join for Free*. Retrieved 02-12 from <https://www.coursera.org/>

- Cowley, B. U., Charles, D., Pfuhl, G., & Rusanen, A.-M. (2022). Artificial Intelligence in Education as a Rawlsian Massively Multiplayer Game: A Thought Experiment on AI Ethics. In H. Niemi, R. D. Pea, & Y. Lu (Eds.), *AI in Learning: Designing the Future* (pp. 297-316). Springer.
- Datareportal. (2023). *Global Social Media Statistics*. Retrieved 05-23 from <https://datareportal.com/social-media-users>
- de Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education*, 46(3), 249-264. <https://doi.org/10.1016/j.compedu.2005.11.007>
- Department of Health. (2014, 2014-10-10). *What is simulation learning?* Retrieved 01-15 from [https://www.health.wa.gov.au/Articles/U\\_Z/What-is-simulation-learning](https://www.health.wa.gov.au/Articles/U_Z/What-is-simulation-learning)
- Dieckmann, P. (2009). *Using Simulations for Education, Training and Research* (1st edition ed.). Pabst Science Publishers.
- Dykstra, J. (2023, 2023-04-08). *The Ultimate 46 Item Office Equipment and Supplies List for a Productive Workspace in 2023*. Retrieved 08-15 from <https://www.homestratosphere.com/types-of-office-equipment/>
- edX. (2022). *Free Online Courses by Harvard, MIT, & more | edX*. Retrieved 12-22 from <https://www.edx.org/>
- European Commission. (2017a). *Communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions* (COM(2017) 250 final).
- European Commission. (2017b). *Recommendation on the European Pillar of Social Rights* (C(2017) 2600 final).
- Felten, P. (2013). Principles of Good Practice in SoTL. *Teaching & Learning Inquiry The ISSOTL Journal*, 1(1), 121-125. <https://doi.org/10.20343/teachlearningqu.1.1.121>
- Fisk University. (2021, 2021-08-03T13:00:54+00:00). *HTC VIVE, T-Mobile and VictoryXR Launch 5G-Powered VR Human Cadaver Lab*. Retrieved 12-06 from <https://www.fisk.edu/university-news-and-publications/fisk-university-htc-vive-t-mobile-and-victoryxr-launch-5g-powered-vr-human-cadaver-lab/>
- Gans, J. (2016, 2016-04-10). *Online Research Seminars: First Impressions – Digitopoly*. Retrieved 06-13 from <https://digitopoly.org/2016/04/10/online-research-seminars-first-impressions/>
- Gardner, L. (2019, 2019-02-17T23:30:00). Mega-Universities Are On the Rise. They Could Reshape Higher Ed as We Know It. *The Chronicle of Higher Education*.
- GineersNow. (2016, 2016-03-05). *High Tech Classroom by Harvard HBX*. <https://www.youtube.com/watch?v=P49hyHYPOQg>
- Goel, A. K., & Polepeddi, L. (2016). *Jill Watson: A Virtual Teaching Assistant for Online Education*. <https://repository.gatech.edu/entities/publication/4a7ab707-3311-4c67-a3c5-c309873d75f5>
- Haddeland, K., & Söderhamn, U. (2013). Sykepleierstudenters opplevelse av veiledningssituasjoner med sykepleiere i sykehuspraksis – En fenomenologisk studie. *Nordisk sygeplejeforskning*, 3(1), 18-32. <https://doi.org/10.18261/issn1892-2686-2013-01-03>
- Hakeem, S. A. (2001). Effect of Experiential Learning in Business Statistics. *Journal of Education for Business*, 77(2), 95-98. <https://doi.org/10.1080/08832320109599056>
- Hamilton, C., Fox, J. P., Longley, D. B., & Higgins, C. A. (2021). Therapeutics Targeting the Core Apoptotic Machinery. *Cancers (Basel)*, 13(11), 2618. <https://doi.org/10.3390/cancers13112618>

- Hartvigsen, G. (2012). E-læring for Web 2.0-generasjonen av studenter (“E-learning for the Web 2.0 generation of students”). In S. Blix, N. Anderssen, & S. Tove (Eds.), *Helse.digital. Digitale arenaer i praksis og utdanning*. Cappelen Damm akademisk.
- Harvard Business School online. (2022). *Harvard Business School Online Courses & Learning Platforms*. Retrieved 06-12 from <https://online.hbs.edu/>
- Heckeberg. (2015). Open Education Europa | European Network for Education and Training – EUNET e.V.
- Henderson, M. (2021, 2021-06-25). *Pharmacy’s new active learning classroom fosters creative thinking, team-building*. Retrieved 02-14 from [https://www.ulm.edu/news/2021/pharm\\_class\\_062421\\_hy.html](https://www.ulm.edu/news/2021/pharm_class_062421_hy.html)
- Jakobsen, S. (1998, 1998-08-01T10:00:00.000Z). *Et menneske - ikke bare en kvinne*.
- Johnsen, H. M. (2018). “BEING-IN-THE-WORLD” : Teaching clinical reasoning skills to nursing students through a serious game. *Universitetet i Agder*. <http://hdl.handle.net/11250/2570303>
- Jones, J. D., & Barrett, C. E. (2017). Simulation as a Classroom Teaching Method. *i-manager's Journal on School Educational Technology*, 12(4), 49-53. <https://doi.org/10.26634/jsch.12.4.13551>
- Kellert, S. R. (2015, 2015-10-26). *What Is and Is Not Biophilic Design*. Retrieved 06-12 from <https://metropolismag.com/viewpoints/what-is-and-is-not-biophilic-design/>
- Kellert, S. R., & Calabrese, E. F. (2015). *The Practice of Biophilic Design - A Simplified Framework*. <https://www.biophilic-design.com>
- Kim, J., Park, J. H., & Shin, S. (2016). Effectiveness of simulation-based nursing education depending on fidelity: a meta-analysis. *BMC Med Educ*, 16, 152. <https://doi.org/10.1186/s12909-016-0672-7>
- Kolb, D. A. (1983). *Experiential Learning: Experience as the Source of Learning and Development* (2nd ed. edition ed.). Prentice Hall.
- Korseberg, L., Svartefoss, S. M., Bergene, A. C., & Hovdhaugen, E. (2022). *Pedagogisk bruk av digital teknologi i høyere utdanning*.
- Luo, T., Freeman, C., & Stefaniak, J. (2020). "Like, comment, and share"-professional development through social media in higher education: A systematic review. *Etr&D- Educational Technology Research and Development*, 68(4), 1659-1683. <https://doi.org/10.1007/s11423-020-09790-5>
- Malik, A., Heyman-Schrum, C., & Johri, A. (2019). Use of Twitter across educational settings: a review of the literature. *International Journal of Educational Technology in Higher Education*, 16(1), 36. <https://doi.org/10.1186/s41239-019-0166-x>
- Marcus, J. (2020, 2020-02-20). How Technology Is Changing the Future of Higher Education. *The New York Times*. <https://www.nytimes.com/2020/02/20/education/learning/education-technology.html>
- Mayer, R. E. (2019). How Multimedia Can Improve Learning and Instruction. In J. Dunlosky & K. A. Rawson (Eds.), *The Cambridge Handbook of Cognition and Education* (pp. 460-479). Cambridge University Press.
- Ministry of Education and Research. (2018). *Report No. 4 to the Storting (2018–2019)* [Stortingsmelding].
- Ministry of Education and Research. (2020). *Report No. 7 to the Storting (2020-2021)*.
- Ministry of Health and Care Services. (2009). *Report No. 47 to the Storting (2008-2009) - The Coordination Reform — Proper treatment – at the right place and right time*.
- Murphy, M., & Crowfoot, A. (2021). *Universities without walls – A vision for 2030*. In: European University Association.

- Mæle, S. (2023, 2023-02-27T05:00:00.000Z). *I dette emnet er over 600 oppmeldt – kun 60 moter opp*. Retrieved 05-23 from <https://www.universitetsavisa.no/borge-haugset-foreleser-forelesning/i-dette-emnet-er-over-600-oppmeldt-kun-60-moter-opp/376096>
- Nes, A. A. G., Zlamal, J., Linnerud, S. C. W., Steindal, S. A., & Solberg, M. T. (2023). A Technology-Supported Guidance Model to Increase the Flexibility, Quality, and Efficiency of Nursing Education in Clinical Practice in Norway: Development Study of the TOPP-N Application Prototype. *JMIR Hum Factors*, 10(1), e44101. <https://doi.org/10.2196/44101>
- Office snapshots. (2022). *Bring Collaboration Into Your Office With Connected Furniture Settings*. Retrieved 03-25 from <https://officesnapshots.com/articles/collaboration-connected-media-office-furniture/>
- OFS. (2022). *Meet Heya*. Retrieved 01-25 from <https://ofs.com/heyaa>
- OnlineEducation. (2020, 2020). *Jill Watson: Using AI and Adaptive Learning to Help Teachers and Students*. Retrieved 06-06 from <https://www.onlineeducation.com/features/ai-teaching-assistant-jill-watson>
- Owen, H. (2012). Early use of simulation in medical education. *Simul Healthc*, 7(2), 102-116. <https://doi.org/10.1097/SIH.0b013e3182415a91>
- Patterson, D. (2016, 2016). *Advice for New Computer Science Professors*. Retrieved 02-12 from <https://people.eecs.berkeley.edu/~pattrsn/talks/Patterson.html>
- Profesor Avatar. (2022). *Telepresence Model*. Retrieved 12-06 from <https://profesoravatar.com/>
- Raffaelli, R. (2017, 01 Mar 2017). *HBX Launches Managing Your Career Development, First Program Offered via HBX Live Virtual Classroom*. Retrieved 06-11 from <https://www.hbs.edu/news/releases/Pages/hbx-managing-your-career-development.aspx>
- River, J., Currie, J., Crawford, T., Betihavas, V., & Randall, S. (2016). A systematic review examining the effectiveness of blending technology with team-based learning. *Nurse Educ Today*, 45, 185-192. <https://doi.org/10.1016/j.nedt.2016.08.012>
- Rocha, C. J. (2000). Evaluating experiential teaching methods in a policy practice course: The case for service learning to increase political participation. *Journal of Social Work Education*, 36(1), 53-63. <https://doi.org/10.1080/10437797.2000.10778989>
- Sabus, C., & Macauley, K. (2016). Simulation in Physical Therapy Education and Practice: Opportunities and Evidence-Based Instruction to Achieve Meaningful Learning Outcomes. *Journal of Physical Therapy Education*, 30(1), 3–13. <https://doi.org/10.1097/00001416-201630010-00002>
- Samsung. (2022a). *Samsung Flip*. Retrieved 03-13 from <https://www.samsung.com/de/business/smart-signage/digital-flipchart/interactive-display-wmr-series-lh65wmrwbgcxen/>
- Samsung. (2022b). *Samsung Flip 2*. Retrieved 03-12 from <https://www.samsung.com/uk/smart-signage/digital-flipchart/wm55r-flip2-0-65-inch-lh65wmrwbgcxen/>
- Schon, D. A. (1984). *The Reflective Practitioner: How Professionals Think In Action* (1st edition ed.). Basic Books.
- Schunk, D. (2019). *Learning Theories: An Educational Perspective* (8th edition ed.). Pearson.
- Schwartz, A. (2013, 2013-02-26). *In Cisco's Classroom Of The Future, Your Professor Is Just An Illusion*.
- Sharifi, A., Ghanizadeh, A., & Jahedizadeh, S. (2017). The effect of simulation on middle school students' perceptions of classroom activities and their foreign language

- achievement: A mixed-methods approach. *International Electronic Journal of Elementary Education*, 9(3), 667-680.
- Shimbun, T. Y. (2022, 2022-08-15 01:53:57). *University of Tokyo to open Metaverse School of Engineering*.
- Shorey, S., Pereira, T. L., Teo, W. Z., Ang, E., Lau, T. C., & Samarasekera, D. D. (2022). Navigating nursing curriculum change during COVID-19 pandemic: A systematic review and meta-synthesis. *Nurse Educ Pract*, 65, 103483. <https://doi.org/10.1016/j.nepr.2022.103483>
- Smith System. (2022). *Multimedia Cafe Tables*. Retrieved 02-12 from <https://smithsystem.com/furniture/multimedia-cafe-tables/>
- Steelcase. (2022a). *media:scape*. Retrieved 02-12 from <https://www.steelcase.com/products/conference-collaborative-tables/mediascape/>
- Steelcase. (2022b). *Office Furniture Solutions, Education & Healthcare Furniture*. Retrieved 02-12 from <https://www.steelcase.com/>
- The Economist. (2021, 12-01). The office of the future. *The Economist*. <https://www.economist.com/business/2021/12/04/the-office-of-the-future>
- Walberg, H. J. (1969). Social Environment as a Mediator of Classroom Learning. *Journal of Educational Psychology*, 60(6p1), 443-&. <https://doi.org/10.1037/h0028499>
- Warwick Conferences. (2022). *Indoor creative spaces*. Retrieved 02-12 from <https://warwick.ac.uk/services/conferences/spaces/creative/indoor>
- Watanabe, A., Saka, H., Sakai, S., Hirao, T., Hattori, T., & Shimokata, K. (1990). Bronchoscopic and cytopathological findings of tracheobronchial involvement in esophageal carcinoma. *Endoscopy*, 22(6), 273-275. <https://doi.org/10.1055/s-2007-1012869>
- Wikipedia. (2022, 2022-11-12). *Biophilic design*. [https://en.wikipedia.org/w/index.php?title=Biophilic\\_design&oldid=1121464181](https://en.wikipedia.org/w/index.php?title=Biophilic_design&oldid=1121464181)
- Wilson Architects. (2021). *Bond University Multimedia Learning Centre*. Retrieved 02-12 from <https://www.wilsonarchitects.com.au/education-spaces/bond-multimedia-learning-centre>
- World Health Organization. (2013). *Transforming and scaling up health professionals' education and training*. <https://www.who.int/publications/i/item/transforming-and-scaling-up-health-professionals%E2%80%99-education-and-training>
- X2O Media. (2022a). *About page*. Retrieved 12-02 from <https://www.x2oedia.com/en/company/about-x2o/>
- X2O Media. (2022b). *Digital Workplace & Virtual Meeting Technology*. Retrieved 12-02 from <https://www.x2oedia.com/en/>
- X2O Media. (2022c). *OneRoom Classroom*. Retrieved 12-02 from <https://www.x2oedia.com/en/solutions/oneroom/classroom/>
- Zhonggen, Y. (2019). A Meta-Analysis of Use of Serious Games in Education over a Decade. *International Journal of Computer Games Technology*, 2019, 1-8. <https://doi.org/10.1155/2019/4797032>





