Klaus Kreulich, Sibylle Matern (Eds.)

Teaching and Learning in Virtual Space

HM Hochschule München University of Applied Sciences

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Editors' Introduction

Motivation and starting point for the anthology

When it comes to working and learning, collaboration is often the key to success. In a team, tasks can be completed more efficiently, complex issues are easier to grasp and, as we all know, learning is not only an individual but also a social process. In today's working and learning world, shaped by social media, digital business processes and artificial intelligence algorithms, there are many opportunities for cooperation and collaboration. Indeed, as digitalisation progresses, more and more possibilities are emerging, continuously raising fundamental questions about the design of learning and work: How does the learning behaviour of individuals and groups change under new digital conditions? As the possibilities change, what does learning with and from each other look like? How can teams using digital capabilities come together while physically separated?

At higher education institutions, the question arises as to what control structures, learning formats and didactic methods students and lecturers need when communication takes place not in person, but online, virtually or in a hybrid form. In the digitalised world of work, the challenges are similar. The core questions are: How can employees and managers maintain contact with each other in a sociable and efficient way when collaboration takes place on digital platforms or even in the form of avatars in virtual space? How can all those involved connect socially, benefit from each other and act purposefully? And considered from a critical perspective: How do misunderstandings arise in the virtual, digitally shaped world we live in, and above all, how can misunderstandings be avoided? When using technological communication tools, it is important to use them together with natural language and body language in a way that promotes clear and engaging communication and collaboration in what is usually an unfamiliar virtual environment.

Fundamentally, the questions being raised are not new. On the contrary, developments as a result of the internet and digital progress have already led to a plethora of forms of communication, cooperation and collaboration. Users often recognise and make use of the associated opportunities in a casual way, in a kind of "learning by doing" mode. Thus, collaboration is being practised and professionalised using tools for email, chat, project management, online conferencing and more. However, there is limited systematic, scientifically based understanding of how digital media and the digital automatisms behind them affect what happens between a sender and a receiver, what a communication partner perceives, or how reacting to others or cooperative action work. Communication models and forms of organisation for teams tackling joint projects and challenges are usually based on experience gained in the context of familiar face-to-face formats. But the possibilities of digitalisation now extend far beyond the realm of what can be done "in person". While the asynchronous exchange of electronic messages can still be compared to paper-based correspondence to a certain extent, an online presentation enriched with multimedia tools, for example, is already very different from a classroom lecture. Virtual and mixed reality technologies represent another qualitative leap. A person's experience of an encounter as an avatar with limited natural senses, but equipped with the possibilities of a digitally enriched virtual figure in a space that virtually abolishes physical boundaries, can no longer be derived from any real situation in an office or lecture hall.

Significant progress is currently being made in virtual technologies and application scenarios that rely on them. The vision of virtualising physical environments in all areas of life is becoming increasingly tangible. Various professional applications are already in place, for example in medicine, where surgical procedures are supported remotely by experts off site, or in the field of highly complex machine training, such as flight simulation. The barriers to using these technologies are falling fast, and solutions are being developed to make it easier to use virtual spaces in all areas of life.

Universities play a major role in the systematic monitoring of the developments described above. They are excellent places for innovation in the contributing STEM disciplines as well as in the humanities. At the same time, universities are real laboratories for testing new digital communication tools. For example, engineering research projects are enhancing the technological properties of VR glasses, architecture courses are designing virtual spaces, and the social sciences are evaluating the emotional effects of using avatars.

Universities are the ideal place to make progress. The interdisciplinary exchange that takes place everywhere ensures that lessons learned and new insights spread as quickly as possible. Practical projects with students often involve working on real challenges with partners from business and society, which is closely linked to the relevance of the application. They typically work with prototypes, open source software and improvised system environments. The result is not production-ready solutions, but valuable inspirations and innovation, many of which find their way into the workplace. This is particularly true of concepts, processes and technologies used in learning. This anthology is the result of this university approach.

The articles in this anthology explore new forms of communication and opportunities for collaborative learning and working using virtual reality. The research and discussions presented are exploratory in nature. They are based primarily on prototypical collaboration scenarios developed and tested in teaching and research projects at Munich University of Applied Sciences HM. The following section gives a brief overview of how the articles are arranged.

Articles in the anthology

The anthology begins with "Immersive Collaboration: Facilitating Good Teamwork", a discourse on the central concept of collaboration and its transfer to virtual space. The focus is on the use of virtual spaces and the use of immersion for effective and efficient teamwork. To explore this approach, the paper proposes a simplified model of immersive collaboration based on the established media richness theory.

The article "Psychological Aspects of Virtual Collaboration: A Brief Overview" discusses the impact of virtuality on both team relationships and the emotions of individuals. The resulting changes are evident in perceptions of stress and safety. Personal attitudes, such as identification with the team and shared tasks, are also affected. Among other things, the article sheds light on the perception of stress in virtual spaces and gives advice to HR managers, coaches and lecturers on how to train people to cooperate virtually to achieve goals such as "virtual empathy".

"Let's Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments" examines the additional competencies that team members can acquire through virtual collaboration or learning – in particular, it explores how virtual reality can support the acquisition of knowledge and the development of social skills. In a qualitative study, initial findings on the development of collaboration and communication skills were obtained.

"Virtual Collaboration as a 'Future Skill' – Analysis of an Innovative Learning Scenario for an HEI of the Future" is a study of the transformation of higher education institutions under the influence of new competence requirements. Universities are challenged to educate students to become responsible citizens of a globalised world. Competence in virtual collaboration is one of the skills that will be required in the future.

The collection continues with a focus on virtual communication scenarios. The article "Digital Negotiations across Cultures" deals with virtual communication when using web conferences for intercultural negotiations. Based on a German-Japanese negotiation simulation, the paper highlights various weaknesses of web conferences in intercultural interactions and offers tips for goal-oriented communication in international business relations.

The focus on communication scenarios is maintained in the article "From Second Life to Second Job: Creativity and Entrepreneurship Education in the Metaverse". Drawing on an exploratory study, it suggests how brainstorming and other idea generation concepts can be implemented in the virtual world. In a broader sense, the article contributes to new communication concepts in innovation management.

The following two articles look at how virtual formats can be used to positively influence motivation and attitudes in the team building phase. First, the article "Gamification for Team Motivation" discusses a digitally supported onboarding process for project teams. Based on a tested novel teaching scenario, a process is presented that can be used as a template for team building when learning in the context of work projects. The prototypical model presented is based on a digital escape room.

Another contribution in the broader sense of team motivation is provided by the article "Virtual Collaboration in the Technology Laboratory – an Example from Semiconductor Technology", which deals with preparation for collaborative work among laboratory teams. The approach presented in the article was tested with the aim of increasing students' interest in learning and engagement prior to collaborative practical investigations. It shows how online whiteboards can be used as a simple and effective tool for team building and promoting identification with a common task.

The concluding article "(Virtual) Collaboration in Medicine and Biomedical Engineering", extends the consideration of collaboration to the interaction of team members with machines or robots. Drawing on the state of the art of remote concepts in biomedicine, the paper demonstrates the contribution of virtual technologies to the efficient use of resources in research and development as well as in the training of experts. The article, and thus the book, closes with a postscript from the student perspective.

Taken together, the articles in this collection illustrate a variety of opportunities and challenges that the use of virtual spaces and virtual technologies presents for successful teamwork. The collection cannot and is not intended to be a complete overview of the rapid developments driven by digitalisation, including artificial intelligence. Its aim is to contribute to exploratory research as well as pilot studies of concepts and methods in the use of virtuality, with contributions from different professional and application perspectives. The question of whether teamwork will increasingly take place in virtual space in the future is clearly answered in the affirmative. For this reason, it is necessary to continue to investigate the organisation of virtual collaboration in the future and to continuously develop new concepts for collaboration. This publication is a snapshot of these ongoing developments. It is intended to inspire practitioners to innovate in the design of collaboration in work and learning environments and to stimulate researchers in their future experiments and research approaches.

Acknowledgements

We would like to express our sincere thanks to all those involved in this publication and especially to the authors of this anthology. They have made a significant contribution to future approaches to learning and working in virtual spaces.

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Immersive Collaboration: Facilitating Good Teamwork

Klaus Kreulich

Abstract

Collaboration means acting and performing together in pursuit of a common goal. In this way, collaboration is essential in tackling global challenges and achieving success in organisations, companies, and the everyday working and learning lives of individuals.

Collaboration in the virtual world (virtual collaboration) is becoming increasingly important with the current growth in the use of virtual technologies and the emergence of complex virtual concepts in all areas of our lives. Advances in media technology, especially in the field of virtual reality, enable media users to experience media more intensively and to submerge themselves in the virtual environment (immersion[1]). This article aims to help harness the new possibilities of virtual technologies for effective and efficient teamwork.

The article posits that immersion can enhance collaboration and, in turn, improve team effectiveness and efficiency. To explore this idea, the article proposes a simplified model for immersive collaboration, which draws on the established media richness theory. This model is intended to serve as a starting point for the development of tools that strategically employ immersive media to support collaborative teamwork, particularly in the face of complex challenges. By leveraging the insights of the immersive collaboration model, future tools can help teams work together more seamlessly and achieve their goals more easily.

Keywords: collaboration, immersion, virtuality, media richness theory

1 Immersion is a user's engagement with a VR (virtual reality) system that results in the user being in a flow state. Immersion in VR systems depends mainly on sensory immersion, which is defined as "the degree which the range of sensory channel is engaged by the virtual simulation" (Kim & Biocca, 2018).

Collaboration

Characteristics of collaboration

Collaboration refers to the process of acting and performing together. This is also the fundamental idea behind cooperation, but collaboration takes this concept a step further. A distinguishing feature of collaboration is a common goal or objective. Another is acting and performing together in the spirit of a team. Activities that contribute towards achieving the goal can involve sharing ideas, resources, and information, coordinating efforts, and communicating effectively to ensure that common or individual goals, projects and tasks are completed successfully. Collaboration typically involves a group of individuals with different skills and expertise working or learning together to achieve a shared purpose and can include both in-person and virtual activities. Similar definitions can be found in dictionaries, e. g. "the act of working with another person or group of people to create or produce something" (Oxford University Press, 2023).

The idea of a common goal can also be found in pedagogical approaches, such as the definition of collaborative learning by UNESCO's International Bureau of Education:

> A process through which learners at various performance levels work together in small groups toward a common goal. It is a learner-centred approach derived from social learning theories as well as the socio-constructivist perspective on learning. Collaborative learning is a relationship among learners that fosters positive interdependence, individual accountability, and interpersonal skills. (UNESCO, 2023)

Collaboration is one of the essential conditions for good teamwork in working and learning situations. There are also other basic conditions that promote good teamwork, where both the right things are done (efficient teamwork) and things are done correctly (effective teamwork). A very popular method is setting SMART (specific, measurable, achievable, relevant and time-bound) goals (Drucker, 1977). Other generally accepted conditions for capable project teams are clear roles and responsibilities, clear communication, a constructive feedback mechanism, recognition and appreciation, and trust and respect.

Collaboration is both encouraged by the "team rules" mentioned above and is itself a prerequisite for reinforcing these behavioural principles. The ambiguity of the term underlines its relevance and at the same time raises the question of what a more precise definition may look like.

Collaboration has been described extensively from a practical popular science perspective several times. Well-known examples are the collaboration handbook by Winer and Ray (Winer, 1994) and the leadership book about collaboration published by Harvard Business Review Press (Hansen, 2009). A scientific approach claiming to construct the term without contradictions in distinction to related terms and thus to create a basis for theoretical models is pursued by Bedwell et al. Written from a human ressource management perspective, their paper "describes a multidisciplinary conceptualization of collaboration and discusses the implications of this integrative theory to human resource management and strategy development as well as future research efforts" (Bedwell et al., 2012, p. 128).

In addition to these references, there is a body of popular and academic literature that can be used to summarise disciplinary perspectives on collaboration as follows: From the perspective of psychology, collaboration is a behaviour, whereas in sociology, it is a social process in which individuals work together to achieve a common goal or objective. In economics and political science, the focus is more on conflicting interests and how to achieve mutually beneficial outcomes.

All in all, a unifying idea of collaboration in relation to individuals, teams, and society is people working together to achieve a common goal or objective.

The fact that collaboration is the subject of research in a wide range of academic disciplines underlines its importance and its impact on our lives.

Impact of collaboration

When people work or learn together, they can leverage each other's skills, resources and perspectives to achieve more than they could individually. In this way, collaboration at work and in the learning process is important to our society as a fundamental means of achieving progress in business and education.

In the workplace, collaboration is essential for achieving organisational goals, improving productivity, and fostering a positive and supportive work environment. In learning at university, school or in the workplace, collaboration is important for several reasons. It allows students to learn from one another and gain different perspectives on the material. It also encourages active learning, critical thinking, and problem-solving skills. Additionally, working on projects and assignments with others helps students develop social skills such as communication, teamwork, and time management, which are valuable in both academic and professional settings. All of this is reflected in UNESCO's requirement that "pedagogy should be organized around the principles of cooperation, collaboration, and solidarity" (UNESCO 2021, p. 9).

With respect to its impact on individuals and society, collaboration can lead to a more equitable distribution of resources and opportunities, a greater sense of social responsibility, and a shared sense of protection. It can also lead to a greater understanding and appreciation of different perspectives and ways of life.

Collaboration is also part of UNESCO's Education 2030 Agenda. It is identified as a key competency under the Sustainable Development Goal of quality education:

> … the abilities to learn from others; to understand and respect the needs, perspective and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving (UNESCO 2017, p. 10).

In summary, collaboration is crucial in tackling global challenges and achieving success in organisations, companies, and the everyday working and learning lives of individuals.

In the virtual spaces considered in this article and beyond, in an increasingly digital world, the familiar forms of face-to-face collaboration cannot always be transferred one-to-one. It is therefore all the more important to find suitable new concepts and to develop the necessary competences to apply these concepts, in part by teaching them at educational institutions. This is also how the European Commission's Digital Competence Framework should be understood, in which one of the five key areas for 21st century skills is dedicated to "communication and collaboration" (Vuorikari et al., 2022).

Virtuality and collaboration

Virtuality in academic disciplines

Virtuality is a concept that has been studied and defined in a variety of academic disciplines, including philosophy, sociology, psychology, computer science, and media science. There is no clear, widely accepted definition. For an analysis of the origin of the word in an etymological sense, see Lehman-Wilzig (Lehman-Wilzig, 2021). His paper lists a taxonomy of 35 types and meanings of virtuality that can be used to describe its semantics. Examples include "duplicate/clone", "artificial/synthetic" and "misperceived/illusion".

Kasprowicz and Rieger take a different approach to the term virtuality (Kasprowicz, 2020). Using case studies from contemporary life, they describe how virtuality is being used in practice in areas such as medicine, art, industry and others, and how this use is giving it a definition. In particular, virtuality is described not as a state of exception set apart from reality, but as a new form of normality in society.

The remainder of this text and the resulting model takes a media studies approach to the term, which allows for both academic depth and a practical conception based on popular scientific usage. Virtuality is understood in this article as the representation of a simulated environment or experience, whether it be a computer-generated simulation, a virtual reality experience or the representation of a real-world environment in another medium, such as a film or video game. This can include both the technical aspects of creating and distributing these simulations and the ways in which people interact with and respond to them. Using virtual media for teamwork is a first step towards a virtual form of collaboration.

Virtual collaboration

Virtual collaboration in this article refers to the use of digital and, in particular, virtual technologies to facilitate communication and collaboration between people who are not in the same location. It enables individuals to work together remotely and across time zones using various digital tools, such as instant messaging, video conferencing and online project management platforms. Virtual collaboration allows individuals to share information, ideas, and resources, as well as coordinate tasks and make decisions together, regardless of their physical location.

Virtual collaboration can be useful for working and learning, as well as in a variety of other contexts. In today's globalised world, where companies and organisations often have employees and partners in different locations, the virtual space is becoming increasingly important as a place to communicate and come to agreement in multi-participant projects. Team members can communicate, share knowledge and resources, and collaborate in real time – anytime, anywhere. One obvious benefit is the elimination of travel time.

In many different sectors of business and education, as well as in government, healthcare and other social sectors, virtual collaboration is already taking place. In all these domains, project management methods are being used that are naturally adaptable to virtual scenarios. Agile approaches, such as Scrum[2] and Kanban[3], are well-suited to virtual collaboration because they focus on flexibility, continuous feedback and improvement. These methodologies allow team members to work together remotely while still being able to prioritise and manage their workload. Another category is cloud-based project management tools, such as Asana[4], Trello[5], and Jira[6], which allow teams to collaborate and manage tasks, deadlines, and communication in real-time, regardless of their location. It is expected that future tools will further simplify the joint view of project statuses and the joint processing of

2 https://www.atlassian.com/agile/scrum
3 https://www.atlassian.com/agile/kanban
4 https://asana.com
5 https://trello.com/
6 https://www.atlassian.com/software/jira

work packages and task lists, in many cases making it more efficient to work together in virtual space than in physical space.

Virtual collaboration and didactic methods

When the focus is on learning, it is worth taking a look at didactics. Collaboration as a principle plays an essential role in many didactic methods. The use of virtual technologies is possible in most of them and can lead to new learning scenarios. One example is problem-based learning, an approach in which students are presented with a problem or real-world scenario to solve or explore. Students work collaboratively in groups to identify the problem, gather information, analyse the data, and develop a solution or conclusion. The group work part can be carried out well using online discussion boards, video conferencing, and other virtual collaboration tools and can include elements of other didactic methods, such as design thinking and common creativity techniques.

A didactic method that combines the advantages of face-to-face and virtual scenarios is the flipped classroom. In this method, students watch pre-recorded lectures or read materials by themselves or in groups without the lecturer and before class. After independently preparing themselves, the students attend class in small groups. This approach allows for more individual support for students and deeper discussion of the subject matter. Discussions can take place in small virtual classes and benefit from virtual tools in the same way as in problem-based learning scenarios.

Another method is gamification, which in the real world is often implemented as “business games”. In the virtual world, there are a lot of new opportunities to make learners or gamers more engaged and motivated to solve the (learning) problems and absorb the (learning) content. Gamification can include online quizzes, simulations and other interactive activities that foster collaboration and competition among students.

An established method of learning that is being taken to a new level by digitalisation is self-directed learning. The idea behind this method is to allow students to take charge of their own learning by providing them with the necessary content and letting them take the lead in their learning process. This can be facilitated by providing access to virtual resources and tools, such as tutorials, videos, and interactive activities. An ongoing trend is the use of artificial intelligence to implement a feedback mechanism for learners. Another trend is the intelligent matching of individual learners based on their progress and interests. Meetings for collaborative learning can be set up in virtual rooms. Overall, with the availability of tools that allow people to communicate remotely and connect with other individuals and organizations anywhere in the world, virtual collaboration has become an essential part of working and learning. Despite its advantages, it is clear that virtual collaboration has its own set of challenges, such as the difficuilty of giving non-verbal cues and the need to be more intentional with communication.

As technology continues to evolve and change, the role of virtual collaboration will likely become even more prominent in the future, increasing the relevance of research into new models, concepts and methods of virtual collaboration. This is the backdrop and motivation for the approach introduced in the following section.

Towards immersive collaboration

Immersion as key to even better collaboration

Immersion refers to a state of being deeply engaged or fully absorbed in an activity, experience or environment. Someone who is immersed in something feels deeply connected to it, loses track of time, and becomes completely focused on the experience.

> Immersion is an essential media characteristic and is defined as the extent to which the technology used is able to provide an inclusive, intense, comprehensive and vivid illusion of reality. A VR system is the more immersive, the more sensory modalities are addressed, the higher the speed of information processing and the greater the number of behavioural possibilities provided (Huff, 2021).

From the user's perspective, immersion is engagement with a VR system that results in the user being in a state of flow. Immersion in VR systems mainly depends on sensory immersion, which is defined as "the degree to which the range of sensory channels is addressed by the virtual simulation" (Kim & Biocca, 2018).

In virtual reality there is no real presence, but a feeling of being in the virtual world. The illusion is perceptual but not cognitive, as the perceptual system identifies events and objects and the brain-body system reacts mechanically to the changes in the environment, while the cognitive system reacts slowly with the conclusion that what the person is experiencing is an illusion (Slater, 2018).

In principle, any medium that is used in a receptive or interactive way achieves some degree of immersion. Well-written books and literature transport the reader to other worlds and times, creating vivid mental images and a sense of immersion. Music can evoke strong emotions and create immersive experiences, especially when experienced live in concert or through high-quality audio equipment. Films and television can be very immersive, especially when shown in a theatre or on a big screen with high-quality sound. Exciting stories, compelling characters, and stunning imagery can captivate viewers and create a sense of immersion. Video games are designed to be interactive and immersive, often with intricate storylines, realistic graphics, and challenging gameplay that can fully engage players in the experience. Immersive experiences can be fostered by sophisticated VR technologies such as VR headsets, motion tracking systems and haptic feedback devices, as well as 3D modelling and rendering software that creates and designs a virtual environment including objects, textures, and lighting.

A further intensification of immersive experience can be expected from the combination of virtual technologies with new and future media. First and foremost, social media is all about connections and community. Users can build relationships, join groups, and participate in conversations with like-minded people, creating a sense of belonging and affiliation. The linking of social media with virtual worlds has also led to the currently much-discussed concept of the metaverse[7]. The concept has been used to describe various virtual worlds and online communities, such as Second Life[8], Minecraft[9], and Fortnite[10]. The metaverse is highly social and immersive, allowing users to interact with each other in real-time through avatars, chatboxes, and other forms of communication. The immersion potential of the metaverse is highly valued in the working world and, according to an assessment by the Executive Chairman of the World Economic Forum, can lead to a qualitative evolution of collaboration on the internet:

> Many heralded the advent of the internet and the spread of information communication technologies as the enablers of a 'global village' that would unite people across borders, support the exchange of ideas and revolutionize progress. Until now, that promise has yet to be fully realized. While the internet, and later video conferencing, has brought us together in virtual spaces, human connection has been missing. Instead of generating trust, the foundation for any partnership, the internet has had the deleterious effect of increasing polarization. In recent years this division has accelerated, as misinformation too often has run unchecked. We are now at the beginning of a transformative technological development that could address this divide (Schwab, 2023).

Social robots are another noteworthy development with a high potential for innovation in new forms of work and in other situations of interpersonal interaction. Unlike traditional industrial robots, which are primarily designed for repetitive tasks in a factory setting, social robots are intended to operate in public spaces, such as homes, hospitals, schools, and museums, and to interact with humans in a way that is comparable to human-human interaction. A high degree of immersion is associated here with a sense of trust and can be fostered by virtualising human characteristics.

7 https://about.meta.com/what-is-the-metaverse/
8 https://secondlife.com/
9 https://www.minecraft.net/en-us
10 https://www.fortnite.com/?lang=en-US

In the above scenarios, the use of VR technology and techniques to create more engaging communication and interaction between people can lead to a particularly intensive collaboration. The ongoing development of hardware and software technologies is enabling increasingly natural and intuitive forms of virtual interaction that allow people to feel as if they were in the same physical space, even if they are in different locations. Immersion can create an imagined sense of proximity and simulate real-world experiences, for instance in competitive gaming and mutual team training. In this way, immersion becomes a means for good collaboration and learning with shared milestones and goals. As discussed, the pursuit of a common goal is the qualitative difference between cooperation and collaboration. An immersive environment, such as a VR game with avatars, uses media technology functions to offer specific possibilities to influence the perception and emotionality of participants – and thus also their behaviour. The medium can be used to lead a team to discuss a predetermined topic or focus on a common approach. Identification with a shared goal or collaborative action can be strengthened by increasing immersion. Advanced VR technology enables deep immersion and can thus lead to intense collaboration. In this way, conditions can be created to promote the effectiveness and efficiency of teams at the workplace or in a learning environment (Figure 1).

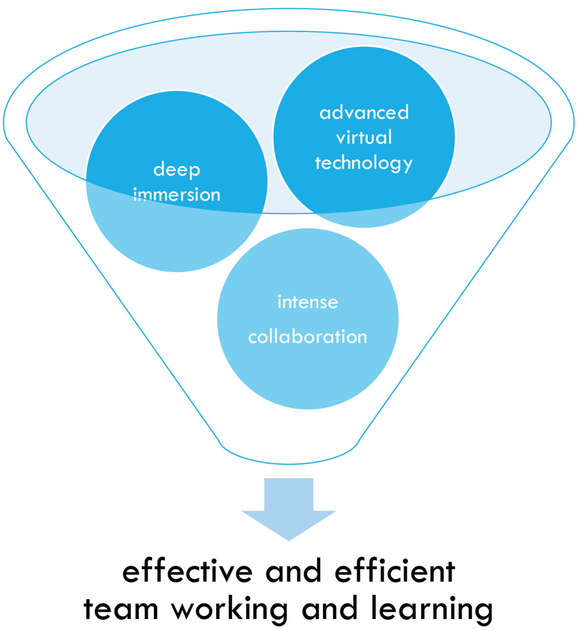

Figure 1: Towards effective and efficient teams via virtual technology and immersion

Approach to modelling immersive collaboration

Given that immersion can be a means of effective teamwork, the question arises as to how to develop a practicable model that supports the strategic use of media for collaborative teamwork. The starting point for such a planning tool is the media richness theory, also called the information richness theory, which was introduced in the 1980s (Daft and Lengel 1983, 1986) and has been widely used since then.

The fundamental assumption of the theory is a proportional relationship between the complexity of a message and the necessary “richness” of the communication medium used. Richness thus becomes a means of reducing ambiguity in communication. To communicate unambiguous messages, such as the transmission of an instruction, text-based messages can be a sufficient medium. However, for complex communication, such as critical diplomatic negotiations, in-person communication is usually necessary. All in all, according to the theory, the more ambiguous and complex the message, the richer the chosen medium must be.

The theory has been used in numerous empirical studies, and each time a new media technology has emerged, the basic assumptions have been challenged and further developed. In a meta-analysis (Ishii et al., 2019) of past research on media richness theory, it was found that the original conceptual approach has become the basis of many models that are relevant today for evaluating and planning media use in communication-related situations. According to Ishii et al., the studies analysed prove that the theory has been successfully applied in interpersonal, educational and organisational contexts, as well as enabling further developments in which special characteristics of new media are considered. Examples of further developments include (a) consideration of the synchronisation potential of a medium, especially regarding its qualities that impact immediate feedback, parallelism and repeatability (Dennis et al., 2008) and (b) the simultaneous use of many media channels (Ledbetter et al., 2016).

A further addition to the model, which is of particular interest in the context of immersion, was developed by Herget (2021). In his analysis of the fit between media properties and communication-related intentions, Herget included social presence as an additional concept to consider under the umbrella of media richness.

The concept of social presence dates back to the early days of video conferencing systems. It encompasses the “feeling of belonging” or the “feeling of being together” regardless of spatial distance (Short et al., 1976). The idea of social presence refers to the subjectively perceived situation during media reception, which does not necessarily correspond to the actual reality. In this respect, social presence shares commonalities with immersion, which creates a subjective experience in the virtual realm for the media user.

Immersion as a dimension of media characterisation incorporates aspects of social presence and media richness. But immersion is not simply a consolidation of these two known dimensions – it also expands on the characterisation of media with new qualitative attributes. Media richness is supplemented with properties specific to sensory media that can stimulate a user's physiological perception of the environment. Social presence is complemented by the aspects of self-focus and contemplation. A media user in a highly immersive state can bond intensively with other media users when immersed in a virtual environment. This behaviour is familiar from online games in which success depends not only individual strategies, but also on collective action. Based on these considerations, this article proposes a model that brings the media property of immersion into media richness theory.

This first working model assumes that the new dimension of immersion is proportional to the complexity of the communicative task, similar to media richness. The more complex the communicative task, the more useful immersion can be in facilitating it. However, the crucial point here is the more specific assumption that immersion is proportional to the degree of collaboration between the participants or team members. More precisely, this model assumes that it is not the "collaboration" itself, but the "collaboration

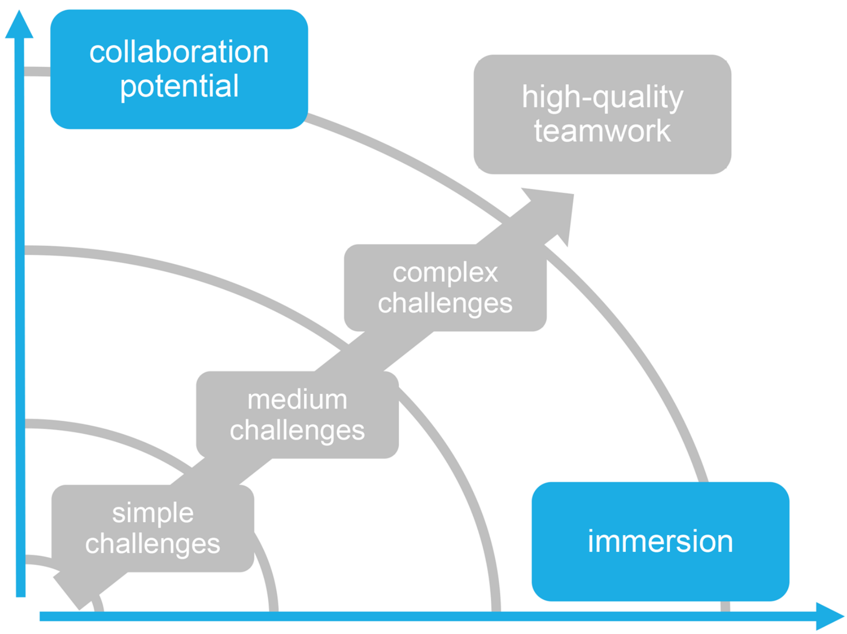

Figure 2: Immersion as means to promote high-quality teamwork

potential" of a communication medium that increases as the medium becomes more immersive. Properly used, immersion leads to collaboration. In this way, a communication medium with high immersion potential will enable good teamwork to address increasingly complex challenges (Figure 2).

Of course, team collaboration is only partly based on immersion and also depends on many other working or learning conditions. To fully exploit the potential of an immersive medium, additional factors inherent to the medium, such as synchronicity properties, multichannel options, etc., must be taken into account. Similarly, the basic conditions for collaboration, which are independent of the medium, are also relevant. In principle, high immersion can even disrupt collaboration. For example, an encounter between two avatars in an online game can trigger aggression, which is why the design of the immersive environment is very important. Again, an analogy can be drawn to media richness theory. When communication takes place in person – that is to say, a situation with a particularly high level of media richness in the sense of the theory – this condition can be used consciously or unconsciously by the participants to create confusion instead of clarity. Immersion and media richness are both enablers, but they are neither a guarantee nor a necessity for effective collaboration or clear communication.

In sum, immersion, media richness and social presence are different factors that have an impact on team collaboration. In view of the expected increase in the importance of immersion, this paper proposes the term "immersive collaboration" for the purpose of future differentiated studies on immersive collaboration.

The approach to immersive collaboration presented here is a starting point for a future model that supports the strategic use of virtual media and media configurations in team building challenges. Empirical studies in the context of real team projects in virtual spaces are a next step to further develop and refine the model.

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Psychological Aspects of Virtual Collaboration: A brief overview

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Abstract

The corona pandemic led to a transfer from offline to virtual collaboration within days. Virtual collaboration has positive and negative effects on an intrapersonal and interpersonal level which need to be highlighted. Such effects are ambiguous and range from an increased feeling of security to high levels of stress and from low investment and identification to high levels of connectedness and personal trust during virtual collaboration depending on how virtuality is used, established, trained, and understood. Specific trainings for virtual collaboration need to train cognitive skills and knowledge how and when to use virtual tools effectively but must emphasise emotional and social skills such as 'virtual empathy'[1] and attentiveness to have a vital positive effect on virtual collaboration.

Keywords: media psychology, virtual collaboration, virtual empathy, virtual skills

Changing relationships in virtual collaboration

Due to the corona pandemic in 2020, cooperative and collaborative work processes shifted from mainly offline settings to online settings within a few days (Evans, 2020). To remain in exchange and contact with one another and to compensate for the lack of physical presence in collaborative processes, new digital methods such as synchronous video conferencing tools and team chats or asynchronous tools such as whiteboards, logging capabilities, and wikis were used extensively. The preparation time for this transformational process was short or non-existent and the transformation was often linked to new types of challenges, some of which replaced traditional challenges of the collaborative work process or created entirely new challenges in addition. For example, terms such as 'zoom fatigue' or so-called 'zoombies' became socially familiar phenomena and concepts that also received attention in the

1 A communication pattern in which the receiver of communicated messages – as in the concept of empathy in general – encounters the self-opening of the other person in a virtual setting with emotional support, understanding or their own self-opening (Carrier et al., 2015)

scientific context (e. g. Toney et al., 2021). Due to the complexity of this transitional process, problems and opportunities are multifaceted and need to be carefully identified and addressed. This chapter specifically aims to give a brief overview on challenges and opportunities of virtual collaboration from a psychological perspective and offer insights into necessary cognitive and emotional skills and knowledge for successful virtual collaboration.

Changes for the self and for each other

First, it is important to look at how virtuality changes collaboration in its core processes. Fundamentally, there are both intrapersonal (= in myself, individual) and interpersonal (= with others, interactive) effects of the virtuality on collaborative processes. On both levels, negative and positive effects are described in the literature.

Concerning the *intrapersonal*, individual level, effects on the emotional perception and cognitive processing are most commonly mentioned in the existing research.

On the positive side, using virtuality in collaboration can lead to less social pressure, an increased feeling of security, and increased creativeness of ideas when the collaboration is virtual due to the person having control over the amount of own exposure and revelation of certain information (Workman, 2007; Hartmann-Strauss, 2020, Murningham, 1981). In other words, people feel more at ease and 'left alone' with their tasks and feel more in control of their situation and better able to have calm 'safe spaces' to think and work when collaborating in a digital space. This leads to them being able to take the tasks in their own pace with their own ideas which leads to better contributions to collaboration.

On the other hand, there are also detrimental effects of the virtual medium on intrapersonal individual processes. There is an altered mode of interaction with less nonverbal cues, less informal interaction, less spontaneous interaction, an increased self-attention which can lead to heightened self-concern due to continued exposure to one's own image, before-mentioned fatigue and even high stress-related brain activity patterns during videoconferencing that resemble our fight-or-flight brain activity in extreme stress situations (Karl et al., 2022). Therefore, digital collaboration can alter and interfere with processing vital nonverbal information in collaboration and increase confusing or 'non-vital noise', which in turn increases cognitive and emotional stress.

The heterogeneity of negative and positive individual intrapersonal effects makes it hard to tell if virtuality leads, for example, to more or less stress in individuals. To determine if virtuality is detrimental or beneficial, one has to understand the interplay of virtuality not only with the collaborative processes but individuals themselves: Effects differ quite profoundly, ranging from soothing effects to high-stress inducing ones depending on my experience, the general framing, training, which results in an own perception: It can lead to either less stress due to feeling in control and having safety and routine or cognitive and emotional stress due to cognitive overload, inner resistance or the feeling of less control (Plass et al., 2010).

In addition to the effects on the individual level, however, there are also effects of the virtual medium on the interpersonal (meaning between people) level. Similar to intrapersonal effects, virtual collaboration has both negative and positive effects on interpersonal processes.

The negative effects range from significant delays in decision-making processes in virtual collaboration and low identification with the collaborative group to a significantly reduced sense of belonging due to a lack of informal social interaction – which is particularly pronounced in all text-based settings (Blanchard, 2021). It is important to handle these shortcomings mindfully and target them with specific interventions such as workshops, change in leadership style, team building events or informal meetings to counterbalance these detrimental effects (Blanchard, 2021; Huang et al., 2010). Summarized, virtual collaboration leads to less personal identification with one another and the project and increases the time needed for successful decision making. These detrimental effects can be countered by increased awareness of these effects and specific interventions such as team building interventions to increase social cohesion and identification.

In addition to adverse effects of the virtual medium, however, there are evident benefits of virtual collaboration. For example, when digital media is used adequately and in a smart way, collaborative processes can become more efficient and key components such as emotional involvement and self-disclosure are increased, which can lead to better relationships and outcomes (Hartmann-Strauss, 2020; Suhler, 2004). Collaboration partners in video settings also feel more involved in the private lives of employees (e. g. insight into the home office), which leads to a greater feeling of connectedness – provided, however, that an informal exchange is consciously planned, and private information is disclosed by the collaborators (Whillans et al., 2021). This could be a potential danger as blurred lines between private and work life can again have negative effects, such as work exhaustion and even burn-out (Golden, 2006). The implementation of virtuality in collaboration needs to be handled mindfully and smartly and has to be supervised regularly as advantages can quickly turn into disadvantages and vice versa.

As mentioned before, if people are willing to disclose parts of themselves in virtual settings, people can open up more quickly via online formats, especially at the beginning. This closeness however is not experienced as actual profound connectedness with one another, especially at the beginning. A kind of 'quick superficial closeness' is established in the online setting, which needs to consciously be strengthened and intensified (Hartmann-Strauss, 2020). However, it is interesting to note that when collaborators actively and consciously invest into the virtual relationship, it has the same quality in the long run as in offline settings – a real, human encounter can also take place virtually – it just needs more time, mindfulness, and willingness and intention to invest effort (Wenzel, 2015).

In summary, many of these effects have been described for the first time since the Corona pandemic, and further research is needed to clear a highly complex picture of the differences in virtual and non-virtual collaboration and how to address them. To navigate effectively in a virtual collaborative environment, one needs specific knowledge and competencies to deal with the difficulties and harness the benefits through a mindful approach and engagement.

Required knowledge and skills

The changes in collaborative processes from non-virtual to virtual settings lead to new challenges that require two complementary types of components for effective and smooth collaboration with digital media and virtual tools: *knowledge* and *skills*. Further differentiated, there are domain-specific knowledge and skills and domain-unspecific ones. These knowledge and skill sets required are also needed in non-virtual settings – however, their importance shifts in the virtual space. In an extensive review on models for virtual collaboration competencies, Schulze and Krumm (2016) suggest a certain set of knowledge and skills that are specific to virtual collaboration:

(1) Knowledge when and how to use different media devices

Collaborators should know about the benefits and detrimental effects of certain media devices and channels and use these accordingly to facilitate the effective transmission of information (e. g. clear, manageable, right amount) and a correct mutual understanding.

(2) Skills for using different media devices

Collaborators should have adequate skills to express and understand emotional information through virtual media, coordinate, and time virtual communication properly and communicate confidently in the virtual world.

On top of these ‘virtual skills’ specific to the virtual world, there are skills which are needed in offline and virtual settings but gain more importance in virtuality: The skills to use oneself and one's own time meaningfully and appropriately as well as the skills to structure, analyse, and interpret information and then make decisions independently seem to be even more important in virtual collaboration than in offline teams (Krumm et al., 2016). This, however, needs to be addressed and sufficient time and a set of different subskills is needed for these skills to be useful in virtuality (Beranek & Martz, 2005).

In addition to these cognitive skills and knowledge types, certain emotional skills are important for virtual collaboration. In different competency models, such as Spitzberg’s (2006), the skills needed for adequate expression and perception of emotions in the form of empathy, interest and attentiveness for others, coordination, and timing of one's own and others' contributions, as well as a confident attitude towards others are seen as even more important in virtual collaboration as conditions for the successful use of these skills are more difficult in virtuality.

Derived from this model and several studies on the role of social skills in a virtual workplace, empathy, emotional intelligence as well as the ability to understand the other person’s perspective are key social skills to thrive in virtual collaboration; making them a necessary 21st century skill for successful virtual collaboration (Ala-Mutka, 2011; Marin-Lopéz et al., 2019). ‘Virtual empathy’, as the ability to cognitively understand and emotionally relate to the other people’s feelings and moods, seems to play an important role: Not only does it increase connectedness and mutual understanding, high levels of ‘virtual empathy’ increase overall performance of collaborators as well leading to better outcomes of virtual collaboration in general (Garcia-Pérez, 2016; Marin-Lopéz et al., 2019). Overall, there seems to be a lack of virtual empathy: It is less trained and acquired by just working in a virtual collaborative environment or throughout traditional offline formal education and must be mindfully focused and trained to prepare future collaborators for success in the virtual environment (ibid).

Therefore, specific trainings that aim to foster specific social, emotional, cognitive, and behavioural skills for the virtual environment, such as virtual empathy, need to be implemented. Otherwise, difficulties and gaps in verbal, non-verbal, and emotional communication can lead to heavy detrimental effects that decrease collaborative effectiveness or even hinder it completely. There are several trainings and projects that foster these skills: One of them is the NEO project – Campus of the Future of Munich University of Applied Sciences HM, which tries to identify and train skills for virtual collaboration and learning to close corresponding gaps. The project aims to train skills necessary according to current research but heavily emphasises student involvement to drive the curriculum based on students' needs.

In summary, new challenges arise from virtual collaboration and many important factors for success can already be found in offline collaboration but are now of greater and more distinct importance. A mindful approach and critical self-reflection of one's own abilities and limitations as well as a conscious, empathetic approach to other people can help to identify difficulties and problems and to adapt adequately to the online setting. Targeted trainings of cognitive, social and emotional competencies for virtual work have to be established as state-of-the-art education and training seems insufficient.

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Let's Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments

Marion Rauscher

Abstract

Virtual reality (VR)[1] applications have been said to improve learning in terms of the acquisition of knowledge and professional skills. Yet, little is known about the development of social and transversal competences in multi-user VR environments. In a qualitative research setting, this study therefore evaluates whether a collaborative VR teaching concept improves collaboration and communication competences and digital literacy and compares it to a face-to-face teaching situation. Among other things, we find that the technology and the related feeling of telepresence promote engagement and interaction. VR collaboration efforts seem to be more focused and unemotional, whereas face-to-face collaboration fosters empathetic team building. Digital literacy and innovation competence are clearly enhanced in the technology-supported teaching environment, although handling difficulties still pose a challenge to smooth implementation. Overall, VR environments are a viable tool for remote collaboration in higher education, and efforts should be made to implement them more widely to prepare students for the increasingly digitalised work environment. Spatial design and didactic concepts and processes should be carefully planned; however, they must also be sensibly aligned with technological capabilities.

Keywords: virtual reality, multi-user virtual reality environments[2], transversal competence, digital competence

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1 An artificial, virtual, and viewer-centered environment, where the user is completely isolated from the physical surrounding so that telepresence is felt at least to some degree. The perception of telepresence ranges from atomistic (telepresence is less important) to holistic (encounter is close to real-life) Virtual Reality scenarios (based on Rauschnabel et al., 2022).

2 A shared Virtual Reality environment where multiple users, represented as avatars, can interact with each other as well as with the environment simultaneously. It is sometimes also referred to as Social Virtual Reality Environment.

Introduction

Digitalisation is impacting many areas of our everyday life, and technological advances are changing the work environment in ever shorter cycles. Processes are increasingly being automated, contents are being digitalised, and the way we interact and acquire information has been disrupted. At the latest since the Covid pandemic, new forms of technology-supported collaboration have now become an integral part of our daily work and learning routines. Consequently, requirements for employees are not only shifting, but are also becoming more complex. Higher education must adapt by teaching collaboration as well as digital competences to ensure employability of the future workforce (Janssen et al., 2016). The proper impulse is already in place, as institutions are moving away from their "emergency" use of technology in higher education during the pandemic years toward long-term technology-supported teaching concepts to ensure more flexible and adaptive teaching and learning experiences (Pelletier et al., 2022). As we head into a future where hybrid and virtual teaching scenarios become more established and consolidated, there is a need to research whether targeted competence acquisition is in fact being achieved.

Online collaboration has become quite common in today's learning and working worlds. Synchronous and asynchronous exchange of text, sound and images through various collaboration tools, such as video conferencing systems that include screen-sharing, joint documents and whiteboards, are now standard pedagogical practice at higher education institutions. However, there is still potential for the use of more progressive technologies (Handke, 2014), for example, xReality[3] (XR) applications. XR is a collective term for any form of technology that generates or modifies reality, such as virtual or augmented reality (Rauschnabel et al., 2022). Within the plethora of digital collaboration enablers, virtual reality (VR) environments play a distinctive role because they are able to mimic real life scenarios in a vivid way. The immersive nature of VR creates the feeling of "really being there" among the users, which stimulates a more natural form of interaction. It is therefore assumed that specific challenges to digital collaboration – for example, obstacles caused by social distance – can be mastered (Schenk et al., 2022). In fact, Mancuso et al., (2010) describe VR environments as particularly suitable for adult education due to their situated and social setting that stimulates user engagement and facilitates a high level of individual empowerment.

Much recent research has been dealing with the technical aspects of VR, such as visualising and interacting with 3D content. Yet, studies on the impact of VR learning environments on the acquisition of soft skills and trans-

3 A collective term encompassing all forms of new realities such as Augmented and Virtual Reality (based on Rauschnabel et al., 2022).

versal competences are still scarce. Janssen et al. (2016) point out that for learning purposes, the effects of technology-supported interaction and the psychological aspects of VR experiences are at least as important as knowledge acquisition. This is especially relevant for collaborative learning, since this form of learning yields various academic, social and psychological benefits (Laal & Ghodsi, 2012) that tend to persist beyond the academic realm. In this regard, educators should support students' participation in virtual learning experiences that provide rich communication and collaboration opportunities, as well as an interactive peer community (Reese, 2015). We hypothesise that this can be accomplished particularly well in social VR learning environments with a well-designed teaching concept. Our study contributes to existing research by investigating which collaboration, communication and digital competences are developed during collaborative work in a VR learning environment. By means of qualitative research, we evaluate the similarities and differences between collaborating in a VR multi-user environment compared to a face-to-face classroom situation.

Learning in Virtual Reality Environments

Virtual reality used to be described as a real-time computer simulation of a 3D environment in which the user can navigate and possibly interact (Gibson & O'Rawe, 2018; Guttentag, 2010). However, technological and economic advances in the recent past have led to a dilution of the terminology, necessitating a more sophisticated and distinct classification of new reality concepts. Recently, Rauschnabel et al. (2022) proposed a new conceptual framework that we follow, where XR subsumes any form of new reality, such as augmented, mixed or virtual reality. In this context, VR is defined as an experience where the physical environment is at least visually completely replaced, so that the user feels some degree of telepresence. Telepresence or presence (Steuer, 1992; Tussyadiah et al., 2018; Witmer & Singer, 1998) is a state in which the user has the impression of being in the virtual environment rather than in the location of the body. Telepresence should be distinguished from immersion. The latter represents the technical features that lead to the user being physically detached from the real world (Rauschnabel et al., 2022; Slater & Wilbur, 1997). A high level of immersion is therefore reached with a device that completely isolates the user from the outside world, such as a head-mounted display (HMD)[4]. A VR environment can be entered alone or with other individuals on a multi-user platform, where multiple users can interact simultaneously.

4 Display devices worn on the head to generate virtual projections directly in front of the user's eyes. It is currently the most commonly used device to enable fully immersive Virtual Reality experiences.

It has been stated that VR experiences can improve learning in various respects (Cortiz & Silva, 2017; Johnston et al., 2017). For example, studies reviewed by Jensen & Konradsen (2018) suggest that VR, enabled by immersive HMD devices, causes learners to be more engaged, to spend more time learning tasks and to acquire better cognitive, psychomotor and affective skills. Likewise, Wang et al. (2018) have found that immersive VR improves concentration. Educational VR activities are also considered to increase user motivation and enjoyment, ultimately leading to a deeper learning experience (Kavanagh et al., 2017). Generally speaking, VR education seems to favour knowledge acquisition and better learning outcomes (Baxter & Hainey, 2019; Chavez & Bayona, 2018; Hanson & Shelton, 2008; Hu-Au & Lee, 2018; Merchant et al., 2014).

Two principal distinctions in learning applications can be made: VR can be used to visualise 3D objects and surroundings, and it can enable remote interaction in a natural way (Cabrera Duffaut et al., 2020). Popular use cases for the first domain include, for example, training in hazardous situations (Feng et al., 2018; Smith et al., 2018; Zhang et al., 2017) or surgical procedures (Huang et al., 2016), where the internalisation of procedural-practical knowledge is important. The same holds for applications where 3D object visualisation is especially helpful, such as engineering (e. g. Wang et al., 2018), architecture (e. g. Sampaio & Viana, 2013) and astronomy (Rosenfield et al., 2018; for an overview of education-related application domains, see Kavanagh et al., 2017). Often, however, analyses of VR use are still experimental and unsystematic, for example in the case of remote interaction. In this sphere of application, questions regarding efficient transversal competences – in particular, how to collaborate efficiently – come to the fore (Cabrera Duffaut et al., 2020).

Only a small number of studies deal with social collaborative experiences (Pirker et al., 2020) or developing social or transversal skills within a VR environment (Radianti et al., 2020). With regard to these skills, some research has been conducted in the area of training. Mast et al. (2018) propose an interpersonal skills training model for human resource development, Broekens et al. (2012) a negotiation training and Baur et al. (2013) an application that simulates the job interview scenario. Recently, Zak & Oppl (2022) recommended activities for a VR sales training scenario. In general, the studies come to a positive conclusion regarding the benefits of the technology. In the educational realm, McGovern et al. (2020) investigate how VR applications can help students improve their communication skills in terms of visual attention, voice and gestures. Their results indicate that VR offers a protected training environment to significantly enhance the needed ability to present in real-life situations. Cortiz & Silva (2017) designed a co-creation scenario using immersive technologies. They conclude, among other things, that students are able to sharpen cultural competences, acquire change-making skills and improve digital literacy.

With the exception of Cortiz & Silva (2017), the aforementioned studies use virtual agents as counterparts in the virtual environments. Only Cortiz & Silva (2017) build on a multi-user platform. However, they do not aim for directed collaboration among the participants – rather, their focus is on novel ways of presenting information and learning narratives. Our approach is different in that we employ a multi-user virtual environment where collaboration is explicitly requested and guided. We aim to better understand what competences are being fostered during collaboration in such an environment compared to face-to-face learning. Finally, Muukkonen et al. (2020) assess the acquisition of collaborative professional expertise in higher education. In contrast to our work, they focus on comparing two groups of disciplines, and their investigation is not embedded in a pure VR environment.

Digital Competence

According to the European Commission, digital competence is key for lifelong learning and "involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (Vuorikari et al., 2022, p.4).

The definition includes five concepts: information and data literacy, communication and collaboration, digital content creation, safety and problem-solving. Each is composed of a set of knowledge, skills and attitudes. This framework served as a basis for our exploration, and we adjusted it to suit our research needs. More precisely, we focused on only two of the five concepts, the first being communication and collaboration and the second being problem-solving.

Collaboration and communication are of broad importance in a higher educational context, as they enhance learning in several respects (Scoular et al., 2020). Therefore, teaching and learning should be a social occasion, where people interact and build relationships (Pelletier et al., 2022). According to Bedwell et al. (2012, p. 130), collaboration is defined as "an evolving process whereby two or more social entities actively and reciprocally engage in joint activities aimed at achieving at least one shared goal." This means that active interaction for the purpose of working together on the same task (Scoular et al., 2020) is key in a collaborative setting. At the same time, effective communication is essential for successful collaboration (Scoular et al., 2020). It serves as a means for exchanging relevant information, reaching a shared understanding and regulating group dynamics. When it comes to digital learning, Frolova et al. (2020) declare the facilitation of networking and collaboration to be one of the central aspects that empowers institutions to transition from information provision in education to high-quality digital learning concepts. This is also reflected from the learner's viewpoint, as collaboration activities in digital environments that foster interaction among participants tend to increase satisfaction with the online class (Shonfeld & Greenstein, 2021). Nevertheless, especially in the context of online collaboration, it is a common complaint that there is a lack of the social element in particular, or what Cortiz & Silva (2017) call the lack of sense of community, compared to face-to-face learning. Thus, while many technology-based collaboration and interactive concepts have been tested and evaluated on a case-by-case basis, the influence of the technology as an enabler of collaboration and communication is still questionable. In this context, it is important to know if and how collaboration and communication competences are developed within a VR learning environment compared to a face-to-face situation, so that learning concepts can be adapted and meaningful learning environments created.

Within the European Commission's framework, problem-solving has transversal meaning and refers to the ability to identify needs and problems and handle and solve conceptual challenges in digital environments. In this regard, problem-solving refers not only to handling problems retrospectively, but also to the forward-looking creative deployment of technology to advance processes and products in an innovative way. In this way, it requires users to stay informed about digital progress and keep an open mind regarding technological innovations. This also implies that users must have a technical understanding of the applied technology and its devices. For our subsequent analysis, three constructs here are relevant for us: digital problem-solving skills, the digital mindset and technical understanding.

Research Design

Theoretical Background

Given the need to ground VR-related educational research in pedagogical theory (Kavanagh et al., 2017; Radianti et al., 2020), we embedded our project design in constructivism. It is widely recognised that VR learning fits particularly well into constructivist learning theory (Aiello et al., 2012; Cabrera Duffaut et al., 2020; Castaneda et al., 2021; Huang et al., 2010; Janssen et al., 2016; Mulders et al., 2020).

Constructivist learning assumes that the experience of the learner is the driver of knowledge and meaning creation (von Glasersfeld, 1982; von Glasersfeld, 1989; Rieber & Carton, 1987). To construct knowledge, learners must ask questions, explore and assess what they know. This means that they actively acquire and exchange information and insights. In this regard, the learning environment is a space for an active, self-directed learning process, rather than a place of passive consumption (Pérez et al., 2002). Individual learning paths are forged and findings achieved that are specifically tailored to each student's beliefs, needs and goals. Knowledge is not imposed upon the student – instead it is subjective and personal, based on each individual's beliefs and experiences in certain situations (Cobb & Bowers, 1999). To create a constructive environment, the learning process should reflect the following six elements (Reinmann-Rothmeier & Mandl, 1997 and Reinmann-Rothmeier & Mandl, 2001):

- Active process: Knowledge acquisition is achieved by autonomous and active participation of the students.
- Constructive process: Knowledge acquisition is achieved only by building into existing knowledge of the students so they can interpret findings based on their individual experience.
- Emotional process: Knowledge acquisition is achieved only when positive emotions are involved.
- Self-directed process: Knowledge acquisition is achieved when students control and monitor their own learning process.
- Social process: Knowledge acquisition is achieved through interaction with others.
- Simulative process: Knowledge acquisition is tied to a specific situation or context.

An active learning process requires that learners not be confronted with a high share of input from the lecturer. Rather, constructivist knowledge acquisition works best when students are provided with only limited information and have to work their way towards a clearly defined goal (Kirschner et al., 2006; Steffe & Gale, 1995). Practical or project-based work in which students experience the process and procedure of a discipline should be the basis for enabling constructivist learning (Handelsman et al., 2004; Hodson, 1988). Teaching methods and environments must be adjusted accordingly.

Setting

Within a bachelor programme in tourism management, two groups of students were given the task of drafting a marketing concept for a destination, ensuring the situational context of constructivist learning. One group was asked to deliver the task face-to-face in a classroom (CL group) using flip charts, if desired. The other group met in a VR room (VR group) to prepare solutions. A Meta Quest HMD was used to create a fully immersive environment and to foster telepresence. Desktop participation was not possible.

The basic procedure was the same in both groups: first, the assignment and instructions were given by the teacher, then the groups were shown a short video about the destination. Before students split up into smaller groups in the next step, they were told to choose one from among three personas that were presented in different areas of the room. According to the chosen persona, subgroups formed to discuss a tailored marketing concept within a 30-minute timeframe. This autonomous group work ensured the active and social processes necessary for employing constructivist learning principles. Finally, each group presented its solution to their fellow learners and the teacher, who were then asked to give feedback. By sharing group-individual outcomes and opinions, each group member was able to reflect on their contribution and appraise their results compared to those of others in a self-directed process.

Participating students were already in advanced semesters, enabling them to draw on existing marketing expertise. In this respect, the task was not about acquiring new expert knowledge, but instead about applying existing knowledge to a specific case. This allowed a constructive process to unfold in each individual, and collaboration was enabled (Reinmann-Rothmeier & Mandl, 2002). Additionally, new information was balanced with the participants’ existing knowledge to avoid cognitive overload (Mulders et al., 2020). Since collaborative learning generally does not favour rigid structural requirements in order to support interactive processes (Reinmann-Rothmeier & Mandl, 2002), no further instructions were given to the students on how to reach a solution. It was left to the participants to work out elements like composition and concept structure.

One advantage of VR environments is the unlimited and freely configurable space available. In terms of collaboration opportunities, spatial design is not only a pedagogically significant element, but also a facilitator of interaction coordination (Minocha & Reeves, 2010). In light of this, we will describe the installed VR room in more detail. We adapted a Mozilla Hubs space, which was divided into two basic sections for didactic purposes (Figure 1). The downstairs served as a plenary area where avatars met as a group. Instructions were given there, and the video was watched. The upstairs functioned as group work zones (Figure 2).

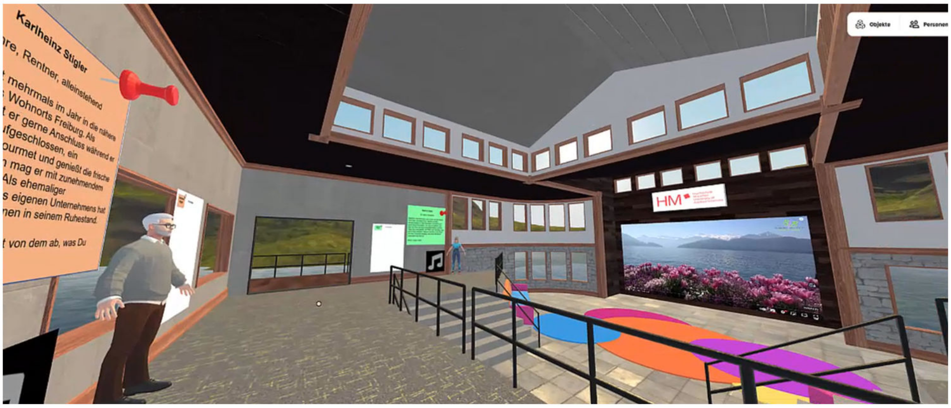

Figure 1: Room design (Source: adapted from Mozilla Hubs)

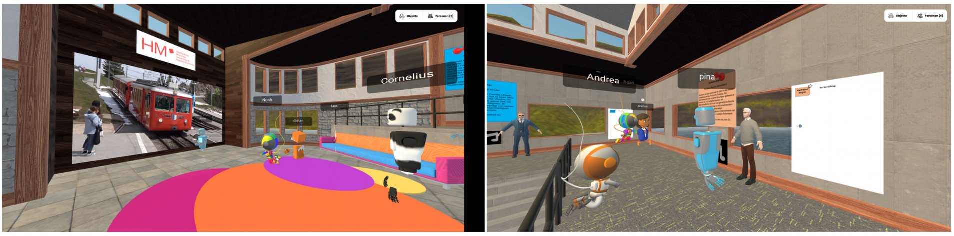

Figure 2: Video sequence (left) and group work (right) (Source: adapted from Mozilla Hubs)

As a cooperative technological support resource that is not available in a face-to-face situation (Zottman et al., 2007), we visualised the personas as 3D avatars and included the text as audio files. This way, visual, auditory and tactile learning types were all stimulated.

In brief, we maintained several of Radianti et al.'s (2020) researched design elements. Students were able to *move around* freely to explore the virtual environment on their own. Since the focus of the study was the analysis of collaboration competences, a passive observational setting would not have been feasible. Rather, the assignment dictated *interaction with others*. Students were given the opportunity to *make meaningful choices* by deciding which persona they were most interested in. Instructions on how to use the device and the multi-user platform were given by the teacher in a 2-hour workshop that had taken place a week earlier (Mulders et al., 2020). Within this training, students were also shown how to load virtual objects into the VR room and how to *interact with these objects*.

Method of Analysis

After completing the collaborative task, participants were asked to take part in a qualitative, semi-structured interview. Altogether, 22 interviews were conducted: 13 VR and 9 CL conversations. Interviews lasted 30–45 minutes. Structured content analysis (Mayring, 2014) was applied to analyse the responses using the computer-assisted text analysis programme MAXQDA. In a first step, we followed a deductive approach to code the statements according to the competences described above. More precisely, we allocated statements to the collaboration and communication competence codes and incorporated them into the social-communicative category (Table 1). In this competence area, the three components of knowledge, skills and attitudes were all of interest, so we did not explicitly split them up.

Within the problem-solving section, the users' technological competences were of particular interest for us. We have therefore reviewed them under the category 'digital literacy' and further broken down the European Commission's nomenclature. Next to digital skills, we consider the digital mindset to be of particular relevance for tomorrow's workforce. Consequently, we included this as a separate code. To better understand students' self-perception, we asked the interviewees to give an assessment of their own digital skills and mindset. They were asked to give an evaluation on a Likert scale from 1 (very low) to 10 (very high). The VR group was also asked to indicate whether their digital skill score changed after the collaborative task.

Finally, given the novelty of the technology and the associated lack of habitual use, we explicitly considered the students' actual operation and application of the hardware and software. For this reason, a separate code termed 'media competence' was created and further broken down into operation of the device and the software, in addition to the areas of application that the participants stated they could envision after having participated in the VR learning experience.

Supplementary to the aforementioned competences, we included the category 'learning outcomes' in order to be able to assess motivation and learning success to some extent. This aspect has been partly neglected in the literature so far (Radianti et al., 2020), or results are somewhat ambiguous (Drey et al., 2022).

Table 1: Overview of deductive competence category system

Social-communicative competences	Digital literacy	Learning outcomes
• Collaboration • Communication	• Digital skills • Digital mindset • Media competence – Operation – Applications	• Motivation • Learning success

Our interview guide followed this category system, and transcripts were coded accordingly. In a second step, the interviews were again reviewed using an inductive approach. The goal was to identify further competence codes or categories that emerged during the conversations.

Finally, for the purposes of interpreting the results, the lecturer's observations were also included in the analysis. Due to time restrictions, we were not able to facilitate comprehensive feedback rounds in the VR groups as originally planned. We therefore do not refer to feedback-related items from the questionnaire in the results section – neither for the CL nor the VR group.

Results

Social-Communicative Competences

We identified five items relating to social-communicative competences that were mentioned in connection with collaborative efforts: spatial distance, technical facilitation, anonymity, interaction and team building. Participants from both groups clearly agreed that the technology is a suitable means to bridge spatial distance between participants. Within the VR group, participants pointed out that this physical distance must exist when working together, otherwise the "virtual feeling" is lost. One person highlighted the spatial freedom in VR:

> "It was supportive in the sense that you have more flexibility in the space, so that you can move around more. Compared to a physical space where you're always sitting."

The second attribute, technical facilitation, was a big issue in the VR group, as various participants faced difficulties in this regard. The challenges ranged from struggles during the process of onboarding into the virtual room, to instable Wi-Fi connections, to problems using features in the room, such as the writing pen. This was clearly the most glaring issue that hindered smooth collaboration in the VR group. We asked the CL interviewees about their general opinion on virtual collaboration in education. For them, it could be an element in addition to face-to-face teaching, but not a substitute. This group also referred to the importance of the whiteboard for capturing thoughts and presenting results. This significance was not highlighted by the VR group – in fact, due to operating difficulties, the whiteboard was hardly used by VR group, but this was not emphasised as a problem. Rather, this difficulty was lumped in among the diverse technical challenges. Additionally, although students made extensive use of the opportunity during training, only one VR subgroup used 3D objects to visualise their solution during presentation.

Another issue that was frequently raised was that of anonymity. The privacy that can be maintained by having an avatar was assessed with ambiguous results. Those who favoured the anonymous environment in the VR group felt more confident acting and speaking with an unknown audience. Even when the person behind an avatar was known, some participants still felt like they were engaging with unfamiliar individuals. As one respondent put it:

> "You can address something directly. I also think that people are not so afraid to say something. Sometimes people look at you a bit funny when you're in the classroom. You just don't have people looking at you."

On this basis, one person even concluded that less interpersonal skills are necessary when working in such a VR environment. Furthermore, participants pointed out that there was no hierarchical structure in the VR environment: *"You talk to the professor as if you were on one level."* Overall, many agreed that the VR environment offered a more personal collaboration opportunity compared to video conferencing because it felt like engaging with *"a person actually standing in front of you"* and *"with whom you have eye contact."* On the other hand, some participants experienced the anonymous collaboration environment as disadvantageous and commented that it was helpful to have met the other participants beforehand. Some noted that seeing fellow students as avatars was odd initially. In the beginning, *"there was really a small barrier, because people actually knew each other in the physical world."* Reluctance, however, quickly dissipated.

The CL group considered personal acquaintance as a clear advantage in collaboration. Participants remarked that collaboration flows more easily and openly when participants know each other personally. Nevertheless, opposing opinions existed in the CL group as well. Two participants were of the opinion that prior personal acquaintance is not important and that work is more focused with anonymous partners than with friends. Interestingly, the CL interviewees pointed out that the lack of ability to perceive others' reactions, gestures and facial expressions is a clear obstacle in online collaboration via video conferencing. The absence of these human elements did not seem to have disturbed the VR group for the most part, as only one person talked about these aspects during the interviews.

It should be noted that all respondents in the CL group immediately associated the term "virtual" with video conferencing systems, even though the interviewer did not explicitly refer to a specific tool. On the one hand, this may be due to the fact that teaching mainly took place via video conferencing during the past two pandemic years, so it is the first thing that comes to mind. On the other hand, many students are still completely unfamiliar with VR learning environments. Thus, students cannot be expected to reflect on the quality of teaching in such environments.

Both the VR and the CL groups appreciated interaction as a motivating factor in learning, and it worked well in both groups. Many VR respondents had a sense of physical presence while they were collaborating on the task. The VR environment was therefore found to be suitable for interactive events, such as small group work, workshops, projects and discussions. Also, collaboration and activities requiring visual support, such as presentations or simulated environments, were mentioned explicitly. In the interview responses, it became apparent that VR collaboration is perceived as more interactive than video conferencing or even face-to-face lectures. Regarding video conferencing, the same holds for the CL group: interaction using this tool was generally perceived as worse than interaction in a face-to-face situation. Reasons given included that exchanging ideas works better and shy people cannot completely withdraw from group work in a face-to-face situation. In general, the CL group regarded the workshop as a normal group interaction that was familiar from previous learning experiences, whereas the VR group considered it to be a completely new experience.

Finally, there were several references to team building as part of successful collaboration. VR participants said that "seeing" others helps in building a team, and even though the unfamiliar situation in VR at first led to a brief period of reluctance to form groups, they worked well afterwards. However, a deeper analysis revealed that no true team building took place. The respondents referred to group formation or interaction when speaking about team building, but there was no conscious allocation of roles within the subgroups, nor did any special dynamics emerge. If there was any allocation of roles, it was more by chance or based on circumstances related to the technology. For example, the person who wrote was the one who was able to use the pen, or the person who presented was the one standing in front. Overall, the VR group rarely talked about teams, and if they did, they mainly mentioned finding group members.

> "It took a while until teams were formed that worked together on this task."

In contrast, the team played a big role in the CL group. The group, its dynamics and role distribution were central in the responses. Openness among team members, the assessment of group members within a team, role distribution and how this was achieved were just some of the points that were mentioned. It even appeared that the CL subgroups left the classroom as teams.

> "Team building also took place. You now get on much better with those with whom you were in the team."

Both groups indicated that communication competences are a prerequisite for effective group work. However, differences were evident in the response behaviour of the two groups. The VR group placed a strong emphasis on the technology when asked about communication during work on the task. More specifically, the spatial audio was described as interesting or exciting, or it was simply mentioned as a positive feature. At the same time, if the audio did not function properly, unsurprisingly, this was identified as a showstopper. The CL group, in contrast, shared many more thoughts about the communication process in this category of questions.

> "It worked well. Everyone made their contribution and there was always understanding for each other. You let the other person finish speaking and then you could talk, so there was a positive atmosphere in the group."

Apart from some technical difficulties, VR group participants articulated predominantly that they felt like they were speaking with real people. Again, both groups perceived their communication setting as better than on a video conferencing system.

Digital Literacy

All participants indicated that they had no previous experience with the technology, except that a few had used it for the occasional gaming session. When asked about their digital competences, respondents from both groups listed digital tools they are familiar with, rather than referring to their skills in this field. The most frequently named tool in both groups was the smartphone. VR participants listed a long catalogue of digital tools, applications and programs. In addition to the smartphone, the CL group only mentioned social networks and video platforms, falling well short of the sheer number of tools mentioned by the VR group. Also, the VR interviewees talked much more about their motivation to try out new technologies, possible educational applications and the necessary prerequisites or implementation requirements. This deeper engagement with technology was also reflected in the digital skill score, where the VR participants rated themselves at an average of 7.3, whereas the CL group self-assessed at 6.0 on average. Some VR respondents increased their personal score due to their participation in the VR workshop. A clear difference in the groups' self-assessment of their digital skills thus became apparent.

The divergence that emerged between the two groups also continued in the realm of the digital mindset. On average, VR interviewees rated themselves as even more open to digital technologies than they rated their digital skills (8.7 vs. 7.3). The majority of them indicated that an interest in digitalisation in general and VR technology in particular was stimulated by the learning experience. Some admitted that they had been sceptical about the technology but had abandoned their scepticism after the VR workshop:

> "I consider it possible that we could either work or learn in this environment in the future. I think that might be an option."

The CL group also reported themselves as open to digitalisation, but to a much more limited extent:

> "I'm not a first adopter, the first to use something new. But at some point, when it's mainstream, when the masses are using it, then I'll adopt and use it as well."

In terms of media use, participants described it the technology as easy to use after prior instruction. The latter was essential for the assignment to run smoothly. Apart from this, the technology was not fully convincing. VR participants described several shortcomings, such as exhaustion after a longer period of use, headaches, technical difficulties, and uncomfortable writing options. In line with this, the CL group described the time investment required to become familiar with a new digital medium as the greatest source of discomfort.

We also asked the interviewees to spontaneously think of further applications for the VR medium. VR respondents generated many creative ideas for current or future use cases. Suggested uses included conferences, political discussions, workshops or group lectures, exhibitions, presentations, info sessions, meetings in a work context and tourism and geographical applications. In general, this group understood the use of digital media as beneficial and did not seem to struggle with the concept of familiarisation. The CL group, on the other hand, hardly developed any ideas for possible applications.

Learning Outcomes

Although we did not explicitly test learning success, we asked for the students' personal assessments. Without exception, VR interviewees saw the learning scenario as motivating. Reasons given included that it was fun, that the technology or VR environment was exciting and interesting, that it was something new or a new way to learn, and that learning happened in a playful way. A few mentioned the stimulation to interaction and the interesting task as motivational factors. Every participant from the VR group would recommend the teaching unit to fellow students. Motivation was also high among most of the CL participants, but reasons differed. Group work was mentioned first and foremost. Other factors included that the task was interesting, that it encouraged active participation, or that it was just a fun thing to do. Within the CL group, a few critical voices mainly addressed the topic of the assignment. Those participants would not recommend it to other students.

Members of the VR grouped said they primarily learned about the application of the technology, but professional expertise was also cited several times. Some said they were able to absorb more of the teaching content compared to a normal classroom lecture. Respondents identified the visual environment and the opportunity to experience the scenario as components that were supportive to learning success. The avatars representing the personas in combination with the audio elements were also mentioned as helpful, as students were able to recall information at any time. Some said that their concentration was better due to the lack of external distractions. The playful component and the unlimited possibilities of designing a learning environment were further aspects that reinforced learning, according to the VR respondents. However, they also identified obstacles for learning in VR. In particular, the significant time spent on explanations and confronting technical difficulties was seen as hindersome to efficient learning. Additionally, there were distractions within the VR environment itself:

> "It's double-edged in my opinion. If you have too much fun with the whole thing, then you don't necessarily concentrate on the task, and you just fool around."

Overall, VR participants perceived various facets of learning success, whereas the majority of the CL interviewees did not because the discussed content was already known to them. Nevertheless, individual participants stated that they were still thinking about the content of the course. Only one person said that although nothing new in terms of facts or knowledge was covered, the means of learning was helpful, as it activated the students to brainstorm, filter information and work actively in a group. Even so, the CL group evaluated the lesson positively overall.

Further Competences

Our inductive analyses revealed several further competences that VR participants acquired. They can be grouped into the following categories: creativity, eagerness to experiment, self-directed learning, illustrative learning, ability to concentrate and adaptability. The categories that appeared by far the most frequently were the first two. Comments relating to spatial design options and possible solutions to the assignment – as well as ideas regarding application areas for the technology – were classified under creativity. The eagerness to experiment was attributed to statements related to the use of different features in the VR space. In addition, several comments that expressed a desire to use the technology more frequently or in other scenarios were coded into this category as well. Remarkably, very little use was made of the various features in the room during the task, but in the subsequent lesson, participants often talked about how useful these features could be.

CL participants mentioned professional expertise and presentation skills. Apart from that, no further competences could be identified. It is also striking that presentation skills were not identified by the VR group, even though the same presentation took place in both learning scenarios.

Discussion and Implications

Our qualitative research gives a clear indication that VR technology is seen as an innovative and flexible facilitator of remote collaboration. In particular, the feeling of telepresence helps users to collaborate in a way that creates a realistic interaction and communication scenario. The spatial feeling and flexibility in space seem to contribute to this sense of being "there." In this respect, we challenge Schenk et al. (2022), who deduce that the sense of space to reinforce telepresence does not play a major role in knowledge generation.

VR technology takes interaction into a completely new setting, which is why it serves as a motivational element to establish interpersonal contacts. Consequently, even though motivational processes as a feature of constructivist learning (Reinmann-Rothmeier & Mandl, 2002) take place in different environments, motivational factors might differ significantly. Kavanagh et al. (2017) caution that the impetus induced by technology might be short-lived and could disappear as soon as the applications become commonplace. However, we argue that the incentive to interact is not a function of the technology alone, but rather matter of conceptual design. Since VR offers practically limitless options to design visually, spatially and didactically meaningful teaching concepts, each experience has a unique character. In fact, we even anticipate that once users will have become accustomed to the technology, teaching and learning will become more efficient because technical facilitation of interaction will recede into the background.

The depersonalisation of the individual and related absence of social cue stimuli has both positive and negative consequences. While group cohesion and social empathy are much more prominent in a face-to-face environment, anonymisation encourages a greater focus on task preparation. In this respect, we agree with Wang et al. (2018) that concentration improves and more focused work takes place with anonymous group participants. Yet, Ibáñez et al. (2013) and Kreijns et al. (2003) argue that group dynamic, which is the product of group cohesion and common understanding, is a positive stimulus for collaboration. Likewise, Erenli & Ortner (2011) consider onboarding measures such as team building to be a prerequisite for successful virtual collaboration. While we have clearly seen this in the classroom setting, we doubt this for VR learning. The VR group performed well in terms of discussing and fulfilling the task, even though social harmony within the group was less distinct. Behavioural and social engagement as part of collaborative group engagement (Sinha et al., 2015) apparently takes place on a different level. The interpersonal dynamics that empower collaborative virtual teams (Lepsinger & DeRosa, 2010) seem to occur in a more unemotional manner. We therefore conclude that VR allows for a strong focus on the learning task, which is reinforced by the fact that outside distractions are largely eliminated through the use of the immersive environment (Müser & Fehling, 2022). As a limitation, it should be added that while some participants appreciate the VR situation as a more protected environment compared to a face-to-face situation (McGovern et al., 2020), others may be somewhat reluctant to engage with it. We derive from the results of our study that collaboration in the VR environment must be clearly stimulated by the educator (Kreijns et al., 2003), and appropriate preconditions – including both task dramaturgy and spatial design (Ibáñez et al., 2013; Minocha & Reeves, 2010; Schmeil et al., 2012) – must be set.

Our analysis reveals that communication competence is generally perceived as a prerequisite for efficient work on collaborative tasks. The teaching concept did not appear to have set the framework for building or developing this competence. For this reason, we are of the opinion that either the task must be specifically designed to target this learning objective, or that communication training should have already taken place outside of the VR environment beforehand. It may also be a viable option for the educator to actively initiate role distribution within the communication framework, since this is an important procedural step within a collaborative process (Camarinha-Matos & Afsarmanesh, 2008).

The biggest challenge to collaboration and communication, however, is technical issues. On the one hand, this includes malfunctions of the devices themselves. Much more decisive, however, are the difficulties users have in operating the technology. Giving the required instructions and training is time-consuming, and even after explanation and testing, not everyone will feel comfortable with a new tool, which makes continuous assistance necessary. Individually, the level of attention required can vary widely. This not only hinders smooth collaboration, but also means that the technology is still too much in the centre of attention at the current stage. Overall, in line with Castaneda et al. (2021) and Müser & Fehling (2022), we suggest the adaptation of a standard classroom didactical approach to a qualified didactic-technical concept that also takes these factors into account. It is crucial to think not only about the room design, but also about how to structure a task and how to guide and frame the sequence of work (Johnston et al., 2017) so that useful collaboration and communication can unfold. Due to the duration and complexity of the planning and implementation processes, this should be seen as a long-term investment (Erenli & Ortner, 2011) and should be considered as such when designing a VR collaboration project. There is significant potential in VR technology for valuable collaboration, but we agree with Zak & Oppl (2022) that it can only be leveraged using well-planned and well-designed didactic work flows. Consequently, for efficient collaboration to occur, there must be a proper triad of space configuration in alignment with didactic concepts and process flow.

Regarding digital skills, it was interesting to discover that students were not able to fully grasp the meaning of the term. They clearly expressed digital affinity, but their actual skillsets remain unclear. We nevertheless agree with McGovern et al.'s (2020) claim that the most recent generation of students is eager to apply new technologies in their learning environment and desires to build competences in preparation for the changing labour market. We also clearly agree with the more straightforward insight that the use of VR in higher education improves students' digital skills (Cabrera Duffaut et al., 2020). In the past, research has shown that a lack of digital competences hinders the use of VR for educational purposes, even though the technology is viewed as helpful (Antón-Sancho et al., 2022), and it may exclude educators without pronounced digital literacy from the educational sphere (Frolova et al., 2020). We believe that efforts should be made to overcome these challenges. Our study shows that it is necessary to explore collaborative VR environments, even on an experimental basis. Not only does it support the acquisition of digital skills, but it also shapes the digital mindsets of students and educators alike. In this respect, hands-on VR experiences enhance digital skills (Cortiz & Silva, 2017; Whewell et al., 2022), although technical difficulties and discomfort in operating the technology still pose a burden. In fact, these complexities represent two of the four barriers Mancuso et al. (2010) found when researching adult learning in virtual worlds. Operating difficulties are not uncommon (Shonfeld & Greenstein, 2021) and can result in the failure to make use of provided resources, which has also been stated by Falah et al. (2014) and Sommool et al. (2013). Consequently, there is a need for improvement of the medium itself, which is beyond the sphere of influence of the institution of education. This particularly applies to the hardware, but also to the software in terms of simplifying and standardising its use or enhancing certain features, such as transcription capabilities.

Collaboration in VR learning environments fosters further supplementary transversal competences, regardless of the subject-related content that is taught. These transversal competences most frequently include the eagerness to experiment and creative ideation of application possibilities and implementation options for the technology. These abilities can be categorised under innovation competence in the sense of Ehlers's (2020) Future Skills. Additionally, applied VR learning experiences can reduce or even eliminate uncertainties and doubts regarding the technology. VR in higher education can therefore contribute to an open-mindedness towards digital innovation – a fundamental requirement in today's digitalised working and learning ecosystem.

Finally, the focus of this study was to gain a deeper understanding of specific competence acquisition within a VR environment. Assessment of learning success was not the centre of our research interest, nevertheless, we found indications of positive learning outcomes. Content was remembered and evaluated better due to the learning format. In line with Castaneda et al. (2021), we want to stress the need for learning success to be evaluated in more detail to assess students' achievements. This is especially true as some researchers question (Castaneda et al., 2021) or even deny (Parong & Mayer, 2021) that there are positive learning effects in certain VR-supported settings.

Conclusion

Our research is subject to some limitations. Firstly, our study is qualitative in nature, so we can only make preliminary suggestions. Additionally, due to the small sample size, it is not possible to generalise the results. Further quantitative empirical research is necessary to solidify and enrich our findings. Second, VR multi-user environments do not necessarily require a fully immersive HMD but can be used with desktop displays as well. In such cases, immersion is lost, and likely presence to some extent as well. It can therefore be assumed that operating multi-user applications on such displays will lead to different results. This has been demonstrated in similar VR learning analyses (e. g. Drey et al., 2022). Studies contrasting different devices will yield further interesting insights, although one may question whether a desktop application is still part of the VR sphere (Rauschnabel et al., 2022). Finally, the participants in our investigation were already quite technologically savvy as a result of the courses they had chosen to study. Since personal user characteristics as well as cultural differences seem to have an effect on technology acceptance and usage (Shonfeld & Greenstein, 2021), responses are likely to be different in other technologically and culturally socialised groups. Future research could therefore look deeper into personality traits, other disciplinary fields (Muukkonen et al., 2020) or more sophisticated task assignments.

Currently, the adoption of VR in academic classroom settings is not very advanced (Shonfeld & Greenstein, 2021). Based on our qualitative research outcomes, we urge educators to implement and develop their use of this technology in higher education in the future. We find that multi-user VR environments are an appropriate means of building transversal competences, such as collaboration and communication competences, as well as digital literacy. The technological component with all its facets is clearly very much at the forefront of users' minds, leading to the overrepresentation of digital literacy in users' perception. Nevertheless, by adapting teaching concepts to the requirements of this novel teaching format, fruitful collaboration for broader and deeper learning experiences can be facilitated, comprehensively preparing students for the requirements of the labour market. This, however, will require not only students but also educators to undergo a process of adaptation. Reese (2015) remarks that the role of the teacher is changing significantly due to the digitalisation of education. We underline this statement, as it is particularly evident in VR teaching. The teacher moves away from being at the centre of knowledge transfer and becomes a designer of meaningful teaching concepts in virtual space and an enabler of self-directed learning. But students, too, will need to get accustomed to this new mode of learning, especially if their institution of higher education is not yet fully geared to the teaching of future skills (Ehlers, 2020).

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Virtual Collaboration as a "Future Skill" – Analysis of an Innovative Learning Scenario for a HEI of the Future

Audrey Stolze

Abstract

Future skills[1] initiatives are currently emerging around the world to refine our understanding of the concept of skills, and many are focusing on the question of what skills employees need in a digitalised and virtual world. This chapter presents and analyses an innovative learning scenario designed with the goal of promoting global citizenship by integrating entrepreneurial and digital competencies as learning objectives in an international and virtual collaboration format. It illustrates how virtual collaboration can contribute to promoting future skills in higher education and provides valuable insights and foresights to teachers and other HEI managers in the design of innovative learning scenarios with virtual cooperation as a central element, implementing appropriate scaffolding measures.

Keywords: virtual collaboration, future skills, entrepreneurship

Introduction

Debates about the future competence profile required of higher education graduates have been going on for some time. In the face of comprehensive societal challenges, it is becoming clear that subject-specific study courses alone are no longer sufficient. In order to meet the complex tasks of shaping the future with outlook of the Sustainable Development Goals of the United Nations, the classic, subject-oriented competence profile must be expanded and interdisciplinary promoted. Future skills initiatives are currently emerging around the world to refine our understanding of the concept of skills, and many are focusing on the question of what skills employees need in a digitalised and virtual world. Ehlers (2020) points out that there is more to Future Skills than a list of skills that higher education institutions (HEIs) could base their curricula on to prepare students for whatever uncertainties

1 Future skills enable graduates to meet the challenges of the future and take responsibility for actively and positively shaping our future. These are, among others, innovation, cooperation, systemic and digital competences (Ehlers, 2020).

the future might bring. He argues that Future skills should be those skills that enable graduates to first, best meet the challenges of the future and second, take responsibility for actively and positively shaping our future and lists, among others, innovation, cooperation, systemic and digital competences (Ehlers, 2020).

In this sense, the role and significance of universities as a whole is also changing – they are increasingly becoming important players in social transformation processes. New paradigms such as the Entrepreneurial University (Clark, 1998; Etzkowitz, 1983), Engaged University (Breznitz & Feldman, 2012), or Civic University (Goddard, Hazelkorn, Kempton, & Vallance, 2016) take HEIs' external environment into account and give them a new sense of purpose for the knowledge society. In response to changing environment, many countries have even reformed their higher education systems, making significant changes in the autonomy, public funding, mission, and accountability of HEIs (Audretsch & Keilbach, 2004; Gibb & Hannon, 2006). In Europe, European Union directives and national governments' initiatives developed to promote a societal development agenda affect HEIs concomitantly. Examples are the directives from the European Commission (2006a, 2006b, 2013) on the Europe level, as well as on a national level, the EXIST program in Germany, A+B in Austria, VINNOVA in Sweden, and the Science Enterprise Challenge in the United Kingdom (Elia, Secundo, & Passiante, 2017; Etzkowitz, 2014; Shattock, 2010).

Today, HEIs are perceived as catalysts for regional economic and social development and are being pushed toward entrepreneurialism. The Entrepreneurial University model is seen as a response to the technological, economic and social demands of knowledge societies for producing human, knowledge and entrepreneurial capitals, fostering innovation, increasing competitiveness and consequently positively impacting regional economic growth (Guerrero, Cunningham, & Urbano, 2015). In a recent foresight study addressing the expectations of entrepreneurship ecosystems' stakeholders towards HEIs, Stolze and Sailer (2021) propose five future scenarios for entrepreneurial HEIs – *worldwide*, *transdisciplinary*, *adaptive learning*, *blended*, and *ecosystem* – and argue that internationalisation, digital transformation, collaborative networks, and co-creation processes are the key drivers for HEIs to advance their third mission (Stolze & Sailer, 2021).

Considering these perspectives and models, this chapter presents and analyses an innovative learning scenario designed with the goal of promoting global citizenship by integrating entrepreneurial and digital competencies as learning objectives in an international, virtual collaboration format (Socher, Stolze, Arnold, Brandstetter, & Kempen, 2021). In the context of the DAAD-funded project “GlobalXChanges/Challenges (GXC)”[2], three cycles of this virtual course on international innovation challenges were carried out, involving a total of 108 students from different study programmes of the Munich University of Applied Sciences HM and its partner HEIs. The analysis is based on extensive evaluation data, as well as student reflection reports collected during the pilot phase (i. e. two first cycles in the winter semester 2020/2021 and summer semester 2021). It elaborates how the virtual cooperation processes were supported and what challenges had to be overcome during by the students, as well as the extent to which the virtual collaboration elements were suitable for enabling students to acquire (future) skills.

Learning Scenario Overview

The GXC course offered undergraduate students from all disciplines a unique 10-week action-learning experience for which five ECTS (European Credit Transfer System) credits were awarded, as it was developed based on the approved module description of an existing seminar called “Real Projects” developed by the Strascheg Center for Entrepreneurship (SCE) and offered every semester. In the new course, public government and non-government organisations proposed innovation challenges that transcend national boundaries and lend themselves to solutions using digital technologies. Participating students were divided into international interdisciplinary teams and followed an innovation process (Fig. 1) to address the proposed challenges and prototype digital solutions using the no-code tools Figma, Glide or Bubble.

2 Acronym for GlobalXChanges/Challenges, a 2-year (2020–2021) international project by the Munich University of Applied Sciences HM, funded by the DAAD (German Academic Exchange Service). It aimed to internationalise the university transfer activities by collaborating with its strategic partner universities in Finland, USA, Switzerland and Austria (https://www.hm.edu/gxc/)

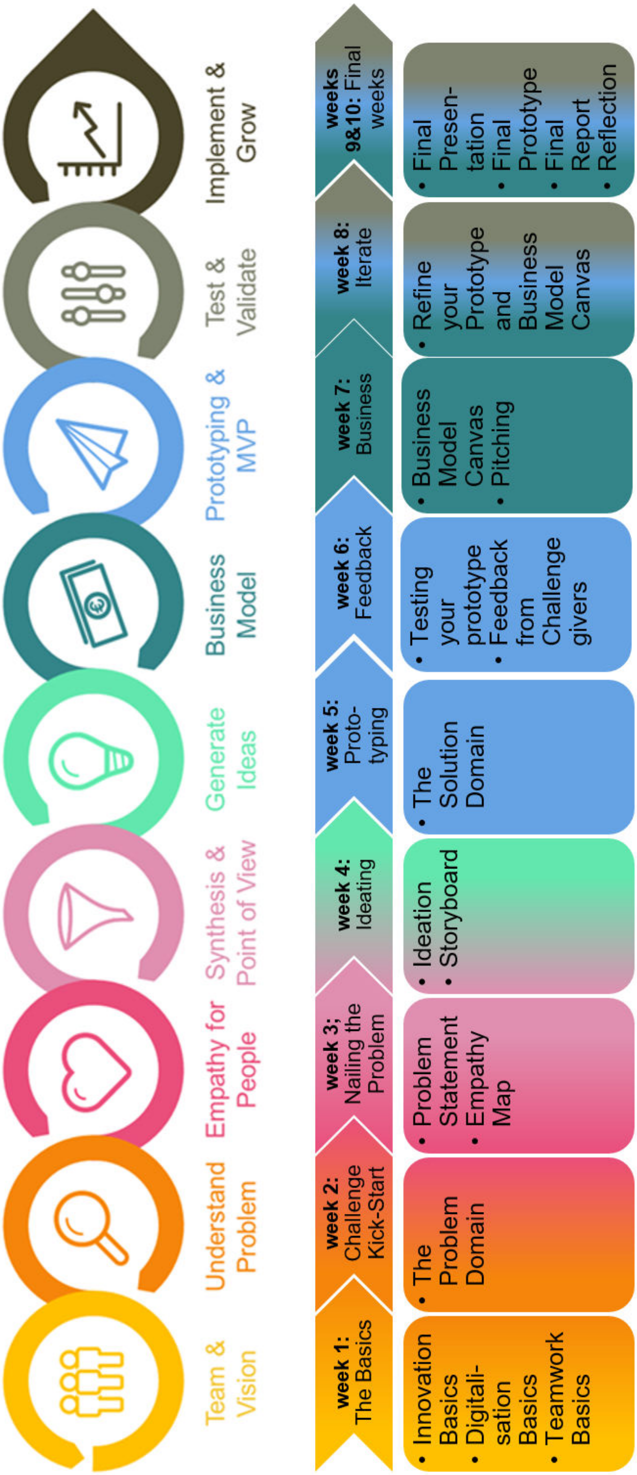

Figure 1: Innovation process and the 10-week syllabus (Stolze and Socher, 2021)

The virtual collaboration included asynchronous instruction via pre-recorded video lectures and reading materials for content input (Fig. 2), as well as synchronous instruction through dynamic weekly live sessions via ZOOM with two instructors. In addition, each student team received systemic coaching sessions via ZOOM to support collaboration in international remote teams. Specifically, the coach assisted the teams with team building, project management, conflict resolution, and team reflection via the virtual action learning experience.

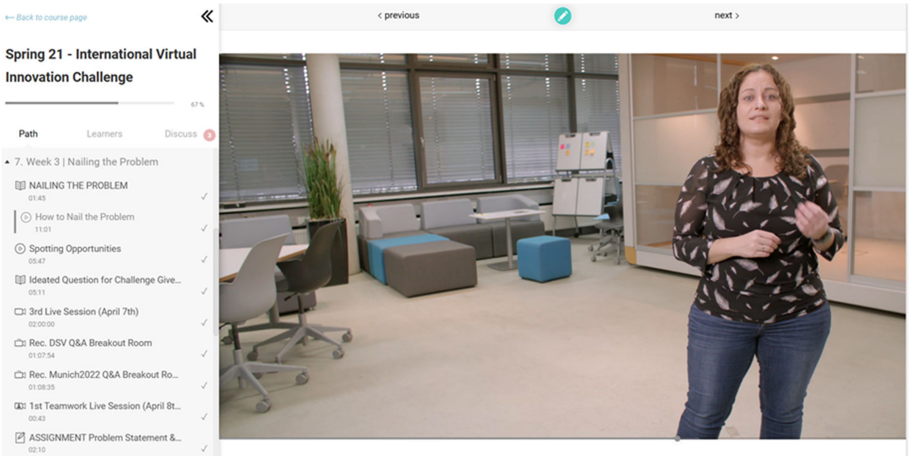

Figure 2: Asynchronous virtual element – online course

In addition, an important virtual collaboration element was the use of the GitHub platform[3]. The course had an "organisation" on GitHub and each team had its own "repository" in this organisation, which were private for the duration of the course. Students created a wiki page for each assignment in their repository. At the end of the course, students created a "GitHub page" as an executive summary and web landing page for their report (i. e. wiki) as part of the final documentation. Upon completion of the course, the teams' repositories were made freely available[4]. Such a learning environment with different virtual collaboration elements is very challenging for students and often contrasts with their previous learning experiences. Therefore, various measures were implemented to scaffold the students' learning experience (e. g. coaching, GitHub, video lectures, no-code tools, Mentimeter), and to recognise the benefits of action learning, students were also asked to write a final reflection report (Arnold, Stolze, Socher, & Brandstetter, 2021).

3 GitHub is an Internet hosting service for software development. It is commonly used to host open source software development projects as it provides the distributed version control of Git plus access control, bug tracking, software feature requests, task management, continuous integration, and wikis for every project (https://en.wikipedia.org/wiki/GitHub).

4 See 2020_GXC_Challenge_Documentation_DSV.pdf (hm.edu) for an example.

Analysis of the learning scenario

Course evaluation measures were employed during the piloting phase of GXC development to assess (1) the course itself, and (2) the course impact on students' skills and competences development. Overall, students evaluated the course positively. The most valued aspect was the learning provided through the virtual teamwork experience, as students acknowledged improvement in their intercultural communication competences and a growth in the size of their networks. At the same time, their course received some criticism, the most frequent of which was related to the difficulty of virtual collaboration due to time-zone differences, as some international teams consisted of members sharing up to 10 different time-zones. Only seven students individually reported team conflicts, which caused them to worry about the course outcome.

Furthermore, the innovation challenges proposed by partner organisations provided students with a real-life meaningful experience, in which they felt able to contribute towards something that could be implemented in the future. Our evaluation measures showed students perceived an improvement in their entrepreneurial skills, as they experienced working with a variety of tools and resources introduced during the course, either as part of the agile project management, or as part of the innovation process. In this regard, a student reflected, "I love the course itself and its overall setting, to be in an international team with other students from around the world. I also like that we were able to experience prototyping for a real-life challenge with team, where nobody knows each other before. I think that that is really valuable experience for the future in my career. The coaches being there for us and having weekly sessions with them was really helpful". Further examples of students' self-reflection statements regarding their learnings and challenges are available in Table 1.

Table 1: Extracts from Self-reflection (selected quotes)

Extract from Students Self-Reflection		
Reflection Question	**Pilot 1 – Winter Semester 2020/2021**	**Pilot 2 – Summer Semester 2021**
Describe your experience when collaborating in an intercultural environment during this course.	*I have experienced working with an actual organization, working with other students from other countries, and what it is like to communicate with each other when everything is only possible digitally and you can't meet in person.*	*I loved the way how you have to collaborate with new people. At first, however, I had trouble figuring out how the course worked and what it was actually about. I think that can be improved. Overall, I would recommend the course to other students as I liked it a lot.*
	Despite its challenges, I enjoyed the intercultural experience that this program provided. At first, it was daunting to manage both the time difference and the communication differences between diffe-	*I had a great team and we did a really good work together. We were continually motivated. The course structure and coaches made so many videos and documentations, so that we succeed in our project without any issues.*

(Continuing table 1)

Extract from Students Self-Reflection		
Reflection Question	**Pilot 1 – Winter Semester 2020/2021**	**Pilot 2 – Summer Semester 2021**
	rent cultural backgrounds. Managing these challenges within not only our team but also our project development objectives allowed me to grow and overcome insecurities that would otherwise prevent me from demonstrating my skills. (...) Despite the time difference, language barriers, and cultural perspectives, we were able to be successful as a productive and cohesive team. I became more aware of my behaviour and how it may be linked to my cultural background; I didn't want to be the stereotypical "loud" and "overbearing" American, so I monitored my behaviour in the team setting to make sure everyone was being heard and felt recognized. In our larger program sessions, I was actually hesitant at first hesitant to speak up, as I was intimidated by the high-pressure of speaking in front of not only peers from various countries, but also non-American professionals who may judge the way I speak or act. However, I decided that I couldn't hold myself back when I knew I had value to bring to discussions and opportunities to demonstrate my speaking and critical thinking skills (after all, I am a communication major). (...) Despite it being stressful, I'm proud of myself for doing it because I overcame my fears of allowing intercultural differences stop me from making the most of the program. By the end of the challenge, I'm more comfortable than I have ever been in acknowledging and appreciating cultural differences without letting them hold me back.	
Which difficulties did you encounter?	*The main challenge we faced was not using GitHub from the get go. Given that only* (name omitted) *had used it before, made it a little challenging. However, we soon became more comfortable with its features and we all eventually, actively used it. As a native English speaker, I found that sometimes I would talk too fast or use big words that my international team members did not understand. When this happened, there was often silence. I soon learned that this meant they did not fully understand what I was saying and I would easily re-phrase my thoughts in a simpler manner. However, though this occurred, it never negatively impacted our team dynamic.*	*Time zone difference, my teammates struggled with balancing their other schoolwork and this course so we often barely made deadlines, and finally, brainstorming new ideas, which was difficult because we often struggled as a team to get into the headspace needed for creative thinking.*
	On the biggest difficulties are the time zones for me. Since in Munich we are 9 hours ahead of US (California) time, we only were able to work actively as group (in a zoom meeting) just in a limited time frame. Which makes it even harder to work	*Working from different time zones was definitely a challenge at times. Our team member from the US always had to get up very early for our team meetings. We tried to accommodate that, but most of the time it still was early. The differences in semester*

(Continuing table 1)

Extract from Students Self-Reflection		
Reflection Question	**Pilot 1 – Winter Semester 2020/2021**	**Pilot 2 – Summer Semester 2021**
	together since no one has always time. Sometimes the day is ok but time is not ok, so it's difficult to find a date and time that fits each member.	*times also meant that some of us had exams and therefore less time to work on the project. Another problem with the time difference was spontaneous work. Whenever we made some last-minute changes, there was a good chance some of us would be asleep. In the beginning, it was hard to transition from narrowing down a problem, to then being creative and coming up with a solution.*
Thinking about what you have expected from the course, what are you actually taking away?	*Even with experience in teamwork, I learned so much more than I expected. I developed a lot more soft skills, like how to pick up body language and how to gauge my level of engagement as someone who is organizing the tasks. I also learned how to work in a team that is located in different time zones. There are subtle actions in scheduling a talk at a specified time that increases its effect. When you want to talk about something with someone else, it's good to give the other person an idea of what to expect so they can prepare. I also learned how to resolve conflicts by providing solutions and checking up with each team member to ensure their voices are heard.*	*I'm taking away a knowledge of how to communicate within different cultures, as well as the skill to know how to adjust to working in international teams. I am also taking away the idea of using digital prototypes, as well as the canvas boards for brainstorming.*
	I'm taking away a more entrepreneurial mindset and a better understanding of product development. Prior to this course, I had taken part in projects that had entrepreneurial opportunities that I didn't feel confident in pursuing because I didn't view myself as someone with entrepreneurial capabilities. Now that I have a better sense of what it means to be an entrepreneur, I realize that I have the potential to seek out opportunities that align with my interests and present exciting new innovations to solve major issues that the world faces. I also feel more confident in the product development process, especially when it comes to digital development.	*I learned a lot of new skills and I feel like I have developed myself as a person as well. I made new friendships, learned how to use digital prototyping solutions and how to work in a truly remote and international team.*

In order to assess the influence of the GXC virtual course on the fostering of students' skills acquisition, we employed a validated scale, developed at the European project Astee and used in other courses, to enable a comparative analysis. The comparison (Fig. 4) shows the students' perceived development of a number of skills associated with entrepreneurship, thanks to their participation in the course in comparison to the results of two other student cohorts who joined initiatives from our institution. One is a massive open online course "Introduction to Entrepreneurship", which is a self-passed asynchronous learning experience. The second is a "Real Projects" seminar, which was taught by Dr. Stolze, in English, to a group of international students. The key differences of this “Real Projects” seminar to the GXC Virtual course are: this was an in-person block-seminar, placing 5ECTS in a single week in summer semester 2020; it did not have partner organisations engaging, and it had a stronger emphasis on business modelling and startup creation on the field of EdTech (education technology). The comparative analysis shows the GXC virtual course enabled the students to improve their skills to plan and manage ambiguity, and marshal resources to a higher degree than the other two formats. This is most likely due to the emphasis placed on agile project management in a virtual collaboration setting for the interdisciplinary international teams during the action-learning experience. The GXC course did not improve students’ entrepreneurial intentions and attitudes at

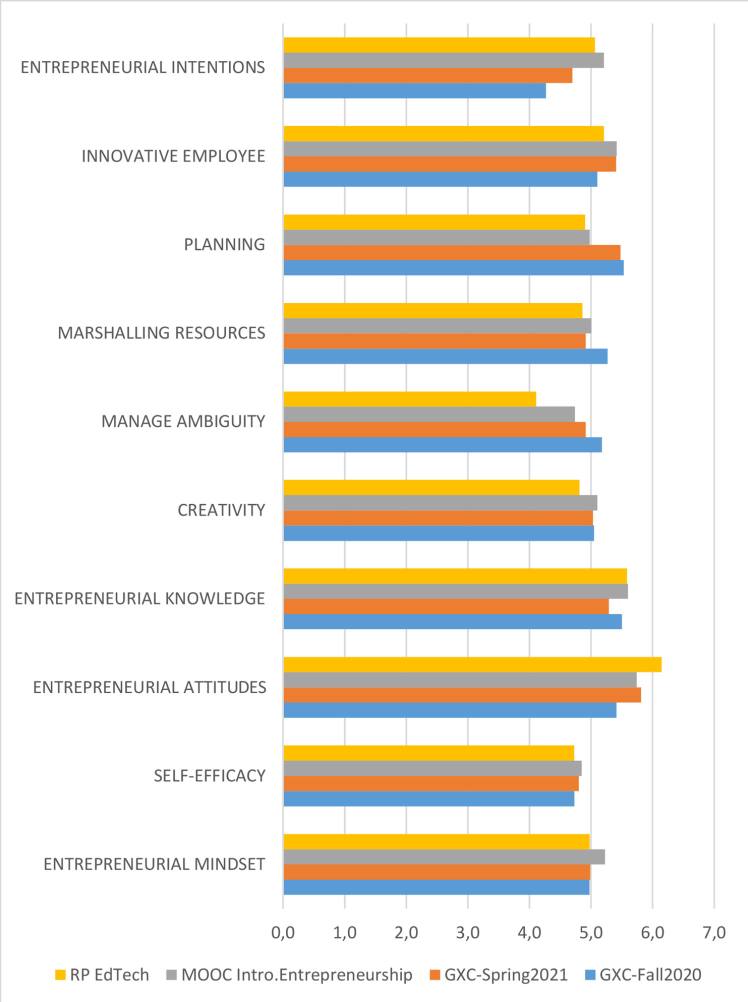

Figure 3: Assessment of acquired skills

the same level as the other two courses. This might be because the other two courses included partner organisations and student teams who could choose to position themselves as a startup team developing the solution or as an innovation-as-service team delivering the solution to the partner organisation, who they viewed as their client.

Based on the assessment results, the educators involved in the GXC initiative reflected on the scaffolding measures implemented on both pilot editions that might have supported students to acquire future skills. These were according to (Arnold et al., 2021, p.337):

Empowering: The fact as such that students were entrusted with a real-life challenge proposed by partner organisations outside the university has an empowering dimension for students. Challenge givers, generally, were impressed by the students' solutions and their professional interactions. The structured innovation process mapped to the different course weeks seems to have supported this overall success, although some students experienced the time-lines as tough. With the help of the no-code prototyping tools, students developed a final solution that could be tested and presented for appreciation. In their course evaluation, students highlighted that solving the challenges was a meaningful real-life experience, and that they felt they had contributed towards something that actually could be implemented in the future.

Experiential: The course had an action-based learning setting and a hands-on approach that all students took up and appreciated. In the evaluation, students emphasised that they went through an entire innovation cycle and experienced prototyping a solution and thereby appropriating a great variety of useful tools. In addition, students reported to have improved their entrepreneurial skills. Students' perceived development of their entrepreneurial mindset showed particularly high scores in the dimensions of planning, marshalling resources and managing ambiguity when compared to courses of a similar content area but without partner organisations as challenge givers.

Collaborative: The learning that stemmed from the virtual teamwork experience was the most valued aspect in their overall positive evaluation of the course. Few students reported team conflicts. The main challenge faced by the students in their teamwork were the time zones (up to 10 time zones apart). Overall, students felt they had increased their network and improved their intercultural skills. The weekly coaching sessions with a focus on team building and process reflection were assessed as highly valuable for the overall positive experience of the virtual collaboration.

Reflective: The coaching sessions focused on process reflection in terms of personal growth, teamwork and the innovation phases. In their final reflections, students highlighted the value of this support and the external perspective. The reflection assignment at the end of the course was introduced with no further explanation of its relevance and did not suggest a certain structure and might seem to have been perceived by many as yet another assignment. The educators noted that students did not directly know how to tackle this assignment. For a second edition of the course, it was decided to add input on the significance and methods of reflection to the course content.

Scaffolding for future endeavours: university management appreciated that all resources are re-usable, hence, GXC contributed to the university's digital transformation. In addition, management acknowledged GXC's efforts to open-access documentation of project results as well as the active search for synergies with other programs in the university's quadruple–helix interactions.

Discussion and Final Considerations

Currently, all higher education institutions are facing challenges due to governments' and society's demands and expectations placed on them. They are "facing both new challenges and old ones with new levels of urgency. Survival and future development will depend on how well universities adapt to unpredictable environments that are becoming global, instead of isolationist; international, instead of domestic; and competitive, instead of regulated" (Klofsten et al., 2019, p.150). According to Audretsch (2014, p.320), "perhaps it is the ability of the university to both adhere to its traditional strengths as well as adapt to the needs and concerns of society that has made it one of the most resilient institutions in society." Within the sector, there is a global call for new models and practices, requiring us to develop new formats that contribute to economic, technological and societal developments in our regions. In this sense, "understanding how universities become more successful thus requires an examination of how campus leaders make the right decisions and put the right processes in place to undergird the organizational capabilities that sustain competitiveness" (Leih & Teece, 2016). With the outlook of digitalisation as a key driver for the future of HEIs, it is mandatory to enable educators to experiment by implementing and systematically evaluating novel formats for learning in virtual settings.

The GXC course's learning scenario illustrates how virtual collaboration can contribute to promoting future skills in higher education by combining entrepreneurial, digital, and intercultural competencies as learning outcomes. The format effectively promoted students' critical global citizenship as it connected "thinking" and "intention" with "action" (Hartman & Kiely, 2014) and enabled students to express their desire to take action and make a difference. The example of the GXC virtual course provides valuable insights and foresights to teachers and other HEI managers in the design of innovative learning scenarios with virtual cooperation as a central element, implementing appropriate scaffolding measures.

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Digital Negotiations across Cultures

Sierk Horn, Miyuki Takino

Abstract

This contribution examines the impact of web conferencing on intercultural negotiation[1]. We simulated an online meeting involving German and Japanese postgraduate business students. The paper asks how and to what extent both parties had to adapt their approach to communication in virtual meetings. Our findings, based on two sets of simulation meetings, show that adaptive efforts are considerable. Web conferencing apparently makes intercultural rapport and relationship building difficult. Shortcomings of virtual environments brought out different things in the two student groups. The challenges ranged from quite basic needs such as equipment, training, and technological issues to very complex social and cultural needs. Overall, web conferencing seems inelastic to cultural expectations concerning rapport and relationship building and, by extension, intercultural communication[2]. There is a real risk that virtual environments magnify cultural differences.

Keywords: negotiation, web conferencing, intercultural communication

Introduction

Young people wake up to a world of work that is utterly different from that of earlier generations. Digitalisation, globalisation and their interplay have a profound impact on organisations. In spite of all these changes, the people within them remain the most critical resource for their future success or even survival. Their emotional, cognitive and behavioural skills will be game changers. In our eyes, language and, by extension, strong communication skills connect these dots. In this technologically rich, cross-culturally complex, and multilingual environment, they are more relevant than ever. This points to the large societal importance and responsibility of Higher Education institutions as key actors to equip graduates with these three skills that fit the

1 Negotiation refers to communication involving resources (Kopelman, 2014). In globalised, meshed and fast-paced environments, this means cooperative and competitive dialogue across cultures. As the likelihood of misunderstanding increases, interactants have to learn to adapt to different ways of doing things. (Kopelmann, 2014).

2 Intercultural communication involves communication between people of different social, linguistic and cultural backgrounds. Interlocutors must share common cognitive ground through culturally and linguistically sensitive communication skills to establish a meaningful dialogue (Kopelmann, 2014).

digital and global world. What can they do to prepare students for these new realities?

The best way to rethink virtual competency development at the juncture of professional and educational transformation is, thus, to provide empirical evidence of what students actually do when interacting online. This contribution analyses collaborations between German and Japanese postgraduate students and tests the degree to which they navigate multilingual and cross-cultural terrain – using only digital media to engage with each other. The context of this collaboration was a negotiation simulation which would bring to life, so we reasoned, the full breadth and depth of what business communication is about today. The immersive and self-directed learning experience challenged the traditional formats of foreign language and cross-cultural training. Evidently, such new formats and cross-border collaboration have only become possible since Higher Education institutions transitioned to online provision while making ample use of virtual conferencing tools.

Exploring Changes in the Digital Business Environment

The big question is how we adjust to a digital world, in which online communication efforts are ubiquitous with most organisations today making use of a wide array of digital technologies. That we all need to be media-savvy in a fast and hyperconnected world is not new. Over the last three decades, we have adapted to each new technology that came around the corner (and was quickly embraced in business), such as e-mails, social networks, AI translations, and so forth. We have learned (sometimes the hard way) to be extra vigilant when it comes to using these technologies for business communication. How we marry communication and digital skills makes (or breaks) our professional selves, with the careful and critical use of technologies as a hygiene factor for success at work and career development.

The Covid-19 pandemic ushered in the most recent turn in professional interaction. While the then digital standard of business communication, e-mail, was pretty much about what we said, the novel combination of sound, video, and messaging offered by many web conferencing tools is about how we say things. From one day to the other, we face challenges that come with navigating new communication channels. This realisation brought together the authors of this paper. Together we wanted to explore what kind of repertoire of social-, cognitive, and affective communication skills students enact when web-conferencing, especially when engaging across cultures.

Research Setting

The starting point of our collaborative journey was that international business relationships are one of the prime channels through which cultures come into contact. Negotiations, defined as "conversations with resources in the mix" (Kopelman, 2014: vii), test our ability to interact well with others, including people who do not share our language and culture. Daily, parties come together with divergent needs and wants. They try to find common ground by sounding out positions, drafting agreements, and delivering mutually beneficial solutions. Negotiations are the basis for any economic and social exchange. They come with many rituals, which are considered most effective when meeting face-to-face (though such soft tactics might not affect the actual outcome, see Galin et al., 2007). They happen every day and students have developed skills that help them to explore business opportunities, establish relationships, or navigate deals with an array of stakeholders.

The Covid-19 pandemic meant, however, that all of a sudden, online negotiations became the only meeting option. Because of lockdowns across the world, business persons could no longer meet and negotiate face-to-face with each other. Certainly, this created extra challenges for atmosphere-creation, dispute-management, deal-making, or decision-making. Now that the urgency of virus protection in many parts of the world is fading, face-to-face meetings are making a comeback. But for matters of convenience, speed and reach, online negotiations are likely to stay with us as a part of the new normal after the pandemic. For this reason, we need to consider how we can prepare the next generation of business persons to fuse communication and digital skills in such ways that they can confidently navigate negotiations in a global world. By implication we ask, how and to what extent web-based conferencing apps change negotiation practices across cultures.

To address our question, we simulated an online meeting involving two parties from two different countries. The context was postgraduate business classes on intercultural communication and negotiation at two different universities, one in Munich, Germany and one in Tokyo, Japan. A joint session aimed to enable German and Japanese students to experience realistic business meetings together. We reasoned that an immersive simulation is an excellent way for students to experience first-hand the full breadth and depth of business negotiations, including communication, building relationships, cooperating and resolving conflict. In addition to working with their own team members, students needed to try to win the trust of the other team in a different country, an essential team skill for future business (Clarke, 2018).

Eight students from a German class and five students from a Japanese class participated in the session. Both classes are part of the postgraduate curriculum in the respective universities. As both sides included international students, cross-cultural teamwork was the base of negotiations between the two country groups. The MA course in Germany taught almost all classes in English, and students were relatively young with less business experience. Meanwhile, the MBA course in Japan taught most classes in Japanese, and students were relatively mature with substantial business experience. Before joining the MBA the majority of Japanese students held managerial positions in their previous work.

Case Storyline

The setting of this online simulation was that of a Berlin-based food delivery company that explores market opportunities outside the German market. Specifically, the meeting simulation was designed to negotiate a partnership with a Japanese supermarket chain headquartered in Tokyo. The students were assigned to assume the roles of representatives of the respective companies (German students for the food delivery company and Japanese students for the supermarket chain). Each group was tasked to research the companies, decide on the culture and business priorities appropriate for the company, and prepare and conduct the meeting to negotiate the potential partnership for market entry.

On the German side, the company is a very young technology start-up that has been hugely successful in Europe and the USA and has become a ‘unicorn.’ The firm is particularly interested in growth opportunities in East Asia as the up-and-coming consumer market. Preliminary market research has suggested that Japan might just fit the bill. Its demography and geography look very promising to the German start-up company. The Japanese distribution system is, however, not without its pitfalls. Many foreign retailers have failed in the food sector. Finding a good partner in Japan seems crucial for market entry and survival.

For this potential partner in Japan, a successful supermarket chain in Tokyo with a history of longer than 100 years has been identified. This company is innovative in its product strategy, actively developing and importing attractive products, resulting in rapid sales growth, but is conservative in its delivery strategy. The approach of a successful German IT company may be appealing to the company. Still, there are vast differences in interests among them.

Given this background, we asked the German team to directly get in touch with the potential business partners in Japan and to agree on a mutually convenient time for the first round of discussion.

Implementation

In the spring/summer semester of 2022, one meeting simulation project was conducted as part of German and Japanese postgraduate classes. For each class, one session before and one after the meeting simulation was assigned for preparation and debriefing. The meeting itself was set up outside of class time for sixty minutes at a time convenient for both parties, taking into account the 8-hour time difference between Germany and Japan. The steps were as follows:

- Students were introduced to the purpose and framework of the simulation activity in Germany and Japan. Both instructors made any preparations they found necessary for their students. In Germany, the meeting was open to volunteers; in Japan, all students in the class took part in the project.
- German and Japanese students formed two teams of two to five members each, and all members were informed of their partner's e-mail address. Consequently, each group was instructed to contact their partner teams autonomously in English, following business protocol.
- Students were given a two-week time window to set up a Zoom meeting and to find a mutually convenient time with their partners. The German students initiated the e-mail communication by proposing a business meeting to explore the potential of a partnership in Japan.
- A sixty-minute Zoom-based mock meeting was held by each team. Students conducted the meeting independently and submitted a video recording.
- The instructors reviewed the submitted recordings and identified items to reflect on in the debriefing session.
- Students were asked to report freely on their feedback, followed by a debriefing session with discussions to improve their meeting skills.

Pedagogical Rationale

Taken together, we reasoned that making online negotiation part of the teaching provision offers students a fresh learning environment. Four skill development opportunities stand out:

Business Skills: From a business skills training perspective, this setting is much closer to a real business setting than pre-scripted cases widely used by business schools. The meeting simulation allowed students more freedom and required independence. As the students represented real companies, they can decide the framework of the meetings based on real research. Students apply their business skills in terms of objectives (what needs to be achieved by the end of the meeting), strategy, agenda, flow, and tactics to realise effective meetings. All of the planning should be made with high uncertainty, knowing very little about the partner, and, thus, required prompt adjustments as the meeting progressed.

Cultural skills: The meeting simulation was cross-cultural, not only because students were from two geographically distant countries, Germany and Japan. It also involved more complex layers of the business and corporate cultures. The two companies have significantly different characteristics, including differences between a start-up and a time-tested company and an IT company and a consumer company. It means that students had to navigate between these complex, multi-layered cultural differences. Students were required to familiarise themselves with the culture of the companies and enact an appropriate meeting style (e. g. appropriate business positions for representatives, leadership style in the meeting and decision-making process and speed). Furthermore, as the virtual meetings were held in a virtual space in-between Germany and Japan and to be communicated in English, a foreign language for both parties, they had to anticipate what cultural norms would be appropriate for the meeting. It required highly flexible cross-cultural skills for the students to respond to the other party's action on the spot.

Digital skills: Obviously, students had to utilise essential digital and technology skills explicitly required for the virtual meetings. More importantly, they needed to anticipate and prepare for the qualitative differences between an online and a face-to-face business meeting. By the time of the session, all students were already quite familiar with the online lessons (due to changes in the teaching provisions during the pandemic). Still, the geographic distance comes with its own challenges for web conferencing, especially in quality terms. Students needed to develop and display online skills on the fly all the while dealing with an unfamiliar "potential" business partner from a highly different linguistic and cultural background.

Language skills: The meeting was set up to use English, the standard language in international business, and the details of how to negotiate in English were left to the student's own initiative. All German and Japanese participants either already use English substantially at work or have learned business English skills in universities. Negotiating in English online is a multi-channel communication experience. Students had to actively utilise a wide range of English communication skills, such as writing e-mails in English, speaking and listening in English, along with non-verbal communication skills appropriate to the situation.

Analysis

The data were drawn from the recording of five Zoom sessions, including video recordings of (i) two sets of simulation meetings conducted by German and Japanese students in English, (ii) two reflection sessions in German and Japanese classes in German and Japanese languages, respectively, and (iii) two interview sessions conducted by German researchers, one with German students in German and one with Japanese students in English.

All of the video/audio recordings were transcribed into text data, and later, the text in German and Japanese languages was translated into English. The analysis processes were conducted in English while drawing from our tri-lingual expertise background and work experience (Germany, Japan, UK/USA). We used qualitative software packages (Jackson & Bazeley, 2019) to process qualitative data analysis with a Thematic Analysis approach (Guest et al., 2011; Maguire & Delahunt, 2017). "The first cycle coding" was conducted inductively (Saldaña, 2021: 85), and we created over 100 codes related to the four crucial professional skills: business, culture, digital and English. During "the second cycle coding," the listed codes were examined and categorised into several groups, and the primary themes of the discussion were extracted.

Findings

A vivid picture of the demands of web conferencing emerged from the data. While ready to take on board web conferencing as a new and alternative vehicle for professional communication, our interviewees were acutely aware of the extra challenges that come with it. Some of these challenges are rather obvious, some less so. Indeed, most of our interviewees felt something was off but could not really put their finger on what exactly makes web conferencing different from tested forms of communication, face-to-face or digital. We present emerging themes from the thematic analysis of students' reports, starting with tangible, in-the-face challenges that make virtual meetings less candid than real-world meetings. Then, we move to explore taxing but more complex and arguably rather hidden experiences when negotiating online across cultures. Table 1 illustrates student views, experiences and attitudes towards the primary themes that emerged from the data.

Table 1: Emerging themes, codes and illustrative quotes

Themes	Codes	Quotes
[1] Costs of Web-conferencing	**Openness to Innovations**	• *It is necessary to occupy oneself with this new technology, so that that one can manage.*
	Age Differences	• *I think that younger people have a technical affinity that older people do not have. This difference is still there, even after two years of using web conferencing apps.*
	Experience/ Learning by Doing	• *At work we were thrown in at the deep end. What you do in online negotiations, the different skills, you have to teach yourself, and you improve over time.*
	Savings	• *Firms (in Germany) offer more home office opportunities. As a consequence, they no longer borrow or lease so much office space.*

(Continuing table 1)

Themes	Codes	Quotes
[2] Quality of Technology	**Infrastructure**	• *Without good internet web-conferencing is not possible. If you live in a dead zone, then online collaboration is difficult.*
	Technical Expertise	• *Good IT skills are essential. It starts with understanding how to dial into the meeting, where things can go wrong. Then, you have to be familiar with software systems such as screen sharing, working together on a document, etc.*
	Noise	• *You cannot talk at the same time. When you have a loss of audio, you have to wait. We have to care about when that speaker stopped talking.*
[3] Security	**Digital Permanence**	• *I will only take part in this exercise if the recordings are not shared with others.*
	Looking Awkward	• *Frankly, I am quite worried about my English skills. If this was shared, permanently, I'd be very unhappy. In a few years' time someone could get hold of this video file.*
	Privacy	• *The Japanese partners looked very professional in their business shirts. They used a virtual background depicting their supermarket. It looked really professional.*
[4] Environment	**Non- and Para-Verbal Clues**	• *The camera was too far away to check their facial expression. I also felt that their facial expressions were different from Japanese people. It might be different when you are face-to-face, or it might be because we are doing it on the web, but there were some differences in the way they made their facial expressions.*
	Reading the Air	• *I didn't know how to start casually. We wore formal suits, but the Germans said they were surprised that we were formal. We were both wearing proper shirts and so on. That was the atmosphere we thought we wanted to have.*
	Reduction to Language	• *With virtual collaboration, you only have the opportunity to engage with each other using words. You simply don't have the opportunity to describe something with gestures, facial expressions.*
	Replicating Face-to-Face Business Environment	• *Going out together (or "Nomikai") makes for a lot of networking, to understand each other well, having some personal space. But the meeting being online we didn't, we couldn't have it. It was really sad.*

(Continuing table 1)

Themes	Codes	Quotes
[5] Contextual Atmosphere	**Icebreaking**	• *The meeting was difficult partly because we couldn't find anything in common. If they actually came to Japan on a business trip, I could ask them questions like 'How was your flight?' or 'Do you like Japanese food?'*
	Team Coordination	• *You just cannot just have a very brief chat with your neighbours, but when you're talking you're pretty much the only one talking.*
	Sequencing	• *When you're online you have a tendency to interrupt others. I have found it difficult to know when to say something. In find face-to-face communication much easier to manage. Here I rarely cut others off.*
	Opting out	• *I'm going out of the room now, because I feel I just disturb the whole meeting.*
[6] Social Interaction	**Trust**	• *Trust is really critical and it takes a long time to develop.*
	Floating Experiences	• *So, if you meet in person and are late, it seems much more impolite than when you are virtually 5 to 10 minutes late for a video call.*
	Empathy	• *I think you have to reassure them, make them feel comfortable talking … I try to praise, or give positive comments.* • *You have to pay a lot of attention. When meeting online you can only see the face and perhaps the upper part of our body. Eye contact or nodding a bit can let others know that we are listening, engaging with what they have to say. It's better than showing nothing.*
	Relationship	• *I always had to deal with a colleague virtually and didn't get along with his virtual persona. And then I got to know him personally for the first time. He turned out very different from how I imagined him. We were pretty much on the same wavelength.*
[7] Emotional Security	**Time Management**	• *I felt like I was answering questions all the time and I couldn't rest.*
	Emotional Connection	• *We, in Japanese companies, rarely talk about personal topics before we start a meeting … only business-related topics. So we tried to start business talk straight after the start of the meeting … I think the German side wanted to talk about some personal issues … I was surprised that the German side wanted to get our information to reinforce our relationship. It's not really correct to ask each other about personal topics, where they live, what their family structure is like, what they like to do outside of work, etc. It's a bit rude.*

(Continuing table 1)

Themes	Codes	Quotes
	Silence	• *I felt that it would have been better if they hadn't said anything.* • *Compared to Japanese people, I got the impression that they spoke a lot.*
	Cultural Differences	No Fuss Communication • *I strongly felt the purpose of the meeting. Everyone focused on the deal.* • *I am not a representative of the Japanese people, but if I had a Japanese way of thinking, I would think that maybe "we are not there yet" (we need to talk more before we will visit each other).* Confidence • *The other side may have thought that the Japanese side would take the deal more easily, saying, "Okay, okay." I think that they felt "Japan can catch on easily."* Respect • *Rather than listening to us carefully, they expect us to be happy "to have the Japanese company as a partner."* Listening to Advice • *But we had disagreements as well. While we told them that we cover only Tokyo area, they said they wanted to start the business from Kyoto, and we felt they didn't understand about Japan. I felt that we needed to have more discussions.* Hierarchy • *So maybe it's a big difference between Europe and Japan, and then because job descriptions are ambiguous, we need efficient communication. So, from virtual communication, it's very difficult to enhance communication. So that's why Japan will go back to face-to-face.*
	Foreign Language	Proficiency • *I had a hard time listening. At the beginning, German accents were unfamiliar and difficult to catch. I tried to anticipate the content and to pick up whatever words I could catch. Following the conversation was difficult.* Muddiness • *You asked them what's better compared to other competitors. Was the German reply satisfactory enough? I wasn't particularly impressed.*

Costs of Web Conferencing

None of our respondents questioned that web conferencing is an important and all-pervasive medium of business communication. But costs are involved beyond software and hardware considerations. As mere users, they might have had little to say about the complex processes of introducing web conferencing tools to business activities (e. g. purchase of licenses, maintenance and so forth). However, they all felt obliged to acquaint themselves with their respective software packages. Some are better equipped than others for dealing with the multiple challenges that come with new workflows. Next to differences in the openness to innovations, they observed that some colleagues felt overwhelmed and insecure when this new digital tool was being introduced. One prime reason for this uncomfortableness was that web conferences were introduced overnight (as firms had to quickly react to government stipulations surrounding the Covid-19 pandemic). At the time, the forced rapidness of the web conferencing rollout meant that little training was offered that would prepare staff (and students) to integrate the new application into their daily routines. It was all about learning by doing and that at a quick pace. Out respondents felt that "age" would make a big difference in how people absorbed and made use of the possibilities that come with web conferencing tools. They assumed that, as digital natives, younger people would be more at ease with virtual communication and the intuitive use of app interfaces than older employees. Moreover, the German informants reported that web conferences have become an integral part of everyday life at work. For cost considerations, firms would consider cutting down on office space while increasing home office opportunities (Table 2, [1]). While also obviously important during the pandemic in Japanese business environments, the majority of our Japanese respondents agreed that firms have resumed office work.

Quality of Technology

Web conferencing technologies are supposed to offer similar experiences to that of a real conference. What looks good on paper, can, however, be quite a different experience in practice. According to the students, the infrastructure matters greatly. The wifi signal, broadband stability and the equipment (camera, speakers, microphone) facilitate seamless virtual collaborations. The online experience is only as good as the weakest link in the interplay of wireless networks, servers, and devices. And that on both negotiating sides. In many ways, our technological skill set, too, influence how well we can connect with others. Our informants were also mindful of "noise" that can make or break online experiences. Such disruptions can come from the physical environment (for instance, construction noise, or disruptions through family members) or delayed and distorted signals (which is quite common when working with geographically distant colleagues or with people from countries in which the IT infrastructure is not top-notch). A modest clarity of voice and video greatly confuses flows of communication and, by extension, patterns of interaction (Table 2, [2]).

Security

Our informants were, to some extent, also concerned with security. They knew that the meeting simulation was, for purpose of analysis, being recorded. Recording the online conference made students aware of potential "audiences" of the recorded video. One of the team had a loose and unstructured conversation after the meeting simulation, and they reported that the exchange was "very friendly and straightforward." One of the Japanese students said only during the free talk he got to know the personality of the German students. They could be more expressive about their character because it was a free conversation and the session was not recorded. All students agreed to record the session for analysis by instructors, but they paid careful attention to how they should behave when the session was being recorded. They were also concerned about how these videos were being used, especially whether these recordings would go public. They feared the permanence of these records, and that how they came across would potentially negatively reflect on their professional appearance (now and in the future). Most notably they worried that an awkward or less competent use of English would be shared amongst their peers (the original plan was to use this video for in-class discussion amongst a larger group of students). The module leaders alleviated such concerns through non-disclosure agreements. Nevertheless, one group only shared the voice recordings with the module leaders. Privacy concerns, too, mattered. Web conferencing tools allow for the use of virtual background pictures. These images disguise how we live or under which conditions we work, and thus prevent a worrisome intrusion of our private space (e. g. a look at our furniture, childcare, or pets walking about, to name only a few weird things that can go on in the background). By contrast, the right picture can convey a certain of amount professionalism. While the Japanese groups made ample use of virtual backgrounds (including a firm-themed one of the Japanese supermarket chains), the German groups were less worried about not looking camera-ready or disclosing private information (Table 2, [3]).

Environment

When web conferencing interlocutors are boxed into "tiles," with only their face and upper body being visible (if they have turned on the camera, that is). As expected, our students reported manifold challenges that go with this loss of physical sense. In most cases, the gallery view and its small onscreen squares commonly used in virtual apps limit access to crucial communicational clues. Non- and para-verbal communication usually enable good contact. Our participants felt, however, that they often missed out on posture, mimic, spatial behaviour, or voice volume when engaging in dialogue. As a result of this, they needed to work very hard to catch any additional meaning through body language or movement. Remember that the meeting simulation was not only virtual but took place across cultures. They not only had to focus on what was said (in a language other than their own) but also needed to make sense of culturally tainted and limited non- and paraverbal communication clues. Between all these layers of communication and the interaction between them, the students often stumbled over what they perceived as a mismatch between what was said, and how this was couched into eye contact, facial expressions, body movement and so forth. All this made finding common ground extremely difficult between the negotiating parties. They addressed issues of the environment in different ways. From experience, the two German groups assumed that their virtual persona would be primarily reduced not only to what they would say and how well they would use English. Both assumed that the use of plain English would make life easier for both sides. The Japanese side, in contrast, expected challenges from nonverbal aspects when preparing for the meeting. To them not only what was said mattered but the underlying tone of negotiating setting, too. To create a professional atmosphere, the Japanese students considered dress code and virtual backgrounds. One participant used Japanese characters for his name on Zoom. By the same token, they voiced frustration with the impossibility of transferring essentials of Japanese business culture to the virtual environment, the exchange of name cards ("meishi") being a point in case. For Japanese these convey vital information about interlocutors and usually set the tone for any business discussion (including what language and level of formality to use). In our eyes, these differences in overcoming the drawbacks of the virtual environment added to the challenges of genuinely relating to each other (instead of solving them) (Table 2, [4]).

Contextual Atmosphere

Apart from e-mailing (to set up a mutually convenient meeting slot), the groups did not know each other. Under these circumstances, "icebreaking" is an important step to create some form of common ground for virtual negotiations to kick off and evolve. However, we found that both groups were quite insecure about which way they could ease themselves into dialogue. All respondents felt that the virtual situation made it difficult to find suitable topics that would have been much easier to talk about, had the meeting taken place face to face. Obvious icebreaker questions relating to the weather, food, or trip did not readily impose themselves. Perhaps out of necessity, perhaps because of culturally-induced task orientation both the German and the Japanese groups evaded small talk and got to the point quickly. The Japanese sides felt that from the get-go they missed out on identifying common or shared topics such as talking about food or weather. Creating an informal space in the virtual world (similar to chit-chatting over coffee) was not possible. The virtual environment also brought about coordination issues within and between the groups that stood in the way of dialogue. In face-to-face negotiations, we usually share glances and look for clues from our partners. In virtual situations, this is not possible. Neither can we quickly (and informally) exchange ideas with team members. All this makes speaking with one voice at the negotiation table difficult. We found that this lack of coordination could lead to confusion as to whom to address or whom to expect answers from. There were also difficulties concerning the sequence of speakers. In contrast to a face-to-face meeting, in which we usually know quite well when others stop talking or invite a response from us (including intonation, and body signals), we have found virtual communication to be rather arhythmic. Participants, voluntarily or involuntarily, interrupted each other or cut others off altogether. Some found it difficult to participate in the discussion or find the right moment to say something. They commented that the technology itself is unforgiving when it comes to even small overlaps of communication. More than one person cannot talk at the same time. What looks like good communication, i. e. one person speaking while all others are listening, was felt to be unnatural and scattered (Table 2, [5]).

Social Interaction

Respondent accounts suggest that web conferencing tools are good at getting things done, but less so when it comes to social interaction. The problem of course is that business comes down to relationship-building processes. Negotiations, especially in cross-cultural contexts, involve much ritual behaviour geared toward building trust. Our participants felt that it was quite difficult to have or develop feelings about others. They questioned whether others were likeable in general and trustworthy in particular. The interview data suggest two main reasons for such doubts: First, meetings online are floating experiences. People go in and out of negotiations (lending online meetings a “beehive” character), or hop from one potential business contact to the next. Meetings are as easily set up as they are cancelled. In the eyes of our students, all this makes virtual meetings appear multi-optional, less important and perhaps even less real. In our specific case of cross-cultural negotiations involving a Japanese and a German company, they thought that for the food delivery company taking the effort of travelling to Japan and meeting the supermarket chain representatives would have signalled a very different level of commitment. They would see in such an approach to negotiations less flitting about and perhaps even a much more meaningful business contact. Second, and in line with the rather floating experiences, participants agreed that virtual meetings do not feel real. It is seen as all rather distant, almost like a computer game. The issue of overall commitment extends to doubts about whether others are really listening to what one has to say. Are they paying full attention, or are they elsewhere in their thoughts? Dialogues are felt to be depersonalised and almost like being wrapped into cotton. The loss of verbal and non-verbal clues makes active listening and feedback loops very challenging. Despite all the effort of not tuning out, such disruptive experiences play no small part in social disengagement. Despite all these challenges, the students thought it possible to tackle such floating experiences. They self-reported attempts at more empathic communication styles in the hope of establishing more emotional connections (Table 2, [6]).

Emotional Security

Both German and Japanese students spent considerable time reflecting on issues of personal security. Making sense of the situation, and their roles and those of others were felt to be difficult. In this vein, our informants shared a great sense of emotionality. Many of them spoke of intense experiences, including curiosity, surprise, stress, and even anger. In our eyes, there were three main sources of such feelings: The task forced them out of their comfort zone, first, in terms of the virtual environment per se; second, in terms of the cross-cultural setting; and third, in terms of communicating in English. What looked easy and exciting on paper ("how hard can it be?") turned into a strenuous and, at times, perplexing encounter. From a student's perspective, tackling each aspect individually was seen as taxing but made for a tremendous challenge. For the Japanese participants, the main driver of said worrisome feelings was the lack of emotional connection between the participants (warmth and sense of sharedness). Our German students reported that finding the same wavelength when making and maintaining contact was difficult. They often felt misunderstood, as they were less clear about whether and to what extent the Japanese negotiation partners really got the point they were trying to make. And feelings of uncertainty and inadequacy in handling this situation were a result of that.

Expectation Gap*:* Participants reported differences in what they wanted to achieve, especially concerning the first online meeting. The German sides had clear ideas of what they wanted to get out of the meeting. This planning propelled a certain task orientation with numerous, perhaps unintended knock-on effects: (i) they took charge of the scheduling and programme; (ii) they came straight to the point (thereby avoiding small talk); and (iii) in their role as the food delivery company representatives, they were quite confident what extra services they could offer to Japanese consumers. All this created a sense of urgency to get to an agreement (or so the Japanese counterparts at least felt), which made them somewhat uncomfortable. The Japanese students did not expect to make any decisions during the first meeting (see below for more details on cultural differences) and felt that German students were too rushed. The virtual environment magnified this gap in expectations. During web conferences, we see ourselves and others in small squares. There is a constant feeling that we are onstage. Like in a theatre, we feel compelled to perform.

Emotional Connection: In the data of this project, both teams skipped small talk. They immediately got into business topics after a brief self-introduction. The lack of small talk and the seemingly rushed communication style from the German side were seen as counter-intuitive to the Japanese way of doing business. The informants expressed their wish to build trust first before potentially moving to do business. Small talk plays a big role in both business cultures, but both sides felt quite insecure about how to ease themselves into the conversation. Arguably, the German side took charge of the conversation by skipping small talk, and this straightforwardness made the conversation less casual and tipped the scales towards talking about the task at hand (market entry). The Japanese side felt they did not understand the personalities of the German participants. This loss of social cues and consequent loss of sense of social connectedness might have been responsible for rather reserved attitudes throughout the meetings (see also Hogg & Reid, 2006 for reduced information and idea sharing). Both parties thought they could not feel the mood of the conference participants. They also found it challenging to get to know the personality of the members of the other teams. German students had an impression that Japanese students were overall polite but reserved. Japanese students felt the German students acted with a somewhat icy and domineering negotiation strategy. Some Japanese students resorted to intentionally making more smiles, they thanked more often, and made more explicit gestures, in the hope this would give more personal impressions. The effectiveness of such efforts was unknown, as German students did not mention these efforts. Again, the virtual setting underpinned these misconceptions, even if it did not exacerbate them. In one group, these mistaken impressions were never restored, resulting in a rather abrupt end of the meeting simulation. Yet, the other team had a spontaneous free talk after the meeting in order to fill in the absence of the emotional connection, and the talk successfully created some emotional bond. For us, it was evidence of students' ability to adjust.

Silence: Silence is a natural and good part of any interaction. It provides rhythm and gives us time to think and move the conversation forward (Jiang, 2020). However, cultures differ in how they approach silence. In some, it is part of accepted communication while in others it is not (making people feel they need to jump in to fill this void). Our data suggest that when we use a web conference platform, things are not as clear-cut. There were worries about technical glitches, and some students felt unhappy about others and how they interacted with them. The combination of different group sizes and initiative-taking meant that it was sometimes hard to identify who would talk next or indeed whom to talk to. Participants reported that they found it difficult to deal with silence during the meeting simulation. They wondered if and when they should fill the void.

Cultural Differences*:* If we feel something is off when engaging with people from other cultures, it is quite natural to justify one's own way of doing things if not blame others for doing things differently. In hindsight, our Japanese informants referred to cultural reasons to explain their passiveness in response to the German foray (most notably, in terms of decision-making, authority or responsibilities). The Japanese students decided beforehand that the first meeting was simply an opportunity to listen to the other party's offer and exchange opinions. In Japanese companies, they needed to have an internal meeting afterwards to build consensus within the company, one Japanese student explained. How cultural differences play out virtually makes for very different participant readings of the negotiation situation. There were clear differences in expectations of what could be achieved online. The Japanese sides were unwilling to move forward quickly with a reference to the importance of face-to-face interaction. The German task orientation ("Let's do business straightaway") juxtaposed the Japanese relationship orientation ("Let us get to know each other first"). They felt the German side to be "pushy," "too confident" and, thereby, unaware of cultural differences in decision-making. For instance, they voiced their concerns about the German side brushing aside the agenda they had suggested via email. They also stumbled over the randomness of turn-taking and the apparent need to fill the silence. All this gave the Japanese side the impression that the German group was representing the food delivery company as individuals representing different divisions, with individual agendas, and not with one group voice. Respect for differences (or lack thereof) was a concern of one Japanese participant. Although the German students found themselves wanting something from the Japanese company, in the eyes of their Japanese counterparts they might have played their roles as representatives of a young start-up company perhaps a little bit too well. According to them, the German students seemed overly confident in their business proposal but had not conducted enough research about the Japanese market (about geographic focus when entering the Japanese market). In other words, Japanese students were aware of the cultural differences, but they stuck to their own practices, rather than trying to explain explicitly their own culture or listen to the German way of negotiation. The German sides perhaps underestimated cultural differences (that "were not an issue") as they felt that these were less relevant online. Yet, they also experienced cultural surprises: A German student reflected that they did expect to have a longer small talk with the Japanese because he had an image that the Japanese are polite. Thus, he was surprised that small talk did not happen at all. Later, during the after-meeting free talk, he discovered that Japanese students wanted to have small talk, but they could not find suitable small talk topics. Ultimately, the virtual environment seemed to have shackled the ability of both sides to read between the lines and gauge each other's true feelings and intentions.

Language Skills*:* Considering that both courses are part of a postgraduate curriculum, we would expect students to have largely similar levels of English language expertise, including business-specific vocabulary. Both the Japanese and the German participants felt uneasy about the adequacy of their communication skills in English. They knew that good English skills make or break negotiation success. This includes (i) email communication (finding and setting a suitable time slot, including time differences); (ii) preparation (in terms of finding and accessing materials, presentation development); and (iii) agility (thinking and responding quickly to questions). Both sides found it difficult to fully engage in dialogue, including getting their respective points across and grasping what was being said. There is of course more to successful communication than merely exchanging facts. When talking we reveal a lot of ourselves, including how we see ourselves and others. Then there are our needs and wants embedded in every message. In the present situation, all these multi-layered messages embedded in communication took place in English (as a foreign language to all participants) and in a virtual environment. Technical difficulties (signal delays, poor sound quality) made negotiation efforts even trickier. In some instances, language was not the only problem. What was being said was at times unclear (most notably in the context of business calculations and market analysis topped up by unfamiliar currency and conversion rate considerations). What were perceived as fuzzy answers to probing questions muddied the subsequent negotiation process. There was also evidence of misinterpretations across all layers of dialogue. What was said, who said it, and how it was said were easily misunderstood. Apart from the English language per se, Japanese participants were particularly critical of their foreign language skills. Because of the unfamiliar German accent, they found it difficult to follow their German counterparts. One Japanese student said he felt he missed almost half of what was said (but despite this proficiency gap, he felt he did not have too many problems making sense of the main points made by the German side). Interestingly, both student groups made little effort to repair communication breakdown and skimmed over possible misunderstandings (this could be problematic in real business, see Tsuchiya & Handford, 2014). As a consequence, one group simply engaged in Q&A after the presentation, without coming to a decision during the one-hour meeting (Table 2, [7]).

Discussion

Businesspersons today operate among offline and online realities. We are, by nature, social people as we interact with our environment. Web conferencing platforms enable virtual collaboration. They combine sound, video, and messaging and appear to have all the bells and whistles of face-to-face meetings. But not quite. Despite all their richness, there are trade-offs and essential aspects of rapport building are missing. And these shortcomings are likely to bring out different things in us. When we get into a conversation over a web conferencing platform, some of us feel awkward and uncomfortable, while others are comfortable with interacting online. Be this as it may, our review suggests that we need to learn more about what virtual work

Table 2: Common challenges of web conferencing, ranging from obvious to hidden

	Category	Challenges
Hidden	**Emotional Security**	• Time management, urgency and uncomfortableness • Trust building and emotional connection with participants (warmth and sense of sharedness) • Difficulties in sharing or understanding participants' culture, language (accents), and emotions • Power balance, discussion/negotiation lead
	Social Interaction	• Less commitment and more fleeting experiences • Empathy and creating desirable/comfortable/safe atmosphere for relationship building • Difficult to be open & straightforward (reservedness) • Worries/less clear about audience understanding
	Contextual Atmosphere & Dialogue	• Little cues for icebreaking, small talk • Informal team coordination • Fewer cues for turn-taking, repairing for communication breakdown, and asking questions • Reactance and opting out
	Environment	• Limited social cues • Paraverbal and non-verbal communication • Multilingual and multicultural engagement • Unforgiving technology: "Artificial" eye-contact, body movement, facial expressions
	Security	• Privacy concerns • Data protection • Disclosure of private space • Permanency of records
	Tech Quality	• Network connectivity and speed • Sound and video quality • Ease of soft and hardware navigation • Physical environment
Obvious	**Tech Cost**	• Virtual environment (hardware, software, maintenance) • Rapidness of introduction (adjustment takes time) • Training and bringing staff up to speed • Variations in openness to innovations

worlds do to us. In particular, web conferencing platforms pose completely new challenges to the direction, extent and nature of how we adapt. Communication skills, compressed to social, cognitive and emotional worlds are at the core of what we make of these challenges.

Table 2 charts common challenges that we can expect when using a web conferencing platform. Arguably, these range from very basic needs such as equipment, training and technological issues to security concerns and lack of privacy. Web conferencing may very well disrupt complex social needs such as dialogue and belongingness.

The Role of Language and Communication When Web Conferencing

Our analysis makes it abundantly clear that appropriate language and communication skills matter greatly, perhaps even more so than in face-to-face situations. Dialogues have to make do largely without relying on non- or para-verbal signals. The virtual environment is all artificial: We cannot look others in the eye, we cannot relate to them through body movements or spatial behaviour, and we cannot form impressions from touch. Reduced to online communication, what we convey through tone, pitch and voice can easily get lost. When meeting virtually, it all boils down to how well we can build rapport through our way of talking and sense-making of what others say. In short, we may look hard for such silent and social signals, but vital clues for good communication and turn-taking are simply missing (see Mehrabian, 2009). The problem is that web conference meetings make us believe these signals to be there. After all, we can see and hear others, can we not? However, because it is only you and your device, virtual communication brings about very different, according to our data, apparently alienating experiences. Under these circumstances, language and communication are one of the few aspects of the digital world that are under one's control. To be clear: It is not only about what we say, see and hear. Language is at the core of our virtual persona and mirrors our social, cognitive and emotional worlds. Honing these skills can help you make lemonade out of virtual lemons.

Affective-communication skills: First off, the virtual situation and what others say affects us in specific ways. The outlook of communicating online – with strangers, in English, with little to no non-verbal cues to hold on to – can make us feel rather uncomfortable. Like onstage, we may feel constantly on edge and at the very centre of attention. There is no time to sit back and relax. Like a vessel and in line with Lindquist (2021), language carries not only information but our emotions, too. In the colourless and odourless environment of web conferencing, language sets the rhythm of dialogue and emotions. Our data, however, suggest that our virtual persona has fewer channels to express feelings (how we feel, what we think of others, the proposal etc.). It seems that we may choose to complement what we say, with exaggerated gestures, in the hope of providing comfort and cementing trust.

Cognitive-communication skills: Our findings would seem to show that virtual environments can substantially get in the way of the flow of communication. What stood out in terms of web conferencing was how it challenged, if not altered turn-taking and attention skills (see Greenwald, 2021). In person, we are usually quite attuned to the back-and-forth of conversations. We intuitively know when to talk and when to listen and so forth. Web conferencing seems to override such cognitive-communicative rules. Two reasons might be responsible for poorer orientation and attention. First, web conferencing technology is rather unforgiving when it comes to turn-taking. An overlap of voices easily results in a cacophonic experience. When meeting face-to-face non-verbal signals help us to navigate small communicative overlaps. These we pick up and usually let others take over. Second, unless gestures, facial expressions or body language are quite crude, the virtual environment makes it hard to read any such turn-taking signals. One affects the other and together disorients our ability to abide by the etiquette of good dialogue, including attention, appropriate responses and so forth.

Social-communicative skills: Virtual reality makes for a huge and growing gap in healthy dialogue. We usually know that business communications are fragile, especially when talking to strangers. All our efforts are geared to find "common cognitive ground" with business partners either at the personal or the organisational level (Nonaka, 2007). The way we make use of language is much more than merely conveying information. We want to promote trust and establish such relationships (Horn & Holden, 2018), and the basis of that is to air empathy and understanding and, thus, to be okay with us and the situation and make others feel comfortable around us. The key to being successful in this social game is to adjust our conversational skills to the audience and context, particularly when negotiating across cultures. But the online world makes impression management difficult, as we cannot proffer gifts or cannot be our most eloquent and persuasive selves (Mauss, 1954). And an inability to relate to one another and deal with differences is the result of that.

In sum, virtual environments result in some differences in our social, cognitive, and affective experiences. Language and communication needs are even more acute in virtual meetings because of the lack of nonverbal communication. We cannot tap into our vast repertoire of making and maintaining contact. This makes conversations difficult.

Cultural Differences under the Spotlight

We were surprised by the extent to which the virtual environment magnified cultural differences. Web-conferencing tools are largely seen to eliminate not only geographic barriers, but break down cultural barriers, too (but also see Appadurai, 1996). This type of levelling was not necessarily what we have seen in our data. We have found ample evidence of culturally induced "noise," that leads to misunderstandings and even conflicts. Sure, both teams intuitively used English as a bridge language but differences in expectations, business conduct, or communication styles (to name just a few examples) did not go away. Paradoxically, and despite the training and priming (both the German and the Japanese groups were part of a module that prepared them for the intercultural and international world of work), the students seemed to have underestimated the impact of culture on cross-cultural negotiation. We were somewhat baffled by the difficulties both sides had in building rapport. While the differences in ways of doing things are undercurrents of any negotiation involving people from different cultures, it would seem that the virtual mode of communication adds an extra layer of complexity. We see two interconnected reasons for this. First, web conferencing readily disrupts our social, cognitive, and affective experiences. These, in turn, further distort relationship-building across cultures. After all, web-conferencing apps remain leaner than face-to-face conversations. They might be adequate in situations in which success depends more on literal and direct understanding than on the context of the situation. But for more ambiguous situations, that cross-cultural situations by definition are, they might be a sub-optimal choice. Second, and in the same vein, it would seem that the format particularly disadvantages participants who prefer high-context communication styles. Those who focus on intricate and implicit factors of dialogue (specifically non- and paraverbal communication) might find it more difficult to find their bearings in a virtual environment that is more specific and direct. Virtual communication may magnify the difference between high and low context-cultures because of the different levels of challenges. People leaning towards low-context communication might get away with such slimmed-down possibilities, but those leaning towards high context communication less so.

This would suggest that virtual communication brings out different things in us, and the efficiency with which we use web-conferencing apps depends on the cultural environment we are in.

Although based on the rich data of students' detailed reflections and observations of their meetings, this qualitative case study approach has its limitations. Thus, we should be cautious with generalisations beyond their specific context. Yet, our findings make it very clear that there is an urgent need to further study this emerging application of technology to business practice in a broader range of cultural and business settings. We argue that the findings from our work are a first step toward a better understanding of digital negotiation across cultures and offer several business and pedagogical implications.

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From Second Life to Second Job: Creativity and Entrepreneurship Education in the Metaverse

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Abstract

Creativity[1] is one of the most important future skills and a fundamental factor for business success. It has long been widely investigated, but the rise of new immersive technologies like virtual reality (VR) opens opportunities for individuals and teams to discover new ways to enhance their creative process. The aim of this article is to present a first exploration of how immersive technologies can be applied to foster the generation of ideas in the context of digital entrepreneurship education. The findings are based on academic and professional literature, observations, surveys, and initial testing conducted by the Munich University of Applied Sciences (HM) with its Strascheg Center for Entrepreneurship (SCE). Given the rising importance of immersive technologies in all disciplines, the article aims at providing educators and practitioners with an overview of how the potential of 3D and VR can be captured to improve creativity in digital innovation management and entrepreneurship education.

Keywords: entrepreneurship, entrepreneurship education, creativity, innovation in virtual world

The metaverse: a new place for creativity and entrepreneurial collaboration?

We are at the beginning of a new digital era in which our physical and digital lives and work will be even more closely intertwined. Since the tech-company Facebook rebranded itself in 2021 as Meta, if not before, the topic of the

1 Online creativity refers to the ability to generate original and valuable ideas, insights, or solutions to problems using the internet and digital tools. It can also include creating digital artwork, composing music, writing, or producing videos and other forms of multimedia content. It is a form of creativity shaped by the internet and digital technologies that are transforming traditional forms of creative expression and enabling new forms of innovation and artistic expression that would not have been possible without these technologies.

metaverse[2] has been heavily covered in the media and has attracted the attention of many, garnering both praise and criticism. However, the concept of the metaverse is not new. The term was coined as early as 1992 by science fiction author Neal Stephenson in his novel Snow Crash. A metaverse is an extension of the current internet into a ubiquitous, persistent, and immersive digital world that complements our physical world (Weinberger, 2022). This new digital world is described as a place "where [the internet] becomes something we immerse ourselves in, rather than something we just look at" (McKinsey & Company, 2022).

The global metaverse market is growing steadily and is estimated to exceed US$678 billion by 2030 (Statista, 2022). Metaverse offerings and solutions are expected to establish themselves in a wide range of industries and fields of activity. In this context, virtual 3D worlds, which can be used with or without virtual reality (VR) glasses to facilitate new ways of communication and virtual collaboration, are expected to play a particularly prominent role. In the AGORA project, which is funded by the German Academic Exchange Service (DAAD) for the period 2021–2024, the Munich University of Applied Sciences (HM) and the Strascheg Center for Entrepreneurship (SCE) are exploring the opportunities and challenges inherent in integrating virtual 3D and extended reality (XR) into digital formats and online project work for entrepreneurship education.

In the first place, it is important to differentiate between augmented reality (AR), virtual reality (VR), and extended reality (XR). AR overlays digital content onto real-world elements. The popular game Pokémon GO is one of the best-known examples of this technology. AR augments the physical world with digital content and does not require a headset, only a mobile device. VR is a fully immersive digital environment that provides a realistic simulation experience that tricks users' senses into believing that they are in a world different from their physical world. VR can only be experienced with a head-mounted display (HMD) or headset. XR is an umbrella term that encompasses AR and VR, as well as any computer-generated "realities" in the future.

This article deals specifically with the topic of using VR to enhance creativity in virtual teams within the framework of digital entrepreneurship education and innovation management. Creativity and idea generation together consti-

2 The term "metaverse" refers to a hypothetical future version of the internet that is fully immersive, interactive, and a virtual world where users can engage with each other and a virtual environment in a way that mimics real life. It is a concept of a shared space, created by the convergence of physical and virtual reality, where people can interact with each other and digital objects as if they were in the same place.
The metaverse is often depicted in science fiction and popular culture as a virtual world that is fully accessible to people through virtual reality or augmented reality devices. In this sense, it represents a next step in the evolution of the internet, where online experiences are fully immersive and closely resemble real-life activities.
While the metaverse is still a concept and not yet a reality, there are some emerging technologies and platforms currently in development that could eventually lead to its creation.

tute one of the phases of the innovation process and lay the groundwork for innovative solutions. They depend on a variety of factors, such as personality, talent, and motivation (Taplick, 2021), as well as the social environment. One additional important factor influencing creativity is the space in which the person or team is located and expected to work. Indeed, a physical space affects creativity because it influences other factors, such as interpersonal interaction, information sharing, autonomy, and sense of control, all of which contribute to the creative process (Vithayathawornwong et al. 2003). In addition, physical spaces or facilities for non-work activities have also been shown to influence organisational creativity (Vithayathawornwong et al. 2003).

According to the World Economic Forum (2022), creativity is one of the most important future skills, and it is considered a critical factor for companies, as it is fundamental to innovation and business success. In an increasingly virtually connected world, it is therefore essential to explore how digital technologies can support higher education institutions and companies in fostering creativity in virtual teams. With this in mind, this article presents the potential of virtual 3D/VR for the creative process and idea generation in virtual teams, based on findings from the academic and professional literature, observations, surveys, and initial testing conducted by the AGORA team in 2021 and 2022.

Exploration of virtual 3D and VR technologies in digital entrepreneurship education

In the wake of the Covid-19 global pandemic, universities worldwide were forced to transfer their lessons to digital media. HM and SCE have expanded their digital offerings in entrepreneurship education as a result of a growing international network, as well as constraints related to Covid-19. During the pandemic, project-based entrepreneurship classes at HM and SCE included asynchronous formats (delivering text and video material via massive open online course (MOOC) platforms) as well as synchronous formats (teaching via online conferencing platforms, such as ZOOM or MS Teams). In online classes, students were given opportunities for teamwork, coaching, reflection and to ask questions live. Nonetheless, it was not uncommon for instructors to experience a fairly anonymous audience who had the camera off most of the time. Three years after the Covid-19 outbreak, some students still do not feel comfortable letting their cameras show their faces and private work environment, while others continue to lack the technical requirements for image transmission.

The space in these synchronous lessons was dictated on the one hand by the video conferencing tool, which could be split up to allow subgroups to work more selectively on their topics and projects in open or closed breakout rooms. On the other hand, spatial extension took place on digital collaboration platforms, such as cloud drives like Sync & Share, digital whiteboards like Miro, and virtual project management solutions like Trello.

However, all these digital work environments are two-dimensional, the direct interaction between participants is primarily auditory (at best also visual, incorporating a partial video image of their communication partner), and the experience is complemented by the sharing of information about the activities carried out on the collaboration platform. Three-dimensional encounters and interactions are not possible with the digital collaboration platforms currently in use. Physical space has an impact on the creative process, but of course, participants' individual physical spaces cannot be adapted when they work virtually. This raises the question of whether and how technological advances could help entrepreneurship educators address this issue.

To answer this question, HM and SCE are making use of technologies such as virtual 3D/VR and examining their potential to take virtual collaboration to a new level for creative processes. In a virtual collaborative workspace, users are given a three-dimensional sense of space and a virtual representa-

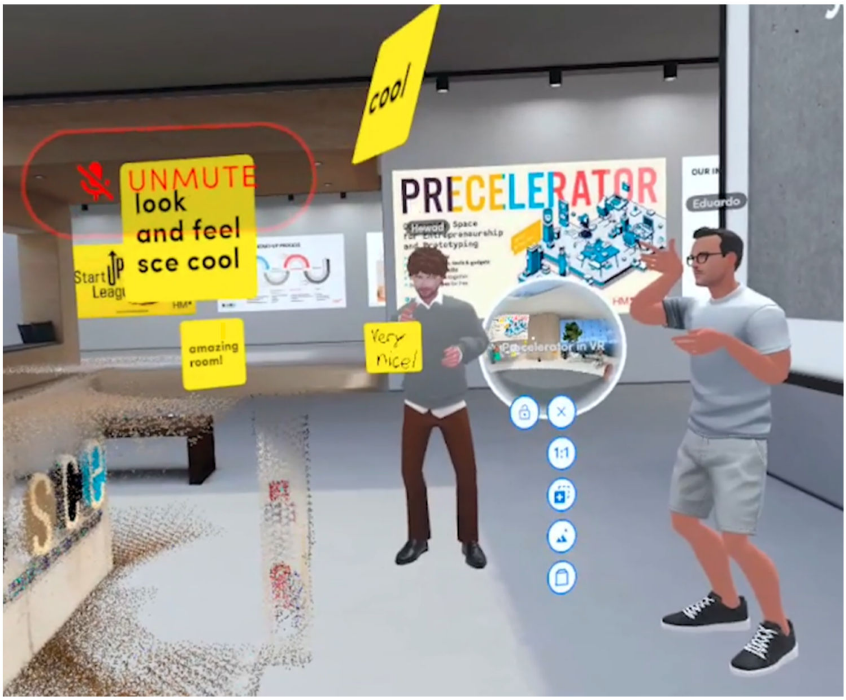

Figure 1: Event room at the HM/SCE virtual 3D entrepreneurship space AGORA

tion of themselves (an avatar[3]). Here, they interact with other people and objects while sharing information and new ideas.

On modern virtual 3D/VR platforms, such as Spatial, Mozilla Hubs, and Engage, communication and interaction mechanisms used in physical spaces merge with the information and collaboration capabilities we expect from digital workspaces, such as the ability to access and edit written documents, view presentations, and play audio and video files. In other words, on these platforms, instructors can design a synchronous teaching format that combines video conferencing with virtual 3D/VR when closer interaction between participants is beneficial for their creative process.

In a virtual 3D/VR environment, the visualisation of new ideas can take various forms. As a result, mechanisms that we are familiar with from collaboration in physical spaces are in place, such as collaborative generation of ideas on post-its and subsequent visual and spatial clustering. In a virtual 3D/VR environment, not only can the development team try out solutions that are only produced digitally and not physically in a usage scenario, but team members can also get feedback from potential customers with little effort. Software solutions such as Polycam, Canvas, and EM3D make it quick and easy to take a 3D picture with just a smartphone or tablet. These tools help entrepreneurial teams identify potential errors, adjustments, and improvements at an early stage in the innovation process, saving time and money and increasing efficiency and efficacy.

In a physical space, people generate new ideas as they look at their surroundings. Being able to look around a physical environment is associated with a higher number of creative ideas. In video conferencing, this number decreases significantly, as participants tend to fix their visual focus on their conversation partner(s) – that is to say, on the screen. In their study of the effects of video conferencing on collaborative idea generation, Brucks and Levav (2022) point out that video conferencing hinders ideation because the virtual space shared by participants is limited to the screen of the device being used. When virtual communicators restrict their visual domain to the shared environment of a screen, their cognitive focus is also narrowed. This narrowed focus restricts the associative process responsible for idea generation (Brucks and Levav, 2022).

Idea generation in a virtual 3D/VR environment can help overcome this problem because the user's eyes gaze around the virtual space while wearing

3 Avatar refers to a visual representation of a person, character, or entity in the digital world. It can refer to a 2D or 3D graphic, an animated figure, or a virtual representation of a real person. Avatars are commonly used in virtual reality, online gaming, and other virtual environments, where they serve as the player's representation within the game or platform. They can be customised and personalised to reflect the player's individuality and preferences. The term is also used to describe a person's representation in social media or other online communities.

a VR headset. Consequently, in principle, the visual-cognitive link that contributes to idea generation is present. Moreover, virtual 3D/VR allows users not only to set up creative spaces that resemble their physical spaces, but also to create spaces that look completely different and are even imaginary or inaccessible in the physical world. Users can teleport to another planet for a brainstorming session or immerse themselves in places relevant to their target audience to better understand its daily context, problems, and needs.

The potential of virtual 3D/VR for entrepreneurship education is still a fairly unexplored topic that needs further research and practice. To fill this gap, HM and SCE, together with nine international partner universities, are developing an entrepreneurship metaverse as a complementary platform where students, professors, and industry partners can meet, exchange ideas, and familiarise themselves with a more immersive internet.

Building a metaverse for entrepreneurs

The main area of the HM/SCE metaverse is the AGORA 3D, located in a multi-faceted virtual space for gatherings and exhibitions on Spatial (www.spatial.io). On the platform, each user can generate an avatar and access the space through their computer, mobile device, or VR headset. The AGORA 3D offers a space for *meet&match*, displays information about project partners as well as posters of start-up teams, and has portals to other 3D spaces. It is designed as an additional tool for international entrepreneurship students, educators, and industry partners to exchange and collaborate in an immersive platform.

In workshops conducted in 2022, students in innovation seminars started with a 10–15 minute tutorial to familiarise themselves with the VR equipment (headset and controllers). Next, they were invited to explore various 3D environments in the HM/SCE metaverse. Observations made by the project team indicate that for most participants, the novelty of being in VR for the first time had a positive impact on their motivation and willingness to check out the 3D spaces. When asked to give feedback on one of the rooms, for instance, two participants wrote on their sticky notes “nice environment” and “I want to stay in this place forever.” Such enthusiastic reactions tend to be the rule when participants experience VR for the first time.

In the second session, participants visited larger rooms and learned more about the potential of VR in entrepreneurship and entrepreneurship education. It was common for users to notice their ability to grasp the characteristics of a product or a place in VR in a more realistic way than in 2D. Indeed, a VR platform can support remote entrepreneurial teams in prototyping, product design, marketing activities, and getting feedback from potential customers.

Figure 2: Virtual prototype presentation for need-finding, testing, or marketing

At the time of writing, given the exploratory nature of the project, 3D objects for testing have been purchased online or uploaded as 3D pictures of physical items or university rooms. 3D objects created or modified in a virtual session can be stored in the space for future meetings, providing a centralised repository for virtual collaboration that can be accessed by teams and individuals at any time.

Since creativity in groups relies on team members' communication and ability to access, visualise, and display content, technologies that expand visual representations are beneficial. Ewenstein and Whyte (2011) draw attention to the communicative dimensions of visual representations as artifacts to interact with and point out that they play a central role in knowledge work. Research on the use of virtual worlds in industry underlines that visualisation provides opportunities to communicate differently in a remote work context and helps create greater awareness and understanding of different insights, ideas, and cultures (Bosch-Sijtsema & Sivunen 2013).

An immersive experience is thus conducive to fostering creativity thanks to its textual, visual, auditory, and graphic stimuli, as well as users' ability to interact with digital content and communicate with each other. Immersion refers to drawing the user into a virtual world where they receive computer-generated stimuli to one or more of their physical senses, often blocking out stimuli from their physical reality (Sherman and Craig 2003). Recent improvements in optics have resulted in more realistic virtual spaces, contributing to an increase in the degree of immersion and making the experience seem more real to the user. Despite these technological advances and the associated advantages for virtual collaboration, some challenges prevent VR technologies from spreading to a wider public: headsets are not intuitive enough, and their weight, size, and set-up are still a burden for students and educators in regular use.

Idea generation as an avatar?

All users join AGORA 3D as avatars, their graphical representation in the virtual world. Users can design their avatar according to their preferences – that is to say, their avatar can look like the them or have a completely different appearance. This freedom of design can have a positive effect on the creative process. In the workshops conducted by HM/SCE, the project team observed that for most participants, designing an avatar is a new activity that triggers their creativity through the selection of skin color, hair, clothes, body shape, etc. This is a fun experience for most participants, and it serves as a warm-up and a team-building activity.

Figure 3: Virtual collaboration as avatars in a VR room

Users always have an experience – whether good, bad, or indifferent – whose quality makes them feel more or less committed to the creative activity. Ideally, it drives them to continue and keeps them motivated to perform at their best (Kohler et al. 2019). An enjoyable and engaging experience is extremely valuable because it brings participants into flow, a state of mind that people try to maintain and seek to repeat. Therefore, it is important to support educators in experimenting with new technologies and innovative experiences, helping virtual teams have more fun, enjoyment, and engagement. In this vein, VR can provide a more inspiring experience for virtual collaborators by enabling team members to do many unconventional things in a 3D environment, such as flying, diving, or sitting around a campfire in the form of avatars. Such activities might also contribute to team building and strengthen the team members' identification with their virtual team (Bosch-Sijtsema & Sivunen 2013).

Furthermore, studies show that in multicultural and hierarchical settings, avatars allow for anonymity, giving users the freedom to express their ideas on a completely equal footing, which in turn increases the willingness of users to share ideas with the group and indirectly promotes creativity (Taplick 2021; Voigt 2013). The anonymity of users helps overcome cross-cultural challenges where a strong hierarchical structure might prevent certain groups from expressing their ideas when individuals with more power are present, which has in turn a positive effect on the creative process, as users can interact in the virtual space freely.

Although the use of avatars can be beneficial for virtual collaborators, there are still challenges to overcome. VR platforms still do not provide avatars with the natural movement, body language, and gestures that are key in human communication. This weakness is indeed particularly problematic when people have never met face-to-face, as well as in situations where understanding facial expressions and nonverbal cues is particularly relevant (Bosch-Sijtsema & Sivunen 2013).

Conclusion

The integration of 3D/VR technologies in higher education, and specifically digital entrepreneurship education, is still a nascent field. Nevertheless, as this article has shown, 3D/VR are new collaboration and communication tools that provide several opportunities for virtual teams, including interaction, learning, and 3D modeling as avatars, as well as a feeling of social presence and fun. In terms of creativity, virtual worlds provide an environment where users can visualise nearly any idea they have, which is an important ingredient in innovative thinking. As a result, educators now have at their disposal an increasingly accessible technology to boost creativity through new, mostly still unknown educational formats that will expand students' freedom to experiment and innovate. Future AGORA activities will focus on how virtual 3D/VR can help foster virtual collaboration in other areas relevant to entrepreneurship education, such as team building, enhancing empathy, and improving presentations.

For more information on the HM/SCE AGORA project please visit:
https://www.sce.de/en/topics/funding-projects/agora/agora.html

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Gamification for team motivation

Markus Stäuble

Abstract

The success of many companies today is characterised by participation and collaborative development of services and products. In most cases, a successful company consists of a large number of employees who work together efficiently and with motivation in order to achieve the company's goals which are aligned with the strategy. For the efficient development of innovative products, these employees are put together in teams according to their competences. In order to quickly reach a productive working phase, good onboarding processes are necessary. These onboarding processes should support the establishment of a good team culture. Concepts from the games industry help to make this getting-to-know phase motivating and goal-oriented. To show how such onboarding can be implemented, a digital teaching format was developed that strengthens the competences of readiness for change, teamwork and virtual (digital) collaboration. The effectiveness was tested in several runs.

Keywords: gamification, agile mindset, teambuilding, collaboration

A playful onboarding format to promote team motivation

A game-based teaching format was developed for the agile objectives and key results (OKR)[1] method to help give experts and managers the education they need for the "World of Work 4.0" – the working world emerging from the Fourth Industrial Revolution. Such playful formats are also known as serious games (Kerres et al., 2009).

The OKR method is encountered in the context of lean management and the accompanying dismantling of hierarchies, which are often associated with the use of agile methods and lateral leadership models. Developing sound

1 OKR is the abbreviation of "objectives and key results". This is an agile management model used to monitor the vision and strategy of a company in short cycles. It is a management system for setting measurable goals at team and company level. The principles are based on management by objectives and SMART. OKRs consist of a goal (objective) and several results (key results) that quantify the achievement of the goal. OKRs are usually used at a variety of levels, from corporate strategy to individual employee goals (Helmold, 2022; Kudernatsch, 2022; Teipel & Alberti, 2019).

corporate strategies on this basis also requires collaborative development at the strategy level. OKR, a method developed in the 1970s by Andy Grove (the co-founder of Intel), is a suitable means of achieving this. Rather than a completely new system, it is a combination of "management by objectives" (Peter Drucker) and the "SMART method" (specific, measurable, achievable, relevant, time-bound). Grove was interested in measurable goals, defined with input from employees themselves. He set out two questions:

- "Where do I want to go?" (objectives)
- "How do I measure whether I have achieved my objective?" (key results)

Generating broad support for OKRs across a whole enterprise means being transparent about them. Businesses therefore compile all their OKRs in a list that can be accessed by all employees at every level of the hierarchy. To enable the enterprise to respond quickly to market developments, OKRs are only set for the next quarter. Progress on the OKRs is reviewed at regular intervals (weekly). At the end of each quarter, the OKRs are redefined (Helmold, 2022; Kudernatsch, 2022; Teipel & Alberti, 2019). OKRs can be quickly adjusted to new circumstances, enabling the business and its teams to swiftly respond to change.

The name of the game-based teaching format is Your Agile Thrill (YAT). In addition to promoting an agile mindset (Eilers et al., 2022), the format addresses and reinforces the following three competences:

- Readiness for change
- Teamwork
- Virtual (digital) collaboration

Digital collaboration refers to a team working together using digital tools (software tools) – for example a group of participants sitting in a room with laptops and working together on a digital whiteboard. In some cases, participants may be in different rooms, e. g. different departments working on an intranet page. Virtual (digital) collaboration means digital collaboration by people in different places or at different times, where the individuals involved do not or cannot physically meet. Virtual collaboration may be synchronous or asynchronous. In the case of synchronous (digital) virtual collaboration, video conferencing software is used.

Structure of Your Agile Thrill

Your Agile Thrill (YAT) was developed as an online format in 2020, the first year of the coronavirus pandemic. A user-centred design (UCD) approach using design thinking was chosen for the development work. UCD means involving a product's users in the development. This is achieved through an iterative process, in which the target group constantly participates and reviews any results from the intermediate steps. The target group thereby effectively becomes part of the development team. The YAT format was developed by students at Munich University of Applied Sciences HM. This ensured that the format developed precisely matched the language and expectations of this target group.

YAT is a digital escape game[2] on the theme of OKR. Participants solve multiple tasks relating to the topic of OKR using playful puzzles. The escape game consists of multiple digital rooms, and the participants work their way from room to room. The final objective is for the participants to open a physical box, which is fitted with a lock that can only be opened with a numerical code. To build suspense, the boxes are sent to the participants in advance. This means that all participants start the game with a box full of mystery contents. The physical treasure chest (or "loot box" to borrow from the video games industry) (Brady & Prentice, 2021) is a great motivator for participants.

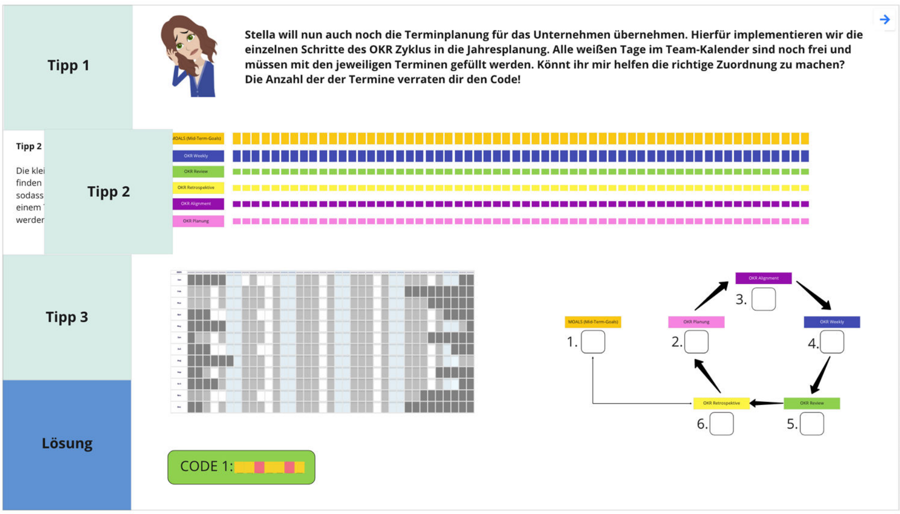

Figure 1: In one of the escape rooms, the students must collaboratively plan an OKR cycle to retrieve the necessary code. A video imparts the knowledge they need to do so. (Source: Screenshot from the workshop on 17 November 2022 in Miro)

2 An escape game is a collaborative adventure game in which a group is locked in a room and has to escape. To open the room, several puzzles of varying difficulty must be solved. To make it even more difficult, the puzzles have to be solved within a certain amount of time. Opening the room is only possible if the group works together (collaboration). An escape game can also consist of several rooms. This type of adventure game is often used for the purpose of team building. Originally, escape rooms were a physical activity. Today, there are also numerous digital escape games (Pornsakulpaisal et al., 2023; Yllana-Prieto et al., 2023).

The tasks in YAT are designed so that they must be solved collaboratively. The students work step by step towards their shared objective: the code for the lock. At the beginning of each room, learning content is imparted on the topic of OKR, which the students must then apply. In one room, for example, the students must translate the individual steps of the OKR cycle into an annual plan (Fig. 1).

Your Agile Thrill can be conducted as a self-learning unit (in the form of an escape game) with a length of 90 minutes or as a workshop with a maximum length of three hours. The escape game takes 90 minutes to play and does not necessarily require a moderator. Experience has shown that it is helpful to have a moderator on call. If the format is conducted as a workshop, a moderator is necessary. In this case, there is also a session before and after the game. In the session before the game, the participants have the opportunity to practice using the digital whiteboard in a "monster workshop" (Fig. 2). If there is sufficient time, the solutions can be discussed in a session after the game. Zaug calls this debriefing (Zaug et al., 2022). The debriefing has a particularly high learning value as it can highlight any elements that some participants may have overlooked. This reinforcement is missing in the self-learning version.

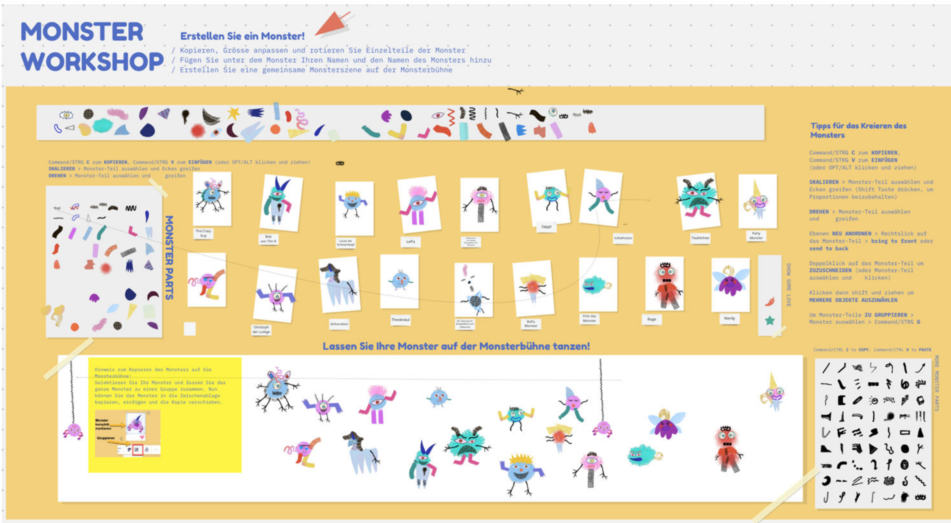

Figure 2: At the beginning of the workshop, the participants build monsters together. This lightens the mood and enables participants to familiarise themselves with the Miro tool. (Source: Screenshot from the workshop on 17 November 2022 in Miro)

Teambuilding in Your Agile Thrill

The composition of the groups is usually decided randomly by computer. This means that the individual participants generally do not know each other well. The format has an optimal group size of three. Multiple groups can play at the same time, with each group allocated their own room. The group stays together for the whole workshop and solves the puzzles in a breakout room, where they can work undisturbed. The room is large enough for private discussions. No moderators are present. Given the time pressure (90 minutes), the participants must quickly learn to work together with the other people in their group to achieve an objective. The objective in this format is to solve a puzzle. Each objective can be achieved in different ways. The participants practice engaging with other people and finding compromises. This is achieved by setting puzzles with different degrees of difficulty, in which the obvious path is not always the correct one. This also means that the participants must be open to changing path (readiness for change).

The study found that motivation arises not only from gamification but also from the agile approach, which remedies problems of Taylorism (Bosch, 2022). In the agile approach, responsibility for the division of labour is passed to the employees, thereby averting the danger of prolonged monotonous work. These observations from the study on YAT, namely that gamification elements in agile projects boost motivation, are confirmed by Kessing (Kessing & Löwer, 2021).

Technical support and requirements for participants

YAT is completely browser-based. The only requirement is that participants can operate a web browser.

The main component is a digital whiteboard. The participants receive a link to the launch page. Each group has a separate board containing all the information. Teaching content is imparted via integrated videos. Deliberately making students switch between different media (change of tool) keeps them in flow (as defined in zone of proximal development theory) throughout the game (see (Wang, 2022)). These elements of surprise help keep the participants highly focused on each puzzle and build anticipation for the next one.

Structure of the study

A module taught in one semester consists of several related course units and is usually evaluated mid-semester to allow improvements as the semester progresses. In contrast, a stand-alone workshop is usually evaluated at the end of the workshop. Participants often fill in the survey forms days after the event. The results can be used for the next time the workshop is held.

The first workshops were evaluated using this traditional approach and the results were fed into improvements for future editions. It became evident that this form of evaluation did not fit well with the other elements of the workshop. Your Agile Thrill involves solving a puzzle and working with the result to solve the next one until the final puzzle has been solved and the participants have received all their rewards, starting with the code and link to the next room and ending with the code to open the box. Originally, this marked the end of the suspense and the beginning of the evaluation phase. At this point, the participants were no longer required to work with the result to solve a new problem but simply asked to provide feedback to help improve the workshop.

It was therefore decided to make the evaluation part of the format. The original feedback survey was broken down into five smaller surveys that can be completed more quickly. The last of these surveys still comes at the end and marks the conclusion of the workshop. For the first four surveys, however, the participants are given a link to a so-called key page once they have provided their feedback. The participants must enter a code on this key page to unlock the next room. The code is obtained by successfully completing the previous room. This system means that participants can only progress if they have completed the survey. They are rewarded for doing so with a link to the key page.

It would be interesting to introduce competitive elements to observe the effects on participants' motivation. To date, the groups have been kept separate and the game ended after 90 minutes. If a group takes longer, this has no impact on the reward. Introducing a leaderboard showing the progress of the groups, and giving an extra loot box to the group that finishes first, might affect how the groups behave. Studies based on saving money have shown that a leaderboard can result in increased savings (Zhang et al., 2021).

Results of the surveys

The most recent game took place on 17 November 2022 and was recorded. The recordings were made of the individual groups (three participants per group) by co-moderators (also students) and enable further studies to be conducted. The digital format was well received by participants (n = 17): 93 % of participants reported that they had learned a large to very large amount about virtual collaboration. This confirms the often-cited value of "learning by doing". The escape game is conducted via a video conferencing system in a breakout room with three people. Here, 100 % of participants stated that they had seen a good to very good improvement in their teamworking. Moreover, 94.1 % found the format highly enjoyable (a high figure for a strategy-related topic (OKR)). It is encouraging that 17 out of 18 participants responded even to the final survey, which can be treated as a summing up of the event as a whole. Virtual collaboration in the group worked well according to 100 % of participants, and 70.6 % said they had achieved a very strong improvement in their digital skills.

Discussion of results

Six workshops have been held to date with a total of approximately 100 participants. For the main part of the workshop (escape game), moderation has proven counterproductive in some instances, since participants act differently when they feel they are being watched. The support offered in the escape game is sufficient and conducive to the group's ability to organise itself. The addition of analogue elements (physical box) to the digital workshop was seen as a particular positive by participants in all the workshops. It is interesting that the individuals who did not have the box with them (because it had not been possible to send or give it to them in time) were disappointed. This suggests that the tangible reward is essential. At the end of one workshop, a participant shouted in delight, "I've opened the box!" It is difficult to imagine more positive feedback.

For teaching staff, escape games involve a shift in workload, with the preparation stage comprising the majority of the work. The materials (in this case the digital rooms) need to be prepared and tested. Once these are ready, the work is largely complete. Where YAT is conducted as a self-learning unit, it is recommended to arrange a subsequent session to reflect on it (debriefing, see (Zaug et al., 2022)) to maximise learning for all participants. The success of Your Agile Thrill is partly attributable to the method by which it was developed. Your Agile Thrill is the third format developed using this approach, and all three formats have been evaluated as good or very good by students.

Conclusion

Work and fun are not mutually exclusive. On the contrary, combining them can help employees find their flow and unleash motivation that is positively reflected in the work they produce. This is recognised by the motto of Your Agile Thrill: Fun and games, learning and a mystery box. As we humans like to play from a very young age, mechanisms of play are deeply rooted in us all. The principle of reward awakens childhood memories – something the video games industry has long taken advantage of using loot boxes that motivate players to purchase additional items. Gamification is the concept of using successful mechanisms from game design in other contexts. Literature offers numerous examples of its successful application, for instance in medicine (Zaug et al., 2022) or care (Hosseini et al., 2022).

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Virtual Collaboration in a technical laboratory – an example from semiconductor technology

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Abstract

Lab courses are an essential component of university teaching that enable students to reinforce and apply the theoretical knowledge they have learned. Careful preparation for the work in the laboratory is important in order to make optimal use of the limited time in the often-costly facilities. This study presents an example from the field of semiconductor technology, in which students use a lab course to design, produce and electrically characterise a diode. The lab course takes place in a cleanroom and uses cost-intensive equipment. Virtual collaboration using an online whiteboard was studied as a means of improving preparation for the in-person component. The students assumed different roles in order to discuss written course materials from different perspectives prior to their time in the lab. The discussion took place in a virtual format. In this way, the students engaged in more depth with the accompanying materials as preparation for the lab experiment.

Keywords: virtual collaboration, lab training, hybrid lab

Introduction

Practical training in university laboratories is important in order for students to apply and reinforce their theoretical knowledge. It also gives students a feel for the laboratory environment they will encounter as graduates starting their career. Virtual elements can be a useful addition to in-person work and serve a number of objectives: The students can begin working as a team in advance using the virtual space, get to know each other and organise the workflow for the lab work. Accompanying materials can be provided to help students familiarise themselves with a new lab environment, explain safety precautions and identify and potentially answer any outstanding questions before the lab experiments begin. Along with traditional course notes, the accompanying materials provided can include self-assessment materials such as multiple-choice questions, safety videos and video explainers for the various processes, or 360° tours of the labs. The latter in particular can build familiarity with the laboratory environment even before the lab course begins, making it easier for students to get started with the practical work during the in-person component. The tours can also include texts or videos explaining the equipment and links to virtual experiments. Before the practical phase begins, students can therefore try out the experiment virtually and make mistakes that would not be permitted in a real laboratory given safety considerations and other factors. Accompanying materials are ideally provided using a single learning platform such as Moodle, where documents, videos, tours and virtual experiments can be directly uploaded or the relevant links provided. This makes them simple for students to navigate.

This paper looks at virtual collaboration by students in preparing for an experiment in the field of semiconductor technology. The lab course takes place in a cleanroom in which groups of up to six students can work. The objective is for students to get to know each other through virtual collaboration before the experiment begins and to engage in detail with the topic of the experiment using a Moodle course. This is to allow a greater focus during the in-person phase on discussing equipment-, process- and component-specific topics. In addition to the materials above, an online whiteboard is also provided, on which students can work virtually (synchronously or asynchronously) in a team and which they can use as a visual aid to discuss questions regarding the experiment preparation.

Framework

Students' virtual collaboration on the Semiconductor and Thin Film Technology lab course was to be supported and investigated. The lab course accompanies a lecture course in English of the same name and is available to students in the sixth semester studying for a bachelor's degree in technical physics. Attending the lab course is voluntary. If the mark for the lab course is better than the mark for the written exam at the end of the semester, it is counted (25 %) towards the overall mark.

In summer semester 2022, 37 students registered for the lecture course and 21 for the lab course. A total of 19 students were assessed, of whom 15 completed the lab course and six were able to improve their overall mark thanks to their mark for the lab course. No students saw their overall mark reduced as a result of participating in the lab course. The lab course was conducted in German.

The materials for the lecture and lab components are provided in a Moodle course. They include lecture slides in PDF format, practice exercises, practice questions to aid exam preparation, multiple-choice questions for self-assessment, videos for each component of the lecture course, exercise sheets for the lab course, software for creating designs in the lab course, a cartoon lab safety video, a 360° tour of the laboratory and references for further reading.

Topic of the lab course

The topic of the lab course is the design, production and characterisation of a diode in theory and practice. The diode consists of several thin, structured layers. The students are given the design of the different layers at the outset. To prepare, the students must determine the manufacturing steps based on the design. They also receive eight flawed designs, for which they must predict the results of the electrical characterisation. The approach to the task follows a similar method to that of the group puzzle (Leibniz Institute, 2015). According to Johnson & Johnson:

> "When efforts are structured cooperatively, there is considerable evidence that students will exert more effort to achieve (learn more, use higher-level reasoning strategies more frequently, build more complete and complex conceptual structures, and retain information learned more accurately), build more positive and supportive relationships (including relationships with diverse individuals), and develop in more healthy ways (psychological health, self-esteem, ability to manage stress and adversity (cf. Johnson & Johnson, 1999, p. 73)."

For the purposes of the lab course, the students divide themselves into groups of four or five. They are able to express their preferences about who they work with. Johnson & Johnson note the following with regard to successful collaboration:

> "The basic elements that make cooperation work are positive interdependence, individual accountability, promotive interaction, appropriate use of social skills, and periodic processing of how to improve the effectiveness of the group. (ibid.)"

Similar to process engineers in industry, each group works on only part of the diode production and prepares a handover log for the next group. The log records the processes covered and the problems that occurred. Finally, each group characterises the finished component, corrects their initial predictions for the process workflow, checks whether the predicted electrical results correspond to the actual measurements and discusses the measurement results in relation to the actual manufacturing process. A plan of the lab course is provided in Figure 1.

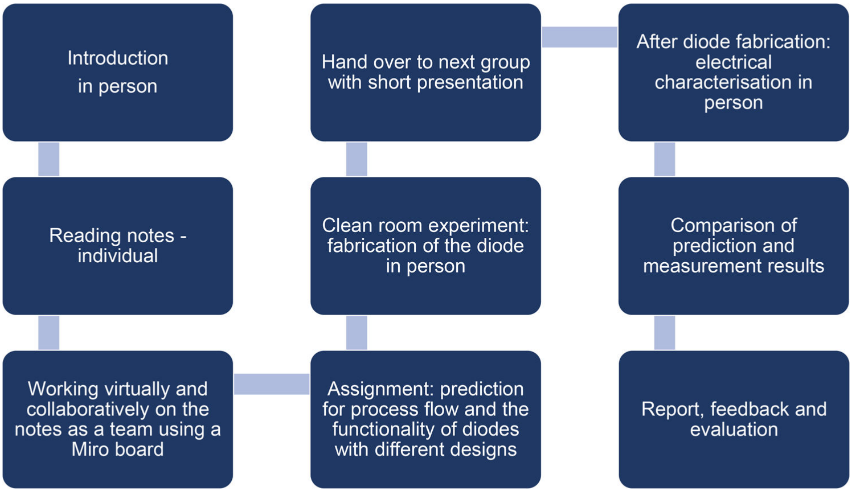

Figure 1: Plan of the lab course

Alongside its contribution to students' technical education, the objective of the lab course is for the students to train how to collaborate in a team and to try out different roles. This includes elements in person and in the virtual environment.

Collaboration: virtual and in person

The students work together in person as a group in the laboratory. They organise themselves during preparation and follow up. Past observations repeatedly showed that the tasks in the lab course were divided up between the group members and only brought together again at the end the report. Often there was no peer review, meaning that the students did not comment on or improve the work of their fellow group members.

To support virtual collaboration before and after the lab work, the Miro tool was used as an online whiteboard in the summer semester of 2022. The aim was for students to engage in more depth with the written materials for the lab course and for everyone to participate in each of the subtasks. Inspired by de Bono's thinking hats (De Bono, 2016), the students took on different roles for the reading of the written materials. The roles were project manager, expert, new customer and consultant, and were chosen for their similarity to the practice of industrial diode production (the topic of the lab work). In these different roles, the students had to summarise the written materials, research terminology and obtain background knowledge of the component and processes from different perspectives. The project manager's role was to obtain a general process overview, while the expert's role was to gain equipment- and process-specific knowledge. New customers looked at component properties and scrutinised processes, and advisers illustrated the experiment workflow in graphical form or as a mind map. While the students could read the written materials individually, they were asked to all work on the Miro board as a group at the same time as each other. Organisational and timing aspects along with the roles and tasks were explained again on the Miro board. The students allocated the roles independently, and compiled and discussed the results on the Miro board as they saw fit. Preparation using the Miro board was voluntary. The students were not supervised during their work, and the results were not assessed.

As part of the introduction to the lab work, the topic of virtual collaboration and the objective of the new experiment preparation method was explained to all students in an in-person session. Of the students participating, 80 % used the opportunity to prepare with the help of the Miro board. Those who chose not to indicated a lack of time as the reason. The students had not yet worked with Miro prior to the lab course; however, they scored highly for digital fitness (4.3 out of 5 points). Feedback on the tool was mixed: most students managed without instruction, while a few indicated that they would have liked training on how to use the tool. As students were already using other virtual collaboration tools, such as Zoom with screen sharing, not all of them saw an added value of the online whiteboard. Overall, the majority of students reported that their communication and collaboration skills had improved, that the virtual communication had worked well, that their learning had been reinforced and that they had successfully made learning progress. Teaching staff found that students had arrived at the in-person lab session properly prepared. The group that had not used the online tool was the worst prepared. The teaching staff linked the latter more to students' general attitude towards learning than to the use or otherwise of the Miro board. The final marks were similar to those of the previous years.

Outlook

The virtual dimension of lab courses is to be expanded. Feedback on the 360° tours was very positive, as they enabled students to picture the new lab environment in advance. In future, a VR experience is planned to introduce students to the lab course. This will aim to provide a playful introduction to this technical topic and thereby increase students' motivation to carefully prepare for the experiment. The lab will also have a digital twin[1] in future so that

1 A digital twin is a dynamic virtual copy of a physical asset, process, system or environment that looks like and behaves identically to its real-world counterpart. A digital twin ingests data and replicates processes so you can predict possible performance outcomes and issues that the real-world product might undergo. (https://unity.com/solutions/digital-twin-definition)

students can familiarise themselves with the equipment in more detail than on the tour. They will be able to run through individual parts of the experiment as if in a video game. The technology for this will work both with and without VR glasses so that students can also use it outside university. Lab equipment is particularly cost-intensive in semiconductor technology and nanotechnology. For this reason, it is planned in future to also equip the virtual lab with features that are unavailable in the university's physical laboratory, so that these can at least be explored virtually. As part of a double degree programme with a Canadian partner, it is planned to create a joint virtual lab so that an international component can be added to virtual collaboration.

In this and other lab courses, the virtual collaboration will be supported by online whiteboards. As well as their benefit for experiment preparation, the training in the flexible use of different digital tools is also seen as an added value. In the lab course group studied, the students already knew each other. In future, experiment preparation supported by the online whiteboard is to be extended to groups who have not already encountered each other on previous courses. To improve implementation and learning outcomes, a more in-depth introduction to the digital tools is to be provided. This will also aim to lower the initial hurdle for voluntary use. The purpose of the different roles for the collaborative reading will also be explained in more detail. In the current setting, there is no feedback about the results on the Miro board. In future, students will be given feedback and asked whether they want the whiteboard results to be included in their final mark for the lab course.

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(Virtual) Collaboration in Medicine and Biomedical Engineering

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Abstract

Especially in the fields of medicine, biology and other life sciences, technological momentum is making a particularly significant contribution to the acceleration of research, which in turn has an impact on industry and thus also on the working world and society. Using a selection of examples from the fields of biomedical engineering and medicine, the following chapter considers how new technologies are already being applied in research and teaching and how they may be applied in the future in medical care, medical research and university teaching. This will cover both the interaction between humans and machines and the collaboration between humans in the digital space. The skills that future generations will need to acquire are dictated by technological trends and the requirements of future working environments, and these skills must be taught both in specific disciplines and across disciplines within the framework of university teaching. Practical examples from courses at the Munich University of Applied Sciences HM will be used to illustrate how this can be implemented in a biomedical context. In the research-based projects, human-machine collaboration is described using examples of applications involving robotics and artificial intelligence, as well as human-machine and human-human interaction with the help of a new VR-based therapy system in conjunction with near-body medical sensor technology. The innovative teaching projects encompass practical applications of virtual reality (VR) and augmented reality (AR) for learning and examination purposes in the subjects of anatomy, physiology and medical technology, case-based training and lectures in medicine and medicine-related subjects that can be viewed anytime, anywhere, medical image reconstruction and 3D printing in medical technology, and a concept for a statistics-based digital peer and self-assessment that can be applied to any subject.

Keywords: blended learning, medicine, biomedical engineering, virtual reality, AI, robotics, new technologies in higher education

Introduction

The shift towards a digital society has been gradual but steady over the last few decades, not only in the professional but also in the private sphere. The increasing availability of fast internet connections, the miniaturisation of electronics, the constant increase in the performance of microcontrollers and processors according to Moore's Law and the triumph of smartphones and wearables are technology-based drivers of this development. In the private sphere, the use of social media and messenger services has changed the way we communicate, while apps help us read newspapers, consume music and videos, shop, navigate, optimise our fitness, keep food diaries, control household appliances and our smart homes, or conveniently do our banking from the couch. In the professional environment, however, the exploitation of the potential of digitalisation appears not to be keeping pace in many areas. This is particularly true in the fields of medicine and education. Nevertheless, even before the COVID-19 pandemic, trends towards virtual collaboration were emerging in the biomedical field, and the pandemic drastically accelerated these developments. For example, with the adoption of the Telemedicine Act in 2018, the foundation was laid for telemedical patient treatment and thus for digital diagnosis and therapy in Germany. The range of virtual solutions in the secondary (privately financed) healthcare market is constantly growing, and health apps are now even available on prescription. As of 2021, some digital diagnostics and therapy services are reimbursed by health insurance companies, thus putting them on an equal footing with pharmaceutical drugs. With the Hospital Future Act (KHZG) and the launch of the electronic patient record (ePA), the digitalisation of flagship projects and patient-care medicine has experienced a significant boost. The following chapter describes technological developments in virtual collaboration between humans and machines – as well as between humans – in the biomedical and medical technology fields. It provides insights into how technologies such as AI, VR and robotics can already be integrated into teaching and are set to shape working and learning in the digital space in the coming years.

The particular value of virtual collaboration in biomedicine lies in its potential to overcome physical barriers and bring together experts from different locations to collaborate on research and treatment. This can lead to more efficient use of resources, faster development of treatments and therapies, and ultimately better patient outcomes. Additionally, virtual collaboration can facilitate education and training in biomedicine by allowing students and professionals to access resources and expertise from anywhere in the world, regardless of geographical location or time-based limitations.

Human-Machine and Human-Human Collaboration in Biomedical Research

Human-Machine Collaboration and Robotics

Human-machine collaboration (HMC) plays a major role in today's world. Machines are increasingly being used alongside humans to improve existing processes and to reduce the workload on humans at work – and in everyday life. Machines can take on repetitive or physically demanding tasks, allowing humans to focus on other activities. The progressive improvement of various technologies in recent years has advanced the development of machines that collaborate with humans in different areas. Autonomous systems are an important part of this collaboration. Their advantages lie in their efficiency, accuracy and adaptability to changing conditions. Autonomous systems range from various vehicles to robots and safety systems that are used in a reliable manner in different fields. Areas of application include manufacturing, assembly and logistics. There are also applications in healthcare, such as robot-assisted surgery, which improves ergonomics, safety, and accuracy.

The concept of human-centred automation (HCA), based on human-machine collaboration, aims at combining the advantages of autonomous systems, such as precision and performance, with the cognitive advantages of humans (CIRP Encyclopedia of Production Engineering, 2019). In healthcare, HCA is used to improve various processes. Areas of application include diagnostics, where CT scans, for example, are analysed to identify abnormalities more quickly (De Cecco et. al, 2022). The analysis of image data in this area is increasingly supported by artificial intelligence (AI). AI takes on the task of analysing image files for abnormalities using object and/or pattern recognition, for example. The increased use of AI is due to technological advances in recent years. More powerful graphics cards, which are crucial for training AI systems, and intensive research have significantly increased the range of potential applications and the accuracy of AI, especially in terms of object recognition. Another area of application is telemedicine, in which patients can be treated remotely by means of virtual collaboration. HCA can be developed by integrating various technologies. Components of such systems can include AI, robotics, various types of sensors, virtual reality and augmented reality.

HCA based on HMC can bring many benefits and has already proven itself in various areas and contributed significant added value. However, it is important to address risks in application and difficulties in development. Especially when robots are involved, there is an initial risk of injury to people and damage to the environment. To reduce these kinds of risks, systems are being developed that are specially designed for interaction with humans. Robots are usually screened off from the working areas of staff for safety reasons. Cobots (collaborative robots) are an evolution of the traditional robot and are an example of the development of technologies that are safe for humans. They are specifically designed to work in a shared environment with humans, and collaboration is enabled by means of their combination with other advanced technologies (often cameras, force sensors, etc.) that allow them to detect and respond to the presence and movement of humans. Combining different technologies can help better prepare the system for the environment and enable it pass on sufficient information to avoid risks. Another aspect is interaction. Depending on the application, it is important to ensure that the human has sufficient information (e. g. visual or haptic feedback) and, if necessary, a user-friendly interface to enable collaboration. Various sensors, cameras and AI systems (e. g. computer vision for the recognition of patterns or objects in the environment) can be used to generate feedback. As such systems are often a combination of different technologies, another aspect must be considered during development. The combination of different complex components requires the development of different interfaces. This can lead to challenges as the number of combinations increases. The subsystems, each of which requires different input data and uses different types of communication, must be able to communicate with one another. For this purpose, it is essential that hardware and software are well matched to achieve the best possible outcome.

In medicine, collaboration between robots and humans is mostly used in the form of assistive systems. In surgery, they help with tasks that require a high level of precision. Unlike in industry, however, they are used comparatively rarely. One reason is that robots are associated with high costs, especially in the medical field, which makes it impossible for many hospitals to integrate them in multiple areas. Another aspect is safety. Safety plays an important role in all fields, but in medicine it is even more critical due to contact with patients. Not only must the robot not harm the environment or staff, but depending on the area of application, it may also need to provide patients with the best possible care. When used in surgery, this means they must guarantee a very high level of precision and not fail due to technical faults.

In medicine in particular, there is still potential to exploit HCA and combine different technologies to develop new systems. The progressive improvement of autonomous systems and technologies such as AI and VR opens up new possibilities for the use of HMC in medicine. Elements such as existing robot-assisted surgery systems or robot-assisted processes in laboratories can serve as core components of new HCA systems in combination with other technologies such as VR and AI. Due to the hurdles already mentioned, including costs, safety and the complexity of combining several systems, we have initiated a research project focusing on the development of a remotely controllable VR- and AI-based telerobotic system. Two environments are set up for the system, a remote environment in which the robot is located and another in which the human is located. The system consists of a cobot that is remotely controlled by a human. Using a cobot is important for exploring the interaction with humans often required in healthcare (e. g. cooperation with nurses or doctors). A robotic hand attached to a robotic arm will be equipped with haptic and force sensors. The haptic and force sensors should enable haptic and force feedback from the robot to the human. The robot's surroundings will be captured by cameras and fed into the user's VR headset. The user can then use the visual feedback to navigate the robot's environment. Using haptic force feedback VR data gloves enables the user not only to see the robot's environment, but also to get haptic and force feedback from the robot hand and feel the objects manipulated by the robot. The physical feedback generated is especially important when it is necessary to grasp or manipulate objects with a certain amount of force, which is often required in surgery. The VR data gloves are also used to perform movements by transmitting the human's movements as feedback to the robot and the robotic hand. In certain applications, it is important not only to see the robot's surroundings, but also to be able to draw conclusions about the size of an object, for example. Since there are cameras involved, additional features can be set up that give the user a closer look at what is happening by using AR to overlay information on the field of view or even measure the size of different objects of interest. This would be especially advantageous in surgical procedures and biopsies. These additional features could help users make better decisions about how to perform different tasks. Therefore, AI-based computer vision (CV) will be integrated to facilitate faster decision-making. The cameras set up in the vicinity of the robot will provide relevant data that can be used for object recognition and measurement. The information generated by the CV will be fed into the headset, enabling the user to incorporate it when making decisions. The automatic detection and measurement of objects can help the user to better assess the next steps to be taken and the movement options available.

The research project aims to overcome current barriers to the use of HCA in medicine and biomedical engineering, but also to develop a system that can solve existing problems in the field of medical care. A telerobotic system in medicine can bring many advantages. Robots usually need to be programmed for the tasks they are supposed to perform. However, when it comes to the treatment of patients, it is clear that the tasks will differ from patient to patient. Differences in body size, health condition and age may make it impossible to program a sequence that can be quickly and easily transferred to other tasks. In telerobotics, the cognitive abilities of humans are used to perform tasks. There is no need to write programmes that must be repeatedly adapted to the needs of each patient. As mentioned above, HCA is already in use in telemedicine, but mostly in virtual conversations between patients and doctors. Treatment cannot yet take place remotely. Point-of-care (POC) refers to a kind of medical examination or testing procedure in which an examination or test (POCT) is taken to the patient instead of the patient going to a central medical facility. POCT is an interesting trend that could benefit from a remotely controlled telerobotic system. In the future, systems like these could be installed in areas with poor medical coverage where treatment by experts is required but cannot be provided for various reasons (e. g. long distances or lack of qualified personnel). This includes developing countries, aerospace, military areas and other areas where medical centres cannot be reached quickly. In these cases, an operator could use the technology combined with their expertise to provide at least initial treatment. Furthermore, the system could be of interest for treatment of infectious patients, as it can be imple-

Figure 1: Human-Machine Interaction via Virtual Reality. The intelligent robot is controlled by gestures, hand controllers or Virtual Realty gloves, a bunch of sensors, cameras and artificial intelligence. (Hanshans, CC-BY-SA-NC)

mented to execute tasks like blood sampling and various diagnostics without the need for a nurse or doctor to enter the room in protective clothing, which is not only inconvenient but also time-consuming. Another advantage is that there is no risk of unnecessary infection to staff. Other applications include the treatment of patients in hazardous environmental conditions (e. g. radiation accidents).

Apart from the treatment of patients, systems of this type can also be used in laboratory automation. A robot can take on tasks in a laboratory, enabling staff to avoid entering the room and eliminating the risk of infection while working with various substances. This also eliminates the preparation time that is otherwise needed for putting on protective clothing. Furthermore, experiments outside of breathable atmosphere, in clean room conditions or involving cell cultures that must not be contaminated can be performed using the proposed concept. When a robot takes on tasks such as specimen collection, the risk of contamination can be decreased by reducing the need for staff to enter the room. When implemented instead of the glove boxes commonly used, a robotic solution can eliminate risks to humans or contamination by humans.

HMC and HCA can add significant value to medicine in the future. The interplay between AI, VR and robotics in interaction with humans can drive the performance of more complex tasks remotely, offering advantages in many different fields and benefiting the people involved. This research project aims to identify the necessary hardware and software and the conditions under which systems of this kind can be developed. In particular, it will focus on evaluating such systems' capabilities in terms of task performance, as well as on generating relevant data that speaks to the accuracy of such systems and their level of user-friendliness. Based on the results, possible areas of application in medicine will be derived to overcome existing hurdles.

Virtual Collaboration in VR-Based Medical Treatment

Alcohol addiction is a taboo subject, but it affects 1.9 million people of all ages and social classes in Germany alone. Around 200 people die every day as a result of the primary or secondary effects of alcohol consumption. However, these figures do not fully reflect the suffering of those affected and their social environment. In the conventional scenario, a patient with alcohol dependency undergoes inpatient withdrawal treatment in a specialised clinic after acute medical detoxification. During inpatient treatment, an interdisciplinary team of doctors, psychologists, social workers and various therapeutic staff work together with administrative personnel to address the physical, psychological, family-related and administrative and bureaucratic needs of the patient. Often, the decision to seek such treatment follows years of deteriorating physical and social health. Patients often lose their jobs, friends, family and driving licences and become socially excluded.

The goal of treatment is to address all aspects of the disorder, including providing medical knowledge and skills for coping with the disorder on a daily basis. A key aspect of this is training for potentially dangerous situations in which the patient experiences a craving for the addictive substance. For this reason, various coping strategies, such as breathing or relaxation techniques, are taught and practised under therapeutic guidance as part of the therapy. These are intended to help the patient deal with acute situations. Not only direct contact with the addictive substance, but also music, certain environments or specific situations can trigger a strong psychological and physical reaction in patients and lead to relapse. This is a bodily reaction that manifests itself as a physiologically measurable stress response. This is where the work of our research team, together with partners at the University Hospitals of Würzburg and Munich, comes in. Using virtual reality and appropriate sensor technology, it is possible to teach coping strategies, measure their positive effects and repeatedly practise common dangerous situations. The software can automatically adapt to the patient's needs and document the success of the therapy or identify deficits. Alcohol is part of our social life, and contact with this addictive substance is unavoidable. To address this, the researchers chose a situation that most patients struggle with. They developed a virtual supermarket and asked patients to write a virtual shopping list. The patient is then equipped with wireless sensors and VR glasses. The sensors and the VR software were developed at the Munich University of Applied Sciences HM. Using remote controls, the user can interact with objects in the virtual environment and place items in the shopping cart or on the conveyor belt at the checkout. Biosignals are continuously recorded during the simulation.

The data are collected to help detect cravings early, document therapy progress and objectively measure the effectiveness of coping strategies. Unlike conventional exposure therapy "in the wild", virtual reality can generate a large number of triggers that are reproducible and adapted to the individual at the push of a button. The intensity of the stimuli can also be varied. During exposure therapy, the therapist monitors the patient's every virtual step as well as relevant physiological parameters using a control monitor. As in a flight simulator, exposure can be the subject of repetitive training in a protected environment. The measurement of physical reactions plays a crucial role in giving the therapist and patient a better understanding of how the therapy is progressing. It also helps verify the effectiveness of previously learned coping strategies and can increase compliance and long-term motivation for abstinence through measurable therapeutic success. While exposure to the addictive substance only takes place under medical or therapeutic supervision,

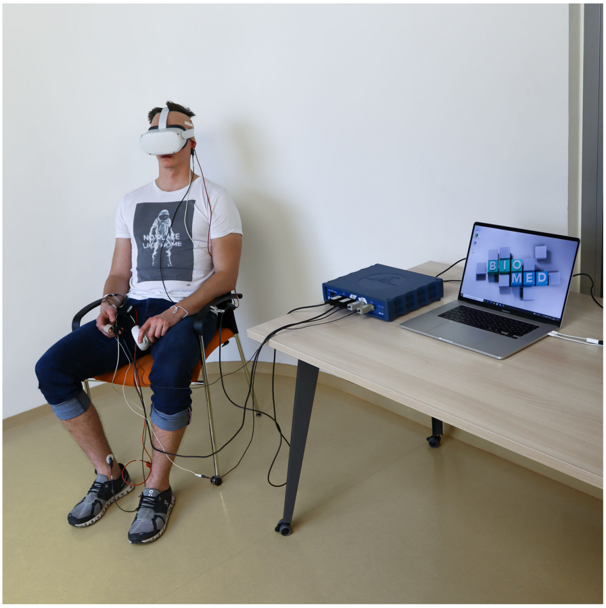

Figure 2: VR-based research setup: The patient is connected to multiple sensors, that measure physiological reactions to stimuli applied via a VR headset. In this case a cue exposure scenario in the framework of cognitive behavioural therapy. (Hanshans, CC-BY-SA-NC)

the VR-based therapy system can help the patient to learn coping strategies independently (and possibly at home in the future). Such a system with biofeedback offers the significant advantage of being able to monitor the patient's performance of exercises using sensors and ensure they are being done correctly. During breathing exercises, for example, respiratory rate and depth, as well as the degree of relaxation and thus the effect of the exercise on the autonomic nervous system, can be measured. The same applies to relaxation techniques. Learning suitable coping strategies can therefore be faster, more effective and more self-directed. Current research focuses on (neuro-)physiological measurement methods, the interaction between patient and software, and above all, the efficacy and superiority of VR-based therapy. Previous research results and the strong interest of professional societies and clinical partners demonstrate the potential of this technology as a new component in addiction therapy. Due to the COVID-19 pandemic, many therapy sessions have been conducted via video conferencing, increasing the acceptance of remote treatment among patients and therapists, even in the area of mental health. VR-based therapy systems could also be used to access and track therapeutic progress, as well as enabling interaction between patients and therapists across geographical borders. This will make a significant contribution to the digitalisation of healthcare, especially for the benefit of patients, and in the near future it may facilitate the use of telemedical applications where patients and therapists can collaborate regardless of each other's physical location.

Virtual Collaboration in Biomedical Education

Anatomical Dissection of the Virtual Body

In a fast-paced environment where new technologies are emerging rapidly, it is important to keep up with technological advances and integrate both state-of-the-art and emerging technologies into medical and biomedical curricula. When students are actively engaged in teaching each other, they are more likely to retain the information, as they are forced to think about the material in a different way and explain it to their peers. Nevertheless, medical education is still mostly taught without the presence of medical devices, neglects the context in which medical equipment is used (e. g. intensive care or emergency gear) and relies on traditional lecture-based teaching and non-interactive teaching resources.

A holistic concept has been developed and successfully implemented at the Interdisciplinary Biomedical Research and Training Centre (BioMed) at the Munich University of Applied Sciences HM; founded and led by the author of this article. The concept consists of a hybrid teaching approach, where traditional teaching methods (e. g. lectures, self-study, textbooks) are combined with advanced digital supplements, such as virtual or augmented reality-based simulations or VR-based 3D anatomy and physiology training, case-based training, anatomical models/wall charts, computer-based training with assessments of learning progress and peer-guided tutorials, and the possibility of using all media unguided for self-study. In addition, medical devices are demonstrated hands-on in a realistic clinical environment (e. g. settings like functional diagnostics, operating theatres and research labs). This combination integrates anatomical and physiological expertise with technical skills, linking different classes and ultimately leading to better understanding and methodological competence. It furthermore allows for remote administration and attendance of exams. This is beneficial for students and staff with medical conditions, families or logistical issues. It also facilitates digital and virtual collaboration between students who are present, online at home or even in other countries (e. g. courses with partner universities).

When students begin their studies, they often struggle with the sheer amount of material they have to learn in a short amount of time. To help them, the media-enriched and tutor-supported courses give them the opportunity to gain a deeper understanding of anatomical structures and physiological processes using virtual and augmented reality. VR provides a highly immersive experience for students, allowing them to explore complex medical procedures, anatomy and physiological systems in a three-dimensional and interactive way. By providing a more interactive and engaging learning experience than traditional classroom and book-based instruction, this multimodal gamification approach can increase student engagement and motivation. This hypothesis was supported by student evaluations.

Figure 3: A virtual patient in the classroom: This AR simulation mimics vividly the course of the disease of a Covid-19 patient from the emergency until he had to be intubated on an intensive care unit without having to worry about ethical or infectious issues.

Various pathophysiological conditions, such as tumour genesis, cardiovascular diseases and neurological disorders, are incorporated into the curriculum using VR, AR or animations. This can help students better understand the underlying mechanisms and impact of these conditions on the human body. Such technologies also provide insight into the dynamics of diseases, such as infection with COVID-19 (see Figure 3), as well as offering direct feedback on training success and enabling exams to be held virtually.

This can help students understand principles and applications in medicine and improve their ability to interpret and analyse medical images. The experiences provide another cross-reference to the anatomical structures and pathologies the students have previously studied.

Another advantage of VR is that it allows for targeted, group-oriented teaching and learning. Bioengineering students focus more on histology and cellular processes, while clinical and optometry students need to know more about the anatomy of the human eye, its diagnostic characteristics, treatment and related pathologies. Biomedical engineering students, meanwhile, focus on how medical sensors and devices work. A key factor in the learning concept is to use different media and sensory experiences to approach the same topic. For example, students can take apart a skeleton and practice finding a particular bone. Seeing it as an AR image, they can compare and reinforce their knowledge by trying to find the same bone on a solid anatomical model, associating the same information with a haptic sensation.

Finally, students have the opportunity to apply the theoretical (medical and technical) knowledge gained from lectures to experiences with a variety of real medical devices presented in a realistic setting. Their knowledge of anatomy, physiology and pathology provides them with the basic knowledge needed to better understand the requirements of medical devices and users, such as doctors and nursing staff. The actual use of medical devices – or the simulation thereof – prepares students for their future working environment in clinics or in medical device development, is highly motivating and consolidates knowledge acquired in previous semesters. Again, virtual reality is a very useful tool to simulate the use of devices that could not otherwise be obtained for reasons of safety (e. g. infectious diseases or radiation), logistics, ethics (dissection or attending a real surgery or intensive care unit with a whole class) or finances. This innovation makes these technologies more accessible. Hands-on training can increase students' (virtual) surgical skills and confidence and prepare them for real-life situations. For example, if they are asked to improve medical instruments or devices, they will be better able to assess the needs of their clients because they have experience using such devices themselves.

Overall, consistent implementation of blended learning, combining traditional and peer-to-peer teaching with the realistic use of interactive technologies such as VR and AR, case-based training and real-world models or devices, can take medical biomedical engineering education to a new didactic level. It can increase motivation and holistic understanding, enhance social skills and collaboration and facilitate competency-based teaching. In addition, it exposes students to emerging technologies (such as VR and AR) and provides an immersive learning experience that can enhance their understanding and readiness for real-world scenarios and their future careers.

3D-Printing a Human Being

3D printing has become a common process in industry to quickly develop prototypes or efficiently produce construction elements and replacement parts. However, it is not as well established in the fields of medicine and life sciences. Yet haptic and three-dimensional representation of medical learning content, such as anatomy, pathology (e. g. fractures), demonstration of surgical procedures, and applications in the ever-evolving field of personalised medicine (trauma and neurosurgery, prosthetics, etc.), offers unbeatable advantages. In the practical course for the lecture "Medical Imaging", students in the Mechatronics/Medical Engineering programme learn to create true-to-life 3D models of bone and organ structures from medical image data and produce them using 3D printers. In addition to the physical and mathematical fundamentals taught in the lecture, the practical course recapitulates knowledge from previous lectures, such as anatomy, manufacturing technology, chemistry and materials science, and provides practical methods and skills that they can use effectively in the working world. The practical application and transfer of knowledge to solve specific problems is one of the most important facets of a university education when it comes to future career prospects. However, the abundance of competing courses (and extracurricular activities) often leads to low participation in voluntary practical courses that are intended to promote competency-based learning. This general problem was analysed within the framework of the cross-university teaching project "Lehrlabor^3" to identify motivating and demotivating factors. A concept was developed that is enriched with motivational and playful elements (Hanshans et al., 2023). The central research question was quite general:

How can students be motivated to participate in a voluntary practical course?

The course includes three essential elements: a lecture to convey the theoretical content, a Q&A session at the end of each topic block to give students the opportunity to review the theory and ask questions, and a voluntary practical course. For the practical task, each participant receives a medical image data set. A three-dimensional anatomical bone model must be reconstructed from the data set and printed using a 3D printer. The skills needed for 3D image reconstruction and 3D printing are taught in the practical course. The anatomical basics are laid in previous courses, and the technical aspects are discussed in the practical course. In general, participation in voluntary courses averages less than 50 %. The practical course was first tested in the summer semester of 2022. It was easy for students to opt to drop out. From the lecturer's point of view, the students showed little commitment, which was also reflected in decreasing number of participants over the course of the semester ("drop-outs"). To increase participation in the practical course, factors inhibiting motivation (misfits) were identified within the framework of the Bavaria-wide teaching project using a gamification method (Bröker et al., 2021). EMPAMOS is an interdisciplinary research and development project and creative thinking tool applied to the field of higher education in the "Gaming the System" working group at the Digital Teaching Research and Innovation Lab (FIDL) (Forschungs- & Innvationslabor Digitale Lehre, 2023). The EMPAMOS method uses artificial intelligence to analyse more than 50,000 board games to identify motivating and demotivating factors for didactic applications [6]. Applied to the practical course described above, three demotivating factors were identified:

1. Players showed too little commitment:
   Participation in the voluntary course was low at the beginning and decreased further during the semester.
2. The game did not promote cooperation:
   So far, each participant had to reconstruct and print an assigned anatomical structure. The threshold for dropping out was low for the participants because they saw their work as isolated.
3. The game seemed meaningless:
   The students were not aware of the added value of this task for their studies.

With the help of the misfit analysis, the method can be used to derive specific measures to increase and maintain student motivation throughout the semester. Students now reconstruct a complete skeleton with joint functions instead of individual bones. Furthermore, at the beginning of the semester, the lecturer clarified the importance of the learning objectives for students' future careers with real-life examples of where 3D reconstruction and 3D printing are or will be used in medical contexts. In addition, the course was moved to the first third of the semester to avoid clashing with exam preparation. The practical course now promotes intensive cooperation within the group, as participants have to coordinate with their peers – at least those who are reconstructing adjacent bones – to complete the construction of anatomically correct joint connections. In addition, each participant's task becomes more important because it is part of a group task whose result (or lack thereof) is immediately visible, thus promoting social integration. With these measures, the students were motivated to participate in the practical course from the very beginning, which was reflected in the almost doubled number of participants (now > 85 %). In addition to a noticeable increase in participation, a higher level of adherence was also observed, resulting in a negligible number of drop-outs during the semester. From the perspective of the course instructor, there was a significant difference in the group dynamic. This was particularly evident in the intensive communication taking place in the course's virtual space (online forum and chat), the increased use of anatomically correct language and the specific questions asked. In the evaluation, 83 % of the students stated that the relevance of the task for their studies was clear and that they were motivated to read anatomical books in order to create an anatomically correct bone model. In the practical implementation, digital tools were used that enable human-machine collaboration. 3D printers were connected to the internet and were made remotely controllable. Not only could the generated 3D objects be sent to the 3D printer farm remotely, but the printing process could also be monitored from home and stopped if necessary.

Figure 4: 3D printing humans: This 3D printed skull is a reconstruction of a real medical imaging dataset. Students do not only learn theory; they finally have a tactile result of their learning success.

As is evident in the example described, when developing a course, instructors should incorporate an explanation of its practical relevance as well as its importance and relevance for future work. Motivation is greater when a task's purpose is understood and its value is tangible. Collaboration between students should also be encouraged, as social skills are essential for success in professional life. It is essential to involve the target group in the development of teaching materials in order to reach them in a targeted way and not overlook their actual needs and desires.

The EMPAMOS method has proven to be a versatile tool for identifying various problems in teaching and finding appropriate solutions, particularly in the context of 3D printing in the medical field. Notably, the method includes a unique team composition for developing teaching projects. A team of three, consisting of a professor, a teaching assistant and a student, brought in different roles and perspectives. The student, as a "consumer" of the course, was able to address problems from the student perspective and articulate the needs of students. Feedback from other university teams was crucial for improving the practical course. Peer review by experienced teachers but not specialists in the field helped to broaden the project's horizons and was the incubator for new approaches, such as the idea of printing the entire skeleton as a playful and interactive element of the practical task. The measures presented here using the practical course as an example have shown that motivation and physical as well as virtual collaboration can be increased by simple means and the use of gamification.

Learn It, Do It, Grade It

Spatial and temporal flexibility are essential aspects of modern education, and online courses have provided an excellent opportunity for students to learn in a more flexible manner. This author has developed two interdisciplinary online courses at the Munich University of Applied Sciences HM, "Light and Health 1" and "Light and Health 2", which offer an in-depth exploration of the fundamentals and theory of the effects of non-visual light, their practical application in lighting design and their impact on human health. The courses cover interrelated topics, such as cellular and molecular science, the anatomy and physiology of the human eye, neurophysiological facets of light exposure and hormonal balance, photobiological risks and the measurement of light and spectra. They are divided into modular learning units, allowing students to work at their own pace.

To ensure that students remain engaged and actively involved in their own learning process, self-assessment exercises are included at regular intervals, and video lectures are interspersed with dynamic text sections. Interactive elements are also included, encouraging students to apply their knowledge and develop a deeper understanding of the subject matter. Online forums, video meetings and peer evaluations encourage communication and collaboration with peers.

One innovative aspect of these courses is the "learn it, do it, grade it" approach, which emphasises the importance of teaching and peer review in the learning process. Peer review is a collaborative element that focuses on the highest level of competency: the ability to teach others and evaluate their work. However, peer review can be challenging for instructors, and new approaches are needed to streamline the process and ensure high-quality feedback.

To address this issue, a statistical script-based method was developed (in the programming language R) and successfully implemented in a rhetoric and presentation course for students. This method involves collecting and analysing feedback from hundreds of evaluation forms and presenting the results to each student in a clear and concise manner, providing them with an overview of their performance compared to their peers. The instructor can also quickly assess whether the student has provided appropriate and differentiated feedback to their peers, which is critical for developing social skills and essential for future employment.

Overall, the courses offered by this author at the Munich University of Applied Sciences HM represent an innovative approach to teaching that emphasises virtual collaboration, while at the same time fostering critical thinking skills, social competence and an accurate perception of the self and others, all of which are important for a future career in industry or research.

Student Postscript

Having grown up with the rapid development of technology, this generation of students faces different conditions, opportunities and challenges to those experienced by most lecturers. This requires communication and feedback to create an innovative learning environment that enhances students' personal and professional development. However, due to hierarchical differences, students may be reluctant to provide (constructive) criticism or to suggest new teaching strategies. Presenting a lecture as a slideshow with a handheld laser pointer is a common practice that typically works well. But of course, the technological possibilities have not stopped there. Even so, the hierarchical gap certainly acts as a barrier to the implementation of modern didactic methods. There is room for at least minor transitions in the education sector in terms of methodological and technological concepts.

For now, as things return to a pre-pandemic state, one way of partially bridging this hierarchical gap is to have a peer teacher who stands between the students and the lecturers to reduce inequalities by passing on feedback and helping to ensure deeper understanding of the content.

Peer teaching, where students or laboratory assistants (if resources are available) teach students, can be an effective form of collaborative learning that promotes a more interactive environment. Peer tutors are able to explain course concepts in different terms to the lecturer and to address any emerging gaps in understanding first hand. Smaller study groups allow for more individual questions. For instance, in engineering classes, a quick refresher about a relevant mathematical operation is possible on request.

An example of a modern teaching strategy is the use of AR/VR-based technologies. In tutorials focusing on human anatomy or physiology, these have been shown to facilitate three-dimensional understanding. AR/VR-based systems can be applied to many other courses, especially where the subject matter is dynamic and complex. In addition to the didactic advantages, the use of modern technologies with high potential for future applications in education also adds interest. State-of-the-art training in 3D simulation is expensive. What if it could be borrowed like a book from the library?

The 3D printing lab in the Medical Imaging course provides an in-depth understanding of anatomical structures and presents students with hands-on use cases for 3D printing. Using software, each student reconstructs a human skeletal part from medical CT/MRI scans, which is then 3D-printed with the assistance of experienced tutors in the lab. After manual post-processing, all the students must assemble a final human-size skeleton model together, which means that the respective connecting parts have to be developed by the students as a team. Student-to-student and student-to-tutor online screensharing sessions have proven to be an extremely effective tool for collaboration during all stages of the 3D modelling process. Tutorials, links, information and forums on how to use the software applications are provided through the “moodle" learning management system. The 3D model files are shared virtually via the LRZ Sync + Share platform (a cloud storage service of the Munich Scientific Network) for support as well as assessment.

With cloud-based management of the 3D printers (RaiseCloud), print jobs can be started, controlled and monitored remotely in real time using a browser or smartphone app. Life-size parts typically take 10 to 20 hours or more to print (up to 3.5 days). Being able to easily monitor the printing process strengthens the students’ connection to the model and engages them in the project.

Like all university labs, the 3D printing lab is very time-consuming – especially the adaptation to multiple software applications (3D slicer, Autodesk Meshmixer, Prusa slicer, Fusion360). Nevertheless, students know that adapting to new technologies will surely be necessary in their professional lives. Likewise, collaboration with team members is a fundamental skill. These aspects of the task shift the focus from studying to pass a 90-minute exam to gaining practical experience.

From the student perspective, this lab can be described as a seesaw between frustration and satisfaction while gaining expertise in their specific part of a larger project. Online collaboration with team members and familiarisation with modern software applications are essential before integrating the part into the whole.

During the pandemic, the Munich University of Applied Sciences HM inevitably lost the "applied" part of its core concept, which mostly took the form of on-site practical training. Gaining practical experience is very important for students, as it helps them decide which career direction they want to pursue. This is why the innovative idea of a "suitcase internship" evolved and gained in importance. Newly designed practical training concepts are condensed to the minimum form factor to fit into a small portable case. Why not bring the equipment to the students? One of them contains the above-mentioned VR glasses for studying human anatomy, others have a blood sugar monitor along with some glucose (candy), a portable medical-grade device for measuring lung function, a microcontroller with jumper cables and skin electrodes to program and build a mini ECG device, a stethoscope, a pulsoxymeter and more. Many students stated that it was very motivating when this specialised hardware was available for longer than the usual 90 minutes and that it was fun to play with.

Flipped classroom concepts using teaching videos and online or offline Q&A sessions with in-depth discussions, rather than traditional face-to-face lectures, are rated positively in general. However, many students are critical of the decreased level of social interaction. This can be partly compensated for by holding Q&A sessions in person. It is crucial to find a balance and – yet again – feedback and communication are key. During these sessions, the lecturer's role should be closer to that of a tutor – with all the advantages described above, plus the benefit of their full expertise. The time needed to make this possible can be freed up by providing existing videos.

In traditional lectures, there are several limiting factors which are interconnected – the most important being time or speed, complexity of content and distraction. Understanding while listening and taking notes at the same time is one of the greatest challenges during a classroom lecture. Whenever a question emerges or things are moving too quickly, trying to resolve that situation on one's own without losing track of the ongoing flow of information can be a barrier to proper understanding. Clearly, neither content density (ratio of information to time) nor complexity can be fully optimised for everyone when addressing a group in a presentation.

Rather than actively interrupting a lecture, which often causes discomfort and near embarrassment, videos can simply be rewound or paused. Unclear words or elements can be looked up as needed. On the other extreme, many students increase the playback speed immensely. Either way, the information density is completely under each student's individual control, and a learning state with high focus and attention (often referred to as "flow") is highly probable.

Instead of lecturers needing to spend time holding the same lectures every semester, recordings can be made once and steadily improved to address common questions and difficulties. As video is already used by many students as a medium for both entertainment and learning, this tool is increasingly powerful. However, it also presents a challenge, as many are accustomed to watching passively. This is where self-control and discipline come into play.

Regular Q&A sessions ensure that students' specific needs and further interests are addressed. In traditional lecturing, especially in large groups, there is usually insufficient time for these requests, even though they would be beneficial for understanding and motivation. Allowing students to submit (anonymous) questions or suggest topics beforehand would further lower the aforementioned barrier to voicing a question or concern. In this way, the lecturer can become aware of the students' difficulties and can prepare additional slides to explain the concept in different words. Again, updating the videos is also an option.

These sessions can be conducted from a remote location or in person, with each model having its own advantages. However, frequent meetings at the university can help both the lecturer and the students adjust to the modern situation. A fully remote design makes it possible to continue learning in exceptional circumstances (such as illness, strikes or epidemics) as well.

The accessibility of the flipped classroom anywhere, anytime can not only can reduce travel time and costs for students and lecturers, but also allows students who are ill or injured to attend. Many students, depending on their chronotype (early bird vs. night owl), have difficulty concentrating and being motivated in the early morning hours. Again, flexibility allows for individualisation according to each student's needs. This can also make it easier to study while holding a part-time job or taking care of children, which is much more challenging when being in a particular place at a particular time is required.

Though it has many advantages, the flipped classroom with videos as preparation for Q&A sessions also presents challenges for students. Being able to manage one's own time may offer freedom, but it also requires structure and discipline. A common result is procrastination at the beginning of the semester and stress at the end. However, establishing these necessary productive habits is an essential part of preparing for professional life, where the ability to work remotely is increasingly expected.

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Glossary

Avatar

→ From Second Life to Second Job: Creativity and Entrepreneurship Education in the Metaverse

Avatar refers to a visual representation of a person, character, or entity in the digital world. It can refer to a 2D or 3D graphic, an animated figure, or a virtual representation of a real person. Avatars are commonly used in virtual reality, online gaming, and other virtual environments, where they serve as the player's representation within the game or platform. They can be customised and personalised to reflect the player's individuality and preferences. The term is also used to describe a person's representation in social media or other online communities.

Digital twin

→ Virtual Collaboration in a technical laboratory – an example from semiconductor technology

A digital twin is a dynamic virtual copy of a physical asset, process, system or environment that looks like and behaves identically to its real-world counterpart. A digital twin ingests data and replicates processes so you can predict possible performance outcomes and issues that the real-world product might undergo.

(https://unity.com/solutions/digital-twin-definition)

Escape game

→ Gamification for team motivation

An escape game is a collaborative adventure game in which a group is locked in a room and has to escape. To open the room, several puzzles of varying difficulty must be solved. To make it even more difficult, the puzzles have to be solved within a certain amount of time. Opening the room is only possible if the group works together (collaboration). An escape game can also consist of several rooms. This type of adventure game is often used for the purpose of team building. Originally, escape rooms were a physical activity. Today, there are also numerous digital escape games (Pornsakulpaisal et al., 2023; Yllana-Prieto et al., 2023)

Future Skills

→ Virtual Collaboration as a "Future Skill" – Analysis of an Innovative Learning Scenario for a HEI of the Future

Future skills enable graduates to meet the challenges of the future and take responsibility for actively and positively shaping our future. These are, among others, innovation, cooperation, systemic and digital competences (Ehlers, 2020).

GitHub

→ Virtual Collaboration as a "Future Skill" – Analysis of an Innovative Learning Scenario for a HEI of the Future

GitHub is an Internet hosting service for software development. It is commonly used to host open source software development projects as it provides the distributed version control of Git plus access control, bug tracking, software feature requests, task management, continuous integration, and wikis for every project (https://en.wikipedia.org/wiki/GitHub).

Head-Mounted Display

→ Let's Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments

Display devices worn on the head to generate virtual projections directly in front of the user's eyes. It is currently the most commonly used device to enable fully immersive Virtual Reality experiences.

Immersion

→ Immersive Collaboration: Facilitating Good Teamwork

Immersion is a user's engagement with a VR (virtual reality) system that results in the user being in a flow state. Immersion in VR systems depends mainly on sensory immersion, which is defined as "the degree which the range of sensory channel is engaged by the virtual simulation" (Kim & Biocca, 2018).

Intercultural Communication

→ Digital Negotiations across Cultures

Intercultural Communication involves communication between people of different social, linguistic and cultural backgrounds. Interlocutors must share common cognitive ground through culturally and linguistically sensitive communication skills to establish a meaningful dialogue (Kopelmann, 2014).

Metaverse

→ From Second Life to Second Job: Creativity and Entrepreneurship Education in the Metaverse

The term “metaverse” refers to a hypothetical future version of the internet that is fully immersive, interactive, and a virtual world where users can engage with each other and a virtual environment in a way that mimics real life. It is a concept of a shared space, created by the convergence of physical and virtual reality, where people can interact with each other and digital objects as if they were in the same place.

The metaverse is often depicted in science fiction and popular culture as a virtual world that is fully accessible to people through virtual reality or augmented reality devices. In this sense, it represents a next step in the evolution of the internet, where online experiences are fully immersive and closely resemble real-life activities.

While the metaverse is still a concept and not yet a reality, there are some emerging technologies and platforms currently in development that could eventually lead to its creation.

Multi-User Virtual Reality Environment

→ Let’s Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments

A shared Virtual Reality environment where multiple users, represented as avatars, can interact with each other as well as with the environment simultaneously. It is sometimes also referred to as Social Virtual Reality Environment.

Negotiation

→ Digital Negotiations Across Cultures

Negotiation refers to communication involving resources (Kopelman, 2014). In globalised, meshed and fast-paced environments, this means cooperative and competitive dialogue across cultures. As the likelihood of misunderstanding increases, interactants have to learn to adapt to different ways of doing things. (Kopelmann, 2014).

OKR

→ Gamification for team motivation

OKR is the abbreviation of "objectives and key results". This is an agile management model used to monitor the vision and strategy of a company in short cycles. It is a management system for setting measurable goals at team and company level. The principles are based on management by objectives and SMART. OKRs consist of a goal (objective) and several results (key results) that quantify the achievement of the goal. OKRs are usually used at a variety of levels, from corporate strategy to individual employee goals (Helmold, 2022; Kudernatsch, 2022; Teipel & Alberti, 2019).

Online Creativity

→ From Second Life to Second Job: Creativity and Entrepreneurship Education in the Metaverse

Online creativity refers to the ability to generate original and valuable ideas, insights, or solutions to problems using the internet and digital tools. It can also include creating digital artwork, composing music, writing, or producing videos and other forms of multimedia content. It is a form of creativity shaped by the internet and digital technologies that are transforming traditional forms of creative expression and enabling new forms of innovation and artistic expression that would not have been possible without these technologies.

Presence

→ Immersive Collaboration: Facilitating Good Teamwork

Presence within the context of virtual reality is defined as one's sense of being in the virtual world. The illusion is perceptual but not cognitive, as the perceptual system identifies the events and objects and the brain-body system automatically reacts to the changes in the environment, while cognitive system slowly responds with a conclusion of what the per-son experiences is an illusion (Slater, 2018).

Virtual empathy

→ Psychological Aspects of Virtual Collaboration: A brief overview

A communication pattern in which the receiver of communicated messages – as in the concept of empathy in general – encounters the self-opening of the other person in a virtual setting with emotional support, understanding or their own self-opening (Carrier et al., 2015).

Virtual Reality

→ Let´s Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments

An artificial, virtual, and viewer-centered environment, where the user is completely isolated from the physical surrounding so that telepresence is felt at least to some degree. The perception of telepresence ranges from atomistic (telepresence is less important) to holistic (encounter is close to real-life) Virtual Reality scenarios (based on Rauschnabel et al., 2022).

xReality (XR)
→ **Let's Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments**

A collective term encompassing all forms of new realities such as Augmented and Virtual Reality.

The book website

What motivates the authors?

Why is virtuality relevant to their disciplines?

The authors answer these questions in personal interviews on the website:

English:
hm.edu/virtualcollaboration

German:
hm.edu/virtuellekollaboration

Selected quotes from the interviews:

"In the working world, virtual teams are now the norm and no longer the exception. That is why it is important that we provide our students with the appropriate skills and support in university teaching."

(Marion Rauscher, author of "Let's Collaborate, Avatar: Competence Acquisition in Multi-User Virtual Reality Environments")

"We only see each other as avatars or in small rectangles. Suddenly we can no longer trust our interpretation of meta-linguistic signals such as facial expressions and gestures which we can usually read with ease [...] In the intercultural context this means: A lot more is going on and we have to balance this information.

Students or participants have to come out of their shells and break with their cherished verbal, non-verbal and para-verbal patterns."

(Sierk Horn, author of "Digital Negotiations across Cultures")

"Often it is not the competences that play a role, [...] but rather retaining an openness, an empathy for [...] those things which are important in the collaborative setting. That is often not tangible, but rather a basic openness, a willingness, a motivation, a will."

(Christian Strobel, author of "Psychological Aspects of Virtual Collaboration: A brief overview")

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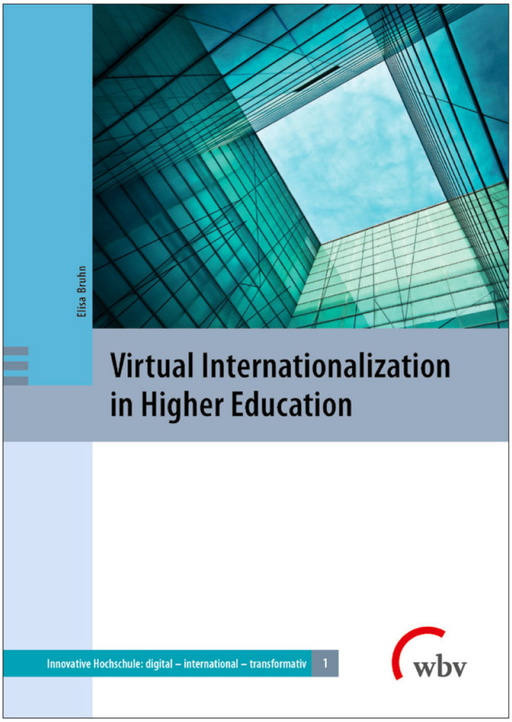

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Elisa Bruhn-Zaß

Virtual Internationalization in Higher Education

Digital media and information and communication technology (ICT) are being used more and more in international contexts at universities. In her English-language dissertation, Elisa Bruhn examines how this technological potential can be used strategically to expand internationalization. The data basis of the thesis is a content analysis of contributions to international conferences on university internationalization, online and distance learning, university management and research, and ICT and internationalization. The selected abstracts were analyzed based on the model of "Comprehensive Internationalization" (CI). From the results, Bruhn outlines a model for Virtual Internationalization (VI) that considers curricula, international cooperation, and distance learning as well as the roles of university strategy, administration, management, and teaching staff. The highly topical dissertation closes a gap in university research and offers universities valuable starting points in research and practice of internationalization.

wbv.de/hochschule

When it comes to working and learning, collaboration is often the key to success. In a team, tasks can be completed more eficiently, complex issues are easier to grasp and, as we all know, learning is not only an individual but also a social process. The articles in this collection illustrate a variety of opportunities and challenges that the use of virtual spaces and virtual technologies presents for successful teamwork. The collections' aim is to contribute to exploratory research as well as pilot studies of concepts and methods in the use of virtuality, with contributions from difflerent professional and application perspectives. The question of whether teamwork will increasingly take place in virtual space in the future is clearly answered in the afirmative. For this reason, it is necessary to continue to investigate the organisation of virtual collaboration in the future and to continuously develop new concepts for collaboration. This publication is a snapshot of these ongoing developments. It is intended to inspire practitioners to innovate in the design of collaboration in work and learning environments and to stimulate researchers in their future experiments and research approaches.

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