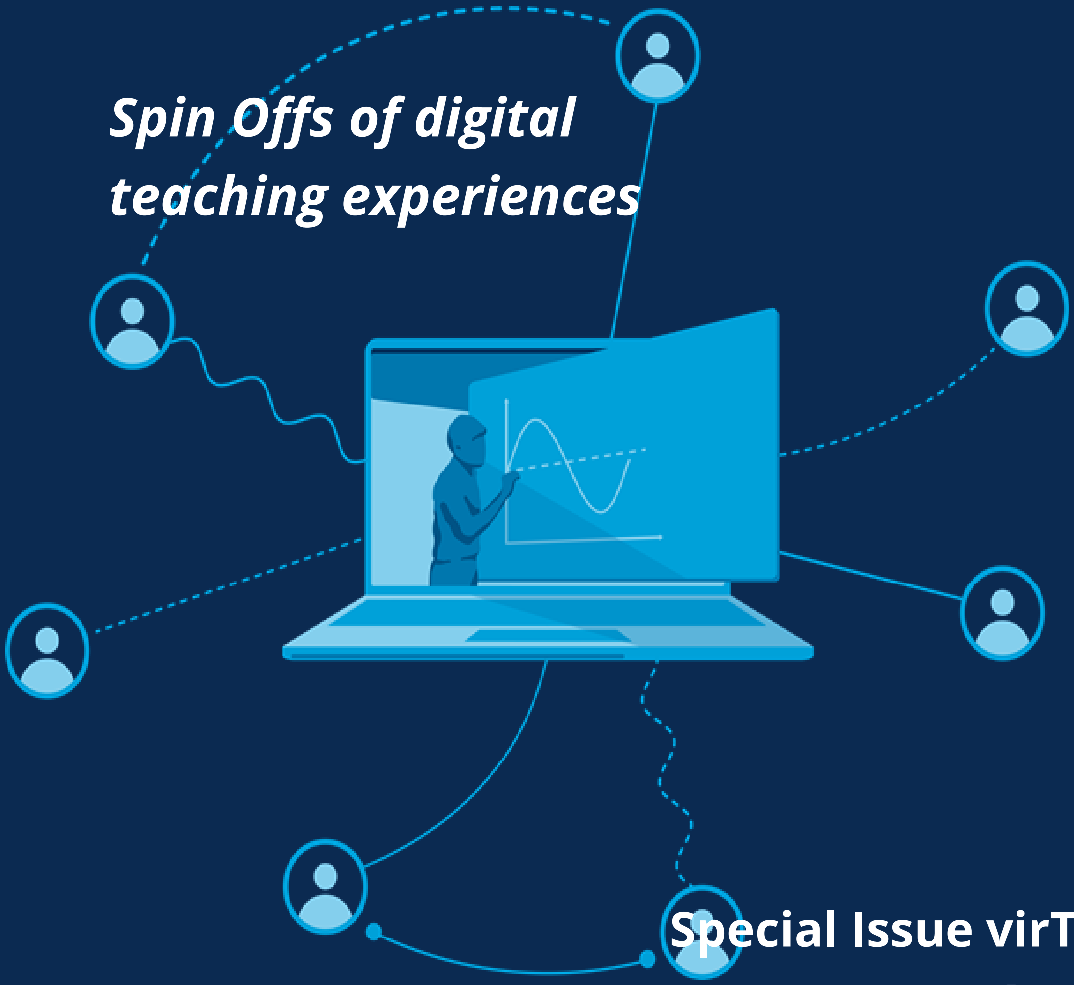
TECHNISCHE UNIVERSITÄT DRESDEN

Lessons Learned

Spin Offs of digital teaching experiences



Special Issue virTUos

virTUos

2

Volume 5 | 2025

Fakultät Maschinenwesen

About the Journal

Due to the sudden and huge restrictions in face-to-face teaching brought about by the Corona pandemic starting with the summer term 2020, an unprecedented change and renewal of teaching formats has occurred. Even though these changes were forced by the restrictions due to the pandemic, the experiences and concepts that were developed are of enormous value for a renewal of teaching towards modern, digitally supported forms of teaching and learning and towards more competence-oriented learning. At the beginning of the winter term 2020/21, a conference entitled "Lessons Learned - Spin Offs of a Digital Semester" was held at the Faculty of Mechanical Engineering at the Dresden University of Technology to support this renewal through the exchange of experiences. A conference series has emerged from this first conference and at the same time the journal "Lessons Learned" was launched. The aim of this journal is to discuss new forms of teaching and learning not only in the mathematical and natural sciences and technical sciences, but far beyond in all subject disciplines and thus to create a platform where teachers can inform themselves about new concepts and adapt them for their own teaching.

The journal is deliberately published in two languages, both to make the experience gained accessible to an international audience and to ensure that the linked examples are accompanied by a text in the language of instruction in which they were produced. This means no additional work for the authors, as articles can be submitted in either German or English. Once an article has been accepted, the journal translates it into the other language, so that the authors only have to proofread the translated article.

Editorial Board

Imprint

ISSN:

2749-1307

Publisher:

Faculty of Mechanical Engineering,
TU Dresden, Dresden

Contact:

Prof. Dr Stefan Odenbach

c/o Faculty of Mechanical Engineering
Magnetofluiddynamics, Measurement and Automation Technology
George-Bähr-Str. 3
01069 Dresden

Editorial

With Volume 5, Issue 2, ***Lessons Learned*** presents the **first thematic special issue** in the history of the journal. This issue is dedicated to the completion of the **virTUos project at TU Dresden** and brings together the insights, experiences, and reflections developed throughout the project within a shared publication framework.

Over the course of its duration, the virTUos project has exemplified a practice-oriented yet academically grounded engagement with digital and hybrid teaching and learning formats. The contributions developed within the project range from conceptual considerations and methodological approaches to concrete experiences in implementation and evaluation. The aim of this special issue is not only to document these results, but also to make them accessible to a broader scholarly discourse.

With this volume, ***Lessons Learned*** deliberately enters new territory. As the **first special issue** of the journal, Volume 5, Issue 2 marks an important step in its ongoing development. Thematic issues make it possible to examine related questions in greater depth and to bring together diverse perspectives within a clearly defined thematic framework. At the same time, the journal's core principles—openness, reflection, and a strong connection to practice—remain unchanged.

We would like to thank all authors whose contributions make this special issue possible, as well as all members of the virTUos project for their commitment and their willingness to systematically reflect on and share their experiences. With this volume, ***Lessons Learned*** aims to make a lasting contribution to the discussion on innovative teaching and learning formats while also giving visibility to the conclusion of a distinctive and impactful project.

The substantive foreword to this special issue can be found in the first article by Henriette Greulich and Alexander Lasch, *From Testing to Prospectives – virTUos at TU Dresden*.

Stefan Odenbach

A special edition on the virTUos project at TU Dresden—this covers the entire range of subjects from the humanities to medicine to engineering and encompasses digital, hybrid, and face-to-face aspects in equal measure. At the same time, it shows how well different subject cultures can learn from each other in teaching.

Range of topics

Lessons Learned 5, 2 (2025)
Submitted: December 15, 2025
Accepted: December 19, 2025

DOI: https://doi.org/10.25369/ll.v5i2.113
ISSN: 2749-1307

From testing to prospects – *virTUos* at TU Dresden

H. Greulich[1*] , A. Lasch[2]

[1] *Project Manager virTUos, Director of the Center for Interdisciplinary Learning and Teaching (ZiLL)*
[2] *Project Manager virTUos, Chair of German Linguistics and Language History, Institute for German Studies and Media Cultures, Faculty of Language, Literature, and Cultural Studies, TU Dresden*

Abstract

This anthology marks the conclusion of the *virTUos* project – virtual teaching and learning at TU Dresden in an open source context, which was funded between 2021 and 2025 by the Foundation for Innovation in Higher Education as part of the "Strengthening University Teaching through Digitalization" funding line. The volume brings together key developments and findings from the subprojects, traces their diverse disciplinary perspectives, and shows how new ideas and solutions took shape in collaborative work with our partners. As a supplement to the already published Open Educational Resources (OER), the documented Open Educational Practices (OEP), and the *virTUos* Prospectives white paper, it offers a coherent framework and an overarching conceptual classification.

Der vorliegende Sammelband markiert den Abschluss des Projektes *virTUos* – virtuelles Lehren und Lernen an der TU Dresden im Open Source-Kontext, das zwischen 2021 und 2025 im Rahmen der Förderlinie „Hochschullehre durch Digitalisierung stärken“ durch die Stiftung Innovation in der Hochschullehre gefördert wurde. Der Band führt zentrale Entwicklungen und Erkenntnisse aus den Teilprojekten zusammen, zeichnet deren fachlich vielfältige Perspektiven nach und zeigt, wie sich im kollaborativen Arbeiten mit unseren Partner:innen neue Ideen und Lösungen formten. Als Ergänzung zu den bereits publizierten Open Educational Resources (OER), den dokumentierten Open Educational Practices (OEP) sowie dem Whitepaper der *virTUos*-Prospektiven bietet er einen zusammenhängenden Rahmen und eine übergreifende konzeptionelle Einordnung.

*Corresponding author: henriette.greulich@tu-dresden.de
This article was originally submitted in German.

1. Project developments

The higher education landscape is facing fundamental challenges that go far beyond the need for pure digitalization. There is still a need to promote a resilient and flexible university culture that not only follows and keeps pace with global and national developments, but also offers opportunities for active participation. The *virTUos* project was designed to address the question of how collaborative, interdisciplinary, and transdisciplinary teaching and learning in project structures can contribute to this under the conditions of the digital transformation of the educational landscape.

One of the success factors of *virTUos* was the broad-based interdisciplinary collaboration organized within the structure. Nine individual projects were located in four different faculties (Linguistics, Literature, and Cultural Studies; Carl Gustav Carus Faculty of Medicine; Mechanical Engineering; Economics) and the Center for Interdisciplinary Learning and Teaching (ZiLL) and were supported by the practice and transfer partners, Dresden International University (DIU) and the Saxon State Library – Dresden State and University Library (SLUB). This division was strategically motivated: it ensured that the didactic and technological concepts developed were tested under a maximum variety of requirements. This is because the challenges in the Medical Faculty, for example in establishing clinical simulations and examination courses, are fundamentally different from the requirements of the humanities for virtual excursions or media competence development. At the same time, *virTUos* tested a new approach to collaboration between central and decentralized structures at TU Dresden, which generated far-reaching added value through close cooperation between departments, the ZiLL, and external partner institutions – which was shared with the public: While the Hybrid Labs (2022 and 2023) were more project-oriented workshops open to a topic-specific audience, the conferences "Spaces & Learning Worlds – Perspectives on the Design of University Teaching" (DIU, November 2023) and "OER Dissemination – Symposium of the *virTUos* Project" (SLUB, November 2024) conferences addressed a national and international audience.

Each subproject pursued specific goals and addressed different needs: DigitalHerrnhut and ExDiMed were based at the Faculty of Language, Literature, and Cultural Studies (SLK). DigitalHerrnhut focused on the use of virtual excursions as learning venues for international teaching and learning collaborations. The added value of these excursions lies in particular in overcoming barriers, giving students access to special historical or cultural contexts that are physically difficult to access. ExDiMed (Experimental Space for Digital Media Competence) was dedicated to teaching basic media skills to humanities scholars and, in particular, to the question of how they can be introduced to programming more easily and in a self-learning module. The trial was conducted over several semesters with great success, including in the master's program "Digital Humanities." At the Carl Gustav Carus Medical Faculty, the TelePresence and HybParc subprojects focused on different problem areas: TelePresence aimed to provide training opportunities even when physical presence is impossible, limited, or inefficient in everyday clinical practice, in order to maintain high training standards through flexible digital support. HybParc (hybrid interactive self-learning, training, and examination courses) aimed to modernize assessment and training tools in order to offer students flexible, individual learning paths and thus be able to tailor learning content and training intensity more closely to their individual needs. PraktikaHybrid at the Faculty of Mechanical Engineering, very similar in its basic approach to the TelePresence subproject, dealt with hybrid co-presence in real experimental settings and the question of how the relevance of physical experiences can be conveyed in digitally supported internship environments. The Faculty of Economics was home to the subproject

DikoLint (digital, collaborative learning in international teaching) project, which further developed the concept of virtual collaborative learning (VCL) and thus collaborative learning under digital conditions in international contexts, cooperating closely with DigitalHerrnhut. Two developments at the Center for Interdisciplinary Learning and Teaching (ZiLL), Tutoring Hybrid and sTUDents, formed the framework. With these two projects, ZiLL took on a central role in scaling the didactic solutions developed from the individual projects. Tutoring Hybrid focused on the professionalization and standardization of hybrid support structures and student teaching contexts by developing, testing, and implementing programs for tutors. sTUDents (student-oriented digital learning and teaching) ensured that all developments in *virTUos* were actively shaped by students according to the principle of "students as partners" and that digital skills were addressed across disciplines. This approach, which makes students partners in development, testing, and evaluation, showed that working on an equal footing guarantees acceptance, practical relevance, and target group relevance of the developed offerings. The successful implementation of digital solutions in such divergent subject cultures, with the involvement of university didactics, revealed the strengths and weaknesses of specific solutions in stress tests – and is thus one of the central findings of *virTUos*: We must open up spaces for experimentation in the academic context and work together on a progressive culture of error.

2. Prospects

These experiences have led to the development of prospects for digital teaching at TU Dresden. Originally referred to as the HYBRID strategy, we now see it as a comprehensive orientation for a university that wants to develop into a flexible, didactically sound, and inclusive learning and living space. The prospects identify various fields of action: orchestrated networking, cultural and social change, work-life-learn balance, society and community, didactics, campus life, study organization, and teaching room equipment. The key messages, which are also addressed in the sub-project reports, are summarized here for better understanding.

Universities are flexible learning spaces. Therefore, blended learning formats should be used widely as a combination of face-to-face and digital formats. The expansion of asynchronous teaching and learning offerings creates temporal and spatial flexibility, which on the one hand promotes the compatibility of studies and other commitments, and on the other hand creates the conditions for, for example, a consistent and more interactive project orientation in face-to-face courses. To ensure learning success, didactically sound approaches are pursued and further training is offered for teachers. Against the backdrop of the opportunities that have opened up over the past two years through generative AI (GenKI), adaptive learning systems for personalized learning paths, flexible teaching design, and automated feedback should also be considered in the future. Universities also promote lifelong learning through barrier-free access to continuing education opportunities and their recognition.

The organization of studies is geared towards individual flexibility. This includes the simplification and digitization of administrative processes (process, course, and exam management) in central systems. Greater modularization is supported by flexible "container" and project modules to promote interdisciplinary and practical teaching. In addition, barrier-free borrowing of teaching materials is guaranteed. The aim of these measures is to enable students to complete their studies within the standard period of study despite impairments, especially in cases of particular hardship.

Equal opportunities and inclusion are key principles for universities. Communication is open, respectful, inclusive, accessible, and gender-neutral. An onboarding semester for all students is recommended, which includes content on good scientific practice and conflict resolution. To anchor diversity issues, the representatives for inclusion, equality, and students with disabilities are mandatorily involved in teaching development.

The university is a networked education and research space where the goal is collaboration in "communities of practice." Regular exchange with external partner institutions (business, politics, society, schools) will be established to better coordinate knowledge transfer. Campus life is designed to be sustainable, inclusive, and lively—green, car-free in core areas, with weather-protected outdoor workspaces and bicycle-friendly infrastructure.

3. Thanks

The success of *virTUos* is inextricably linked to the extraordinary commitment of numerous stakeholders. In addition to the university management of TU Dresden and the teams at our partner institutions DIU and SLUB, we would like to express our special thanks to the members of the Advisory Board Prof. Dr. Bernhard Marschall, Dr. Julia Meyer, Prof. Dr. Andreas Schadschneider, Prof. Dr. Friedemann Vogel, and Prof. Dr. Bianca Watzka for their advice and supportive ideas, as well as the subproject leaders in Dresden, Prof. Dr. Simon Meier-Vieracker, Prof. Dr. Stefan Odenbach, Prof. Dr. Ingo Röder, and Prof. Dr. Eric Schoop for their willingness to engage in cross-disciplinary, constructive, and unconventional collaboration.

Together with the research assistants involved in the projects, we are delighted with the excellent and sustainable results, which, thanks to their continuous and valuable project work, are reflected not only in their theses, but also in an impressive portfolio of teaching and learning ideas, formats, and materials that will continue to exist beyond the end of the project: Mattis Altmann, Eva Bibrack, Dr. Yannick Frommherz, Christina Hirsch, Martin Hirsch, Hanna Hoffmann, Dr. Anne Jantos, Lydia Kilz, Peter Klausing, Maike Krohn, Katja Krumm, Dr. Lisa-Marie Langesee, Melanie Ludwig, Florian Mauersberger, Hanna Möllhoff, Josefin Müller, Claudia Perge, Kerstin Petr, Michelle Pippig, Dr. Doreen Pretze, Anne Röhle, Beatrice Schlegel, Sebastian Schmidt, Robert C. Schuppe, Jette Schwick, Pauline Thamm, Nelli Ukhova, Caroline Wermann, and Marie-Christin Willemer.

They were actively supported by our student assistants Stefanie Backasch, Victor Berger, Gustavo Enrique Barrios Berlioz, Charlotte Daub, Mayalena Echevin, Alexander Grohmann, Sabrina Hänsel, Nick Heidmann, Victoria Helbig, Laura Hilse, Nora Hofmann, Svenja Houser, Paul Florian Kipke, Luisa Klatte, Levin Leidholdt, Eliah Lohr, Jonas Mailach, Anne Josephine Matz, Johann Michels, Gregor Mitzka, Clara Müller, Flora Anne Henriette Neils, Tom Quast, Johannes Reimer, Thomas Tobija Richter, Jördis Römer, Ruslan Sadretdinov, Josefine Salomo, Paula Sambale, Marleen Schindler, Tom-Maurice Schreiber, Anne Seipel, Celina Stransky, Sonja Werner, Alexander Wessels, and Marlene Wolf, without whom many project and networking ideas would not have been realized.

This also applies in particular to our coordinators Sarah Elser and Dr. Ekkehard W. Haring, and thus to all non-academic staff in central and decentralized administration who knew how to implement our project and many unconventional ideas and requirements.

To all of you: you were, are, and remain virtuosos. Thank you.

Lessons Learned 5, 2 (2025)
Submitted: October 1, 2025
Accepted: November 25, 2025

DOI: https://doi.org/10.25369/ll.v5i2.107
ISSN: 2749-1307

Distance learning – local participation: Telepresence systems in medical education

M.-C. Willemer[1+*], J. Mailach[1+], D. Pretze[2], Ingo Röder[2,3]

1 Dresden University of Technology, Carl Gustav Carus Faculty of Medicine, Institute of Medical Education, Medical Interprofessional Training Center (MITZ), Dresden, Germany
2 Dresden University of Technology, Carl Gustav Carus Faculty of Medicine, Institute of Medical Education, Dresden, Germany
3 Dresden University of Technology, Carl Gustav Carus Faculty of Medicine, Institute for Medical Informatics and Biometry (IMB), Dresden, Germany
** shared first authorship*

Abstract

Telepresence robots (TPR) allow students to participate actively in medical education despite physical absence. Compared to purely online teaching, they enhance social presence by enabling controlled mobility and interaction in discussions and group work.
Within the virTUos project, TPR were used at the Medical Interprofessional Training Center (MITZ) of the Dresden Faculty of Medicine in seminars and compulsory courses. Students valued the independent control and direct interaction with teachers and peers. However, technical issues such as unstable Wi-Fi, limited fields of view, and audio-video delays occurred.
As a complementary solution, a pan-tilt-zoom (PTZ) camera system was developed. Although not mobile, it proved to be more stable and cost-effective.
Overall, telepresence systems support equal opportunities and are particularly suitable for practice-oriented learning. Their effective use depends on reliable infrastructure, clear guidance, and active support from teachers and students. TPR therefore represent an inclusive tool with potential beyond medical education.

Telepräsenzroboter (TPR) ermöglichen Studierenden eine aktive Teilnahme an der medizinischen Lehre trotz physischer Abwesenheit. Im Vergleich zur reinen Online-Lehre erhöhen sie die soziale Präsenz durch steuerbare Mobilität und Interaktion in Diskussionen und Gruppenarbeiten.
Im Projekt virTUos wurden TPR am Medizinischen Interprofessionellen Trainingszentrum (MITZ) der Medizinischen Fakultät Dresden in Seminaren und Pflichtveranstaltungen eingesetzt. Geschätzt wurden die selbstständige Steuerung sowie der direkte Kontakt zu Lehrenden und Mitstudierenden. Gleichzeitig traten technische Probleme wie instabile WLAN-Verbindungen, eingeschränkte Sichtfelder und Ton-Bild-Verzögerungen auf.
Ergänzend wurde ein Pan-Tilt-Zoom-(PTZ)-Kamerasystem entwickelt, das zwar nicht mobil, aber stabiler und kostengünstiger ist.
Insgesamt fördern Telepräsenzsysteme die Chancengleichheit und eignen sich besonders für praxisnahe Lehrformate. Voraussetzung sind eine zuverlässige Infrastruktur, klare Einweisungen und die aktive Unterstützung durch Lehrende und Studierende. TPR sind damit auch über die medizinische Ausbildung hinaus ein inklusives Instrument.

*Corresponding author: marie-christin.willemer@tu-dresden.de This article was originally submitted in German.

1. Background

Attending classes is a central part of studying—both for acquiring specialist knowledge and for building social contacts. However, students cannot always be physically present for various reasons, e.g., acute or chronic illness, maternity leave, childcare, or limited mobility. Longer or repeated absences can delay the course of study. Universities are therefore faced with the challenge of integrating learners into everyday student life despite physical distance and enabling social and academic participation. Purely digital distance learning only partially meets these requirements: although it provides access to content, it reduces social presence and can thus weaken learning outcomes and the mental well-being of students. This problem became particularly apparent during the coronavirus pandemic: almost 80% of students said they missed personal interaction with fellow students, and 63% reported a lack of contact with teachers [1]. Restrictions on everyday university life not only affected academic aspects, but also social identity, mental health, and quality of life [2].

Fig. 1: Telepresence robot (TPR) at the Medical Interprofessional Training Center (MITZ).

This is where telepresence robots (TPR) come in. They represent a promising technological advancement over traditional video conferencing systems: mobile devices equipped with a webcam, microphone, speaker, and screen that can be controlled remotely by another person. This allows students to not only follow the content despite their physical absence, but also to actively and interactively participate in class [3]. Unlike conventional systems, TPR enable a higher level of social presence: thanks to their mobility and visibility, the remote operators are more closely involved in the teaching situation and can participate in the action independently, albeit to a limited extent. This creates a more intense feeling of "being there" and participation, which is particularly relevant for longer periods of absence. A key advantage is self-control: students can navigate the robot themselves in the room and decide where to focus their attention. This promotes autonomy and interaction beyond the mere reception of content. Particularly valuable is the ability to move around in discussion groups, make eye contact, and participate in informal exchanges with fellow students—aspects that traditional video conferencing can hardly replicate.

Research confirms the potential of this technology. University staff and students rate its use as overwhelmingly positive, especially in terms of inclusion, interactivity, and social presence [3, 4]. Positive experiences with TPR can also be observed in other areas of education: for example, children with cancer were able to continue attending classes during their treatment and avoid social isolation with the help of these devices [5]. Chronically ill, homebound children in the US were also able to actively participate in school life in this way [6].

These examples illustrate that TPR can make a valuable contribution when participation is not possible. Against this background, the Medical Interprofessional Training Center (MITZ) of the Carl Gustav Carus Faculty of Medicine (MFD) investigated the extent to which this technology can also be used in university teaching—especially in medical education—as part of the virTUos project at the Carus Teaching Center (CarL).

2. Project development

Relevance of the manufacturer for the selection of the TPR

Trust in the technical solution played a central role in the selection of the robot model used. A paper by "Hu" and colleagues emphasizes that this is a basic prerequisite for the acceptance of TPR in university teaching [7]. It is particularly relevant because sensitive data such as audio and video transmissions are processed during use. Compliance with data protection regulations was therefore a mandatory criterion for our institution. Specifically, this meant that server service providers had to be subject to the GDPR or, alternatively, end-to-end encryption of all transmitted data had to be guaranteed. Only providers who could ensure these framework conditions technically and organizationally were considered for use.

Model selection and technical specifications

We decided to use the UBBO Expert from AXYN Robotique because it meets data protection and security requirements and also impresses with its technical features.

The UBBO Expert as a TPR (approx. 1.60 m high, 21 kg weight) is equipped with:

- 13.3-inch HD touchscreen
- Movable camera with large pan/tilt range
- LED panel for nonverbal signals
- Stereo speakers and microphone for bidirectional interaction
- Three wheels (two motorized), cornering and turning on the spot
- Browser-based control (PC, tablet, smart-phone), no additional software required
- Speed: up to 1 m/s, battery life approx. 8 hours
- Step and collision sensors
- 4G-enabled for independent operation of Wi-Fi

Close contact with the manufacturer proved to be crucial for successful deployment. Technical problems could be quickly resolved on site and questions answered directly. This not only increased availability in teaching operations, but also strengthened confidence in the data security and reliability of the solution.

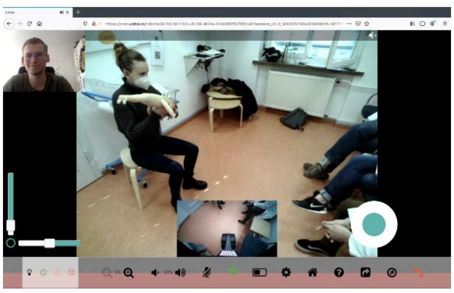


Fig. 2: Screen view of a participant

Integration into various learning scenarios

UBBO Expert was first used in peer teaching formats in rotation training at MITZ, including practical and communication stations. The training comprised full-day sessions in several rooms and on several floors, allowing students to experience different learning environments. In small groups of about six people, the robot was used specifically for students who were unable to participate physically or organizationally – for example, due to mobility restrictions, illness, pregnancy, or childcare.

Fig. 3: TPR in the practical teaching unit on transfusion at MITZ.

In addition, TPR was tested in seminars, internships, and compulsory courses in human medicine, including anatomy, physiology, virology, nuclear medicine, radiation therapy, and communication seminars. In these settings, the robot enabled the remote-controlling students to actively participate in discussions, group work, and practical exercises, to work on learning content, and to ask direct questions. This also facilitated spontaneous conversation between students in small groups.

Particular challenges arose with larger groups, room changes, and floor transitions, as the robot has a limited field of vision. There were also difficulties in overcoming small thresholds. Technical problems such as audio/video latency, Wi-Fi disconnections, and limited zoom and camera resolution were observed, but these were partially offset by targeted support, alternative streaming solutions (e.g., Zoom), and the use of mobile data connections.

Fig. 4: TPR in the virology lab practical.

Briefing participants, attendees, and lecturers using TPR

To ensure the smooth use of TPR, participants received specific instruction in advance. Basic information was provided by email and included:

- Quick start guide for dialing in and operating TPR
- Technical requirements
- Tips for effective communication via TPR
- Schedule information
- Alternative communication channel in case of TPR failure (e.g., the TU-hosted chat platform Matrix Elements)

A brief introductory meeting was held before the start of the course. Technical functions were tested, volume was adjusted, and participants were familiarized with the driving dynamics of the TPR.

Attendees and instructors were also informed about the use of the TPR. Special attention was paid to changing rooms and floors, as this often causes problems: the robot's limited field of vision makes orientation difficult, and the connection can be interrupted when changing Wi-Fi access points or using the elevator. Those present were trained to actively support the TPR, e.g., by avoiding collisions or facilitating elevator use. At the same time, communication, helpfulness, and inclusion were discussed. The tutors received additional tips on integrating the TPR into lessons, particularly on task distribution and active involvement in discussions.

Intensive support and observation protocols

During the pilot phase, individual support for each participant was necessary due to a lack of reliable data on technical reliability. Systematic observation protocols were kept during this phase. Important findings included the following:

- The LED display of the TPR was rarely used.
- The TPR shows difficulties in overcoming thresholds.
- The limited response time due to latency restricts interaction in teaching scenarios with fast question/answer rhythms.
- Students position the TPR specifically to keep tutors and relevant points of interest optimally visible.
- Frequent queries about transmission quality were observed.

PTZ system as a supplement

Based on these observations, an alternative system was developed that is based on a PTZ (pan-tilt-zoom) camera. In combination with a Windows laptop, the "Zoom" video conferencing software, a compact conference audio system, and two power banks, the system functions as a mobile video conferencing setup. Mounted on a rollable table, the system remains flexible in terms of location, while the autonomous driving function is omitted in favor of technical stability. The remote-controlled axis alignment can be used by participants via the "Zoom" feature "far-end Camera Control."

Fig. 5: Setting up a PTZ system on a mobile table.

The PTZ system uses inexpensive standard components that can be flexibly exchanged or expanded. It can be easily adapted to different teaching and room configurations. The manufacturer-independent design in terms of hardware and software facilitates further development and avoids dependencies on individual suppliers.

3. Evaluation results

Evaluation of TPR use

The use of TPR was evaluated in all participating groups – students, lecturers, and participants in external events. Participation was rated positively by the majority: around 79% of participants rated the opportunity as "good" to "very good." The main reasons for use were illness, quarantine/isolation, physical distance, or childcare responsibilities. The TPR was found to be intuitive to use; short test runs or briefings in advance were rated as helpful.

Fig. 6: LEGO® ramp for overcoming thresholds.

Technical problems occurred in about one-third of cases, in particular Wi-Fi disconnections, sound problems (reverberation, echo, motor noise), image quality issues, and control delays. These could usually be resolved by restarting the system or with support from teachers/technical staff. Those present reported that communication worked well for the most part, especially in small groups or quiet conversation situations. Challenges arose when several people spoke at the same time. Barriers such as small thresholds or steps were overcome by specially made LEGO® ramps, which were individually adjusted to the height of the respective steps.

The use of TPR enabled students to actively participate in discussions, group work, and exercises, work on learning content, and ask direct questions despite their physical absence. Suggestions for improvement related to sound/video quality, (optical) camera zoom, more stable Wi-Fi connections, more sensitive controls, and short test runs before the event.

Advantages and disadvantages of the systems used

As part of the evaluation, the characteristics of the TPR/PTZ systems were compared. This revealed different strengths and weaknesses that should be taken into account when choosing the appropriate system for teaching courses. Table 1 in the appendix provides a compact overview of the most important advantages and disadvantages of both systems.

Handouts for TPR/PTZ in OER

During the pilot phase, instructions for using the systems were created. These include step-by-step instructions for preparing, setting up, operating, and maintaining the systems, including information on technical configuration and the use of mobile connections. The materials are designed to be practical in order to support teachers and students in their use. All instructions are available on the OER platform Twillo and can be freely accessed, downloaded, and adapted for your own teaching.

Fig. 7: QR code for the Twillo telepresence collection.

Exchange with the Veterinary Medicine Department in Leipzig

As part of the dissemination process, an interdisciplinary exchange took place with the Faculty of Veterinary Medicine at the University of Leipzig.

Fig. 8: TPR in veterinary medicine in Leipzig.

TPR was used in the slaughterhouse, sausage factory, and seminar rooms. Students rated their participation via TPR as predominantly positive; image and sound quality were rated as good, and communication was largely equivalent to face-to-face situations. Limitations arose in particular with navigation and dealing with hygiene requirements.

Conference contributions

The experiences were systematically documented, published, and disseminated via specialist networks. The publication "Practical teaching goes digital – are we all on board?" [10] shows that telepresence not only enables digital teaching formats, but also specifically promotes equal opportunities and participation. The results were presented in several lectures, poster contributions, and on e-teaching.org, which enabled interdisciplinary exchange and practical implementation in various departments.

The results were also presented in several national and international lectures. These include "Lessons Learned 2021" [11], the 2022 annual conference of the Society for Medical Education (GMA) [12], and the 2024 Human and Computer Conference under the title "Telepresence in Medical Education – From the Path of Participation for the Disadvantaged to the Benefit for All." A poster presentation at the 64th Working Conference of the DVG's "Food Safety and Consumer Protection" working group in 2024 dealt with the use of TPR specifically in the veterinary context and highlighted its practical implementation and evaluation.

In addition, the findings were published on the e-teaching.org platform under the title "Hybrid Teaching Concepts with Telepresence Robots" [13]. As part of the "Digital Inclusion Network Meeting," an interdisciplinary exchange took place in which the participation of different departments in teaching through telepresence systems was discussed. This variety of formats not only promoted scientific discussion, but also strengthened the direct practical relevance: teachers gained insights into possible applications, technical requirements, and didactic integration, while students benefited from improved access to teaching.

4. Discussion

The evaluation of the use of TPR in medical teaching shows a mixed picture: on the one hand, experience confirms the great potential of the technology, but on the other hand, significant technical and organizational challenges are becoming apparent.

Limitations of the evaluation

Our evaluation is not without limitations: the sample was limited, participation was voluntary, and the feedback may have been influenced by positive expectations of the innovative technology. In addition, long-term effects and the sustainability of the use were only indirectly recorded.

Proven and less proven aspects of the TPR system

The use of the TPR system showed both clear advantages and some challenges. Particularly positive is the participant satisfaction: students who used the TPR rated their experiences as 100% positive, and 57.1% also found its use to be a relief. Despite physical separation, a sense of involvement was also successfully conveyed, as users reported being actively involved in the proceedings. Another success factor was didactic integration: targeted training and embedding of the technology in the teaching processes proved to be crucial for learning success.

Some technical and organizational aspects were less convincing. Over 75% of TPR users and 83% of those physically present reported technical problems, such as poor sound quality, connection interruptions, or operating difficulties. In addition, acceptance among those present was rather reserved. They found the technology disruptive. Finally, the PTZ system proved to be a very good alternative to a mobile TPR despite its limited mobility, thanks to its excellent image and sound quality, especially for teaching situations where mobility is less crucial.

Comparison with the literature

Our observations are largely consistent with the existing literature. As Ahumada-Newhart and Olson (2019) [6] report, they also encountered technical problems, including unstable Wi-Fi connections, connection interruptions, and difficulties with navigation, control, and interaction. Participants and teachers sometimes had to intervene to provide support.

In addition, our evaluation results confirm the statements of Trittin & Blumenthal (2024) [8]: TPR increase social presence, enable the participation of students with limited mobility, and promote interaction compared to video conferencing, but still lag behind face-to-face teaching. Stable technology, the active involvement of remote participants, and didactic measures such as clear objectives and hybrid group work are crucial for successful implementation.

The training and preparation of teachers and students proves to be a critical interface between potential and practical implementation. Leoste et al. (2022) [9] show that although TPR is predominantly rated positively in terms of social presence, inclusion, and interactivity, there are also hurdles such as high costs, technical problems, and lack of experience. Targeted training, investment in infrastructure, and further research are necessary to fully exploit the potential of TPR in a higher education context.

5. Conclusion

The use of TPR enables students to actively experience medical education despite their physical absence. This principle of hybrid participation can be transferred to many other degree programs, especially those that focus on practical exercises or group work. Another key aspect is the do-it-yourself approach with freely selectable software: the use and further development of freely accessible systems, such as the PTZ system via Zoom, allows even smaller institutions to introduce hybrid teaching formats without the need for high investments in proprietary systems. Finally, the project demonstrates clear transferability to other subjects: initial experiences with telepresence systems in mechanical engineering show that the concept is relevant far beyond medicine and can be adapted for laboratories, practical training, or practical exams, for example.

It should be particularly emphasized that the willingness of lecturers and students to participate already plays a significant role in the success of such projects and is of great importance for the successful implementation of hybrid teaching formats. Overall, experience shows that telepresence systems are a sustainable, inclusive, and practical tool that can increase equal opportunities in medical education and effectively support innovative teaching formats.

Technology alone does not create participation – didactic concepts, technical support, and the conscious use of hybrid attendance are crucial.

Acknowledgements

We would like to express our special thanks to our former colleague Anne Röhle, whose commitment, expertise, and valuable intellectual contributions have contributed significantly to the success of the project. We would also like to thank Gustavo Barrios Berlioz for his valuable support.

Literature

[1] Lörz M, Marczuk A, Zimmer L, Multrus F, Buchholz S. Studying under coronavirus conditions: Students evaluate the first digital semester; 2020. DOI: 10.34878/2020.05.dzhw_brief

[2] Traus A, Höffken K, Thomas S, Mangold K, Schröer W. Stu.diCo. – Studying digitally in times of coronavirus; 2020. DOI: 10.18442/150

[3] Wolff F, Möller J. Telepresence robots in higher education: Findings from a longitudinal study indicate high acceptance. die hochschullehre 2021; 7. DOI: 10.3278/HSL2118W

[4] Leoste J, Kikkas K, Tammemäe K, Rebane M, Laugasson E, Hakk K. Telepresence Robots in Higher Education – The Current State of Research. In: Lepuschitz W, Merdan M, Koppensteiner G, Balogh R, Obdržálek D, editors. Robotics in Education. Cham: Springer International Publishing; 2022. p. 124–34 (Lecture Notes in Networks and Systems). DOI: 10.1007/978-3-031-12848-6_12

[5] Weibel M, Nielsen MKF, Topperzer MK, Hammer NM, Møller SW, Schmiegelow K et al. Back to school with telepresence robot technology: A qualitative pilot study about how telepresence robots help school-aged children and adolescents with cancer to remain socially and academically connected with their school classes during treatment. Nurs Open 2020; 7(4):988–97. DOI: 10.1002/nop2.471

[6] Ahumada-Newhart V, Olson JS. Going to School on a Robot: Robot and User Interface Design Features That Matter. ACM Trans Comput Hum Interact 2019; 26(4). DOI: 10.1145/3325210

[7] Hu J, Reyes Cruz G, Fischer J, Maior HA. Telepresence Robots for Remote Participation in Higher Education. In: Proceedings of the 3rd Annual Meeting of the Symposium on Human-Computer Interaction for Work. New York, NY, USA: ACM; 2024. p. 1–14. DOI: 10.1145/3663384.3663394

[8] Trittin R, Blumenthal S. On the benefits of telepresence robots in teacher training [12MB]. k:ON - Cologne Online Journal for Teacher Training 2024; 8. DOI: 10.18716/ojs/kON/2024.14

[9] Leoste J, Virkus S, Talisainen A, Tammemäe K, Kangur K, Petriashvili I. Higher education personnel's perceptions about telepresence robots. Front Robot AI 2022; 9:976836. DOI: 10.3389/frobt.2022.976836

[10] Röhle A. Practical teaching is going digital – are we all on board? Implementation and further development of digital teaching at the Medical Interprofessional Training Center (MITZ) with a focus on equal opportunities. Equal Opportunities – Perspectives for Higher Education 2022; Volume 1. Available from: URL: https://nbn-resolving.de/urn:nbn:de:bsz:15-qucosa2-829635 [cited 2025 Sep 23].

[11] Röhle A, Bibrack E. Digital and hybrid teaching in medical education using the example of the Medical Interprofessional Training Center MITZ: Impulses and development potential. LL 2022; 2(1). DOI: 10.25369/ll.v2i1.45

[12] Willemer M-C, Röhle A. MITZ makes it possible: Participation in practical teaching through the use of telepresence robots at the Medical Interprofessional Training Center (MITZ) [German Medical Science GMS Publishing House]. Joint Annual Conference of the Society for Medical Education (GMA) and the Working Group for the Further Development of Teaching in Dentistry (AKWLZ) 2022. DOI: 10.3205/22gma049

[13] Odenbach S, Wermann C, Willemer M-C, Röhle A, Mailach J. Hybrid teaching concepts with telepresence robots. (From practice). Available from: URL: https://www.e-teaching.org/praxis/erfahrungsberichte/hybride-lehrkonzepte-mit-telepraesenzrobotern [cited 2025 Sep 23].

Appendix

Table 1 Comparison of the TPR and PTZ systems based on various criteria

Criteria	Telepresence Robot (TPR) (Modell: Ubbo von Axyn Robotique)	PTZ-System
Mobility	Autonomous; students can move independently in the room; limited navigation when obstacles are present	No autonomous movement; mobile only via a rolling cart
Interaction	High level of interaction and informal exchange	Limited interaction; high degree of informal exchange
Operation	Intuitive, often "one-click"; short introduction required	Setup required; active configuration necessary
Technical Stability	Dependent on WiFi; audio/video latency possible	Technically stable; fewer connectivity issues
Audio /Video Quality	Good; insufficient for highly detailed visualization	Very good; very well suited for detailed visualization
Flexibility /Customization	No custom modifications possible due to closed system	Modular, manufacturer-independent, easily expandable
Support Effort	High (training, technical support)	Lower
Data Protection	European servers, compliant	Local control, compliant
Costs	Higher; specialized system	More affordable; standard hardware usable
Practical Exercises	Limited comparability to in-person presence	Not mobile; therefore, limited direct participation in exercises
Special Features	All-in-one software incl. control; limited multi-user support	Remotely controllable camera ("far-end control"); individually replaceable components

Lessons Learned 5, 2 (2025)
Submitted: September 18, 2025
Accepted: December 08, 2025

DOI: https://doi.org/10.25369/ll.v5i2.103
ISSN: 2749-1307

Digital Herrnhut: From virtual excursions to complex blended learning setups

R.C. Schuppe, A. Lasch*

Chair of German Linguistics and Language History, Institute of German Studies, Faculty of SLK, TU Dresden

Abstract

The aim of the DigitalHerrnhut project was to digitally index and didactically prepare the extensive, interdisciplinary knowledge archives of the Moravian Church within the framework of digitally supported university teaching. The core activities included the creation of virtual excursions, on the basis of which four immersive self-learning modules were developed as Open Educational Resources (OER) and combined with subject-related case studies in blended learning seminars to promote practical and collaborative skills. In addition, ImagoFolio was developed in the context of the project, a cost-effective, mobile digitization setup that has been successfully used in teaching and in international collaborations, for example in South Africa, to digitize tens of thousands of manuscripts. The text sources thus made available formed the basis for seminars in the Master's program in Digital Humanities, in which students acquired digital skills in areas such as XML annotation, metadata linking, and (semi-)automatic transcription using eScriptorium, and linked their results to the virtual excursions.

Ziel des Projektes DigitalHerrnhut war die digitale Erschließung und didaktische Aufbereitung der umfangreichen, interdisziplinär relevanten Wissensarchive der Herrnhuter Brüdergemeine im Rah-men einer digital gestützten Hochschullehre. Zu den Kernaktivitäten gehörte die Erstellung von virtuellen Exkursionen, auf deren Basis vier immersive Selbstlernmodule als Open Educational Re-sources (OER) entwickelt und in Blended Learning-Seminaren mit fachbezogenen Fallstudien kom-biniert wurden, um praktische und kollaborative Kompetenzen zu fördern. Darüber hinaus wurde im Projektkontext ImagoFolio entwickelt, ein kostengünstiges, mobiles Digitalisierungs-Setup, das erfolgreich in der Lehre und in internationalen Kooperationen, beispielsweise in Südafrika, zur Digi-talisierung zehntausender Handschriften eingesetzt. Die so erschlossenen Textquellen bildeten die Grundlage für Seminare im Masterstudiengang Digital Humanities, in denen Studierende digitale Kompetenzen in Bereichen wie XML-Annotation, Metadatenverknüpfung und (semi-)automatischer Transkription mittels eScriptorium erwarben und ihre Ergebnisse mit den virtuellen Exkursionen verbanden.

*Corresponding author: alexander.lasch@tu-dresden.de

This article was originally submitted in German.

1. A project report

The COVID-19 pandemic has posed enormous challenges for higher education worldwide and at the same time acted as an unprecedented catalyst for digital transformation. The sudden restrictions on face-to-face teaching led to unprecedented changes and innovations in teaching formats. These forced changes have yielded valuable experiences and concepts for modernizing teaching. At the same time, however, there is still a need to standardize and evaluate the formats that have emerged, as they were implemented as spontaneous innovations rather than as part of a larger teaching concept.

As part of the "Collaboration & Internationalization" field of work, the DigitalHerrnhut subproject focused on the digital development and didactic preparation of the extensive knowledge archives of the Moravian Church. This project report summarizes the findings and experiences gained in the project and places them in the context of the consortium. First, the initial situation and the preliminary work on which the project was based are discussed. This is followed by a summary of the project activities, before the findings from the evaluation of the teaching formats developed are discussed. A brief conclusion, including an outlook on the continuation and consolidation of various project results, concludes the article.

2. Initial situation

The Moravian Church is a Pietist religious community that was founded in the early 18th century and spread worldwide within a few decades. As such, it represents (1) a unique subject of research for a wide range of disciplines – from theology, history, and art history to linguistics [a] and geography and botany [b], to name but a few. On the other hand, it (2) opens up a field of work that spans generations and institutions.

Founded in the 1720s in Berthelsdorf, eastern Saxony, by Nikolaus Ludwig, Imperial Count of Zinzendorf, the community was characterized by the international mobility of its members and close networking among European scholars and patrons.[1][2] As early as the 1730s, it began its worldwide missionary work, which brought it into contact with numerous cultural circles that were often little known in Europe.

Fig. 1: The Herrnhut Mission in Suriname (from 1735) from the Mission Atlas of the Moravian Church (1860).

The Moravian Church's extensive publishing activities contributed significantly to European perceptions of the world and created central archives of European knowledge. These included handwritten and later printed periodicals, letters, and extensive descriptions of missionary activities and areas such as Greenland, North America, South America (see Fig. 1), and South Africa.[3] These writings, supplemented by works on missionary theology, created an incomparable textual cosmos that describes the activities of a globally networked community over 300 years and brought knowledge about other cultures and continents to Europe. Many of these textual records have not yet been made accessible; many others have been 'forgotten'.[4]

The digital cataloguing of these sources is therefore important, as it makes a forgotten part of cultural history visible and accessible. At the same time, this thematic context offers great potential for (research-oriented) university teaching. For example, working on unexplored topics can be a valuable experience of self-efficacy . This subject also offers various opportunities for interdisciplinary collaboration and the testing of digital methods. This potential should be tapped for academic teaching with DigitalHerrnhut.

Digital skills have become essential in today's university and working world in the wake of digital transformations. Accordingly, modern university teaching should offer added value in this area as well, in addition to imparting content and skills for reflection and critical engagement with a subject. At the same time, the coronavirus pandemic has made it clear how diverse the possibilities are for supplementing face-to-face teaching with digital and hybrid teaching methods. Significant added value can be achieved in terms of accessibility, flexibility, and learner motivation.

Fig. 2: Networking of digitally developed sources at the relevant location in virtual excursions (illustration: Alexander Lasch CC BY 4.0 Int.).

So-called virtual excursions served as the starting point for the development of innovative teaching modules in DigitalHerrnhut. These are virtual models of historical buildings that are enriched with multimedia content and can thus be made useful for teaching. At the start of the project, the Kleinwelka nurses' home was the first building from the context of the Moravian Church to be developed as a virtual excursion (see Fig. 2 with internet reference [c]). The experience gained from this pilot project revealed great potential for university teaching and other educational contexts.[5] This potential was to be utilized, tested, and evaluated in DigitalHerrnhut.

3. Project activities

An important part of the project activities was data indexing and, more specifically, the development of a workflow for indexing handwritten texts from the 18th and 19th centuries. The digitization setup developed was intended to (1) deliver high-quality (i.e., long-term archival) results, (2) be easy to use with a low barrier to entry, (3) be inexpensive and portable, and (4) be suitable for use in teaching contexts.

In order to meet these criteria, ImagoFolio was developed,[6] improved, and put into practice during the project period.To make it easier for users to get started, instructional videos were created in German and English, among others, with our dissemination partner, the Saxon State Library – Dresden State and University Library (SLUB Dresden), which now offers the rental of the setup as a service based on our experience.

Fig. 3: Presentation of the ImagoFolio primary digitization setup and training at the Genadendal Museum, South Africa (photo: Jördis Römer CC BY 4.0 Int.).

ImagoFolio was successfully used both in project-related teaching and in a collaboration with two archives in South Africa (see Fig. 3). As an external transfer of project results, student employees of the Genadendal Museum and the Moravian Theological Centre Cape Town were trained in the use of ImagoFolio as part of international, hybrid workshops . Within a few months, the students trained in this way were able to digitize over 50,000 pages of historical manuscripts.

The text sources developed in the context of the Moravian Knowledge Network project hub are put to practical use through their integration into university teaching. They formed the basis for various seminars that, in addition to primary digitization, focused in particular on the preparation and evaluation of data on the subject and were integrated into the master's program in Digital Humanities. The seminar From Manuscript to Edition, for example, focused on the annotation of digitized texts in XML format. The standardized linking of metadata in WikiData and FactGrid also plays a decisive role in this context and was promoted in collaborative teaching projects.

In the context of events such as the seminar on the indexing of pre-modern manuscripts, students worked in particular on the (semi-)automatic transcription of manuscripts using the open-source software eScriptorium. Due to its free accessibility, ease of use in a browser, and the possibility of collaborative work, this software proved to be particularly suitable not only for academic teaching, but also for integration into non-university contexts such as schools and citizen science education in face-to-face and hybrid environments (see Fig. 4).

Fig. 4: Working with the eScriptorium Desk in a hybrid workshop between Genadendal and TU Dresden and SLUB Dresden in March 2025 (photos: Judith Balie CC BY 4.0 Int.).

Overall, collaborative work on data indexing in the context of academic teaching has proven to be extremely useful. In this way, students were not only able to acquire various digital skills that may also be beneficial for their future careers. Working together on research topics that were perceived as relevant – in South Africa, for example, the 100-year history of the Genadendal community can only be accessed through German-language manuscripts – and on material that had not yet been accessed was repeatedly highlighted as particularly motivating. In addition, it became apparent that a collaborative and low-threshold workflow accessible to a larger group (ideally browser-based) is essential given the amount of data available.

During the course of the project, not only were a total of ten new virtual excursions in the USA and South Africa recorded, but four self- s were also developed based on these, which use gamification elements to convey various topics in language history in an immersive way. On the one hand, these modules can be completed as a stand-alone self- course. They are available for free use via Wikiversity (see Fig. 5 with internet reference [f]). On the other hand, they form the basis for a blended learning seminar, which, in addition to the content focus of the self-study modules, is specifically designed to promote digital and collaborative skills.

Fig. 5: Self-learning courses based on virtual excursions in Wikiversity.

Fig. 6: Virtual excursions at Whitefield House Nazareth, PA USA (Image: Alexander Lasch CC BY 4.0 Int.).

The self-study modules make use of virtual environments by storing content in thematically appropriate locations. The module Introduction to the Moravian Church, for example, is based on the digital twin of a museum in Nazareth, Pennsylvania. The various museum rooms each represent a thematic section in the self-study module. An exhibition room furnished like a prayer hall contains information on the theological foundations of the Moravian

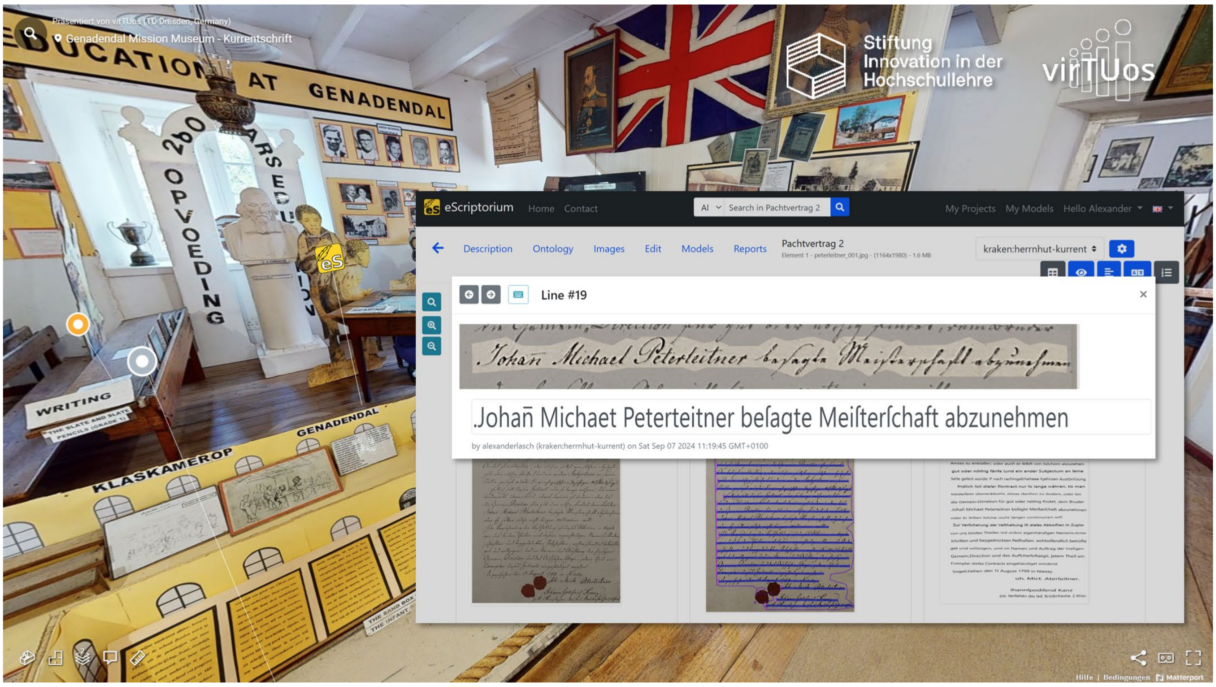


Fig. 7: Self-learning module on German cursive script at the Genadendal Museum, South Africa (illustration: Alexander Lasch CC BY 4.0 Int.).

Church and their linguistic implementation; a room with historical musical instruments is used as a place to explore the interplay of language and music in the Moravian context. This thematic division by room connects content with visual anchors. Furthermore, this approach allows learners to move freely through the building and thus work on topics according to their own interests and in their own chosen order – or simply wonder why Herrnhut stars hang in the museum shop of Whitefield House Nazareth, Pennsylvania (cf. Fig. 6 with internet reference [f]).

The self-learning module on German cursive script in particular also makes use of gamification elements (cf. Fig. 7 with internet reference [f]). The aim of this module is to teach readers how to read the handwriting that was common in German-speaking countries until the beginning of the 20th century.

In addition to introductory audiovisual materials, the self-study module includes exercises of varying degrees of difficulty. Correct answers to more difficult questions unlock access to further exercises. To do this, the link to another virtual room where these are stored is hidden behind a password. The password corresponds to a solution word that must be identified from a historical manuscript. This manuscript originates from the location of the corresponding building, which is unlocked by a correct solution. In this way, the connection between the topic and the location is established.

In the blended learning seminar mentioned above, the self-study modules are used for input phases between face-to-face sessions. The design of this teaching format was based on findings from the DikoLint project with regard to the format of Virtual Collaborative Learning (VCL) (see the article in this volume). For example, the approach of subject-related case studies, which are worked on in student working groups, and the distribution of clear roles such as group leader or secretary were adopted from VCL. Development and analysis projects dealing with the documents digitized in the project context were selected as case studies. Targeted work in groups on a text indexing project brings a number of didactic benefits:

- The practical and methodological skills taught in the self-study modules, such as reading Kurrent script or corpus linguistic analysis of digital text collections, can be tested, deepened, and consolidated in a practical way.

- Working with sources that have not yet been scientifically explored is a highly motivating factor.
- The development of collaborative skills in the areas of organization, task distribution, and project planning through self-directed and research-oriented work promotes critical thinking and practice in problem-solving strategies.

At the end of the project, the project groups develop a creative, digitally supported presentation. This not only gives students the opportunity to understand the projects of the other groups. The development of digital presentation formats also represents another field in which students can develop and further develop their skills. These may include, for example, programming skills, the use of digital presentation tools, or the recording and editing of audiovisual media. Examples include the "Digital Herrnhut Cemetery"[10] and the visualization of Christian Ignatius Latrobe's journey to and through South Africa in 1815 and 1816. [11][12]

The work of the project groups is continuously supervised by tutors. Based on the role of e-tutors in the VCL, they form the interface between students and the teacher. They accompany the group process and are integrated into the communication channels used by the groups for coordination. In this way, they are readily available for questions, help the teacher track the progress of the groups, and can alert the teacher to any difficulties within the groups. In practical testing, the tutors proved to be helpful support for the project groups, keeping the barriers to asking for help low, as students often find it easier to turn to other students with problems in project work than to the teacher.

A central aspect of the project work was the dissemination of the results. Throughout the entire project period, work progress and results were disseminated in a variety of ways to a wider audience beyond the university via . The teaching materials developed are available for reuse as open educational resources via Wikiversity and Twillo. In addition to the virtual excursions and self-learning modules described in detail in the previous section, these also include lectures, instructional videos, and the source code for an exercise page for reading Kurrentschrift.

The activities of DigitalHerrnhut were also documented in the blog of the Moravian Knowledge Network project hub, to which DigitalHerrnhut belongs.[a] In addition to continuous updates, this blog also provides overviews of lectures, publications, and workshops related to the project.

In addition to the digital provision of resources, there was also a strong focus on disseminating project results in a variety of face-to-face events. As already mentioned, the ImagoFolio digitization setup was shared with project partners in South Africa. In addition to academic teaching, the self-learning module German Kurrentschrift was also tested at the St. Afra Landesgymnasium Sankt Afra in Meissen in a group of upper school students.

Fig. 8: DigitalHerrnhut presents project results as part of the SLUB Dresden's Citizens' Academy (photo: Alexander Lasch CC BY 4.0 Int).

Research results as well as developed teaching concepts and modules were also disseminated in various formats in the field of science communication. Particularly noteworthy here are regular lectures as part of the Dresden Senior Citizens' Academy of Science and Art in the Open Science Lab of the SLUB Dresden (see Fig. 8) and the collaboration with citizen scientists. DigitalHerrnhut was also significantly involved in organizing the TU Dresden Campus Classics Rally 2025.[14] This annual event combines a classic car rally with a destination where input on a different topic each year is provided. Together with the Schwesternhäuser Kleinwelka e.V., DigitalHerrnhut 2025 organized such a program in the historic Kleinwelka nurses' home. What was particularly appealing was that this allowed the digitally enriched virtual excursion of this very Schwesternhaus to be linked to the real building, thus enabling a special form of hybrid knowledge transfer to be tested (see Fig. 9).

Fig. 9: Presentation of the project as part of TUD Campus Classics 2025 (photo: Jördis Römer CC BY 4.0 Int.).

4. Project activities

When new approaches are taken with teaching concepts, a detailed evaluation is essential to check which innovations actually promote and facilitate learning processes and at which points the developed concepts need to be refined. In addition, as mentioned at the outset, one of the initial questions for the project was which digital teaching concepts developed during the coronavirus pandemic offer added value as a supplement to face-to-face teaching and where they need to be revised for this purpose. Evaluation was therefore particularly important for the project in two respects. In the DigitalHerrnhut subproject, an evaluation was carried out primarily in two contexts: (1) The participants in the blended learning seminar developed in the project in a university context were surveyed on various aspects of the event using an anonymous questionnaire. (2) As part of the testing of the self-learning module Deutsche Kurrentschrift in schools, the experiences of the participants were also evaluated using a questionnaire. A detailed evaluation of this test run is available in the form of a thesis.[13] The key findings of these evaluation processes are described in separate sections below.

In the course of testing the blended learning seminar developed in the summer semester 2024 and winter semester 2024/25, the extent to which the goals pursued in the design phase could be achieved in practical application was examined. The seminar participants completed a questionnaire that included both predefined questions with answer options on a Likert scale and free text fields.

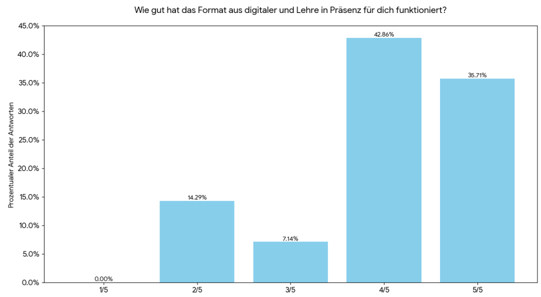


Fig. 10: Results of the question on the quality of the blended learning approach in the seminar (1=very poor; 5=very good).

The overall finding of the evaluation is that the blended learning approach described, which combines elements of face-to-face teaching, self-directed learning, and group collaboration, has proven to be practical and beneficial for academic teaching. More than three-quarters of the 14 participants who completed the questionnaire chose one of the two highest categories on a five-point scale when asked how well this 'format combining digital and face-to-face teaching' had worked for them (see Fig. 10). Various free-text responses also made it clear that the intended motivational effect had been achieved. Both the immersive learning environment and the collaboration in project groups, in which each member is responsible for their own sub-area, were highlighted.

Reading German cursive script is an application skill that was to be taught using one of the self-learning modules developed. In order to test the effectiveness of this module, the seminar participants were asked in the evaluation to assess their competence in this area at the beginning and after completion of the seminar. On a five-point scale, where 1 represents the lowest and 5 the highest possible competence, the average competence at the beginning of the seminar was 1.5. After completing the seminar, participants rated their skills in reading Kurrent at an average of 3.9. The self-learning module's approach, based on immersion, practical exercises, and gamification, has thus proven to be a useful tool for teaching practical skills in an academic context.

Criticism was expressed during the evaluation regarding the clarity of the self-learning modules. Although the virtual environments were perceived as stimulating and motivating, some students found it difficult to orient themselves in the unfamiliar environment and quickly gain an overview of the topics presented. When implementing novel digital teaching formats, a balance must always be found between innovation and accessibility, or this must be ensured in face-to-face formats. While innovation often has a motivating effect and the disadvantages of established teaching formats can be addressed, a certain amount of additional effort is usually required to familiarize oneself with a new format. In this case, the self-study modules were supplemented by additional introductory videos that provided an overview of the virtual excursions and the content they contained, and the self-study phases were structured by face-to-face sessions, which then also had a special relevance: Even though the students appreciated the opportunity for self-directed learning , they also clearly expressed their preference for a significant proportion of (social) face-to-face learning – whether in the regular seminar context or in project group work meetings. Most participants saw self-study modules as a useful addition to the established curriculum, but preferred to work through only a limited portion of the content on their own and to combine these learning phases with learning in direct exchange with teachers and/or other students.

Overall, the evaluation results of the two test runs of the blended learning seminar confirmed that this is a useful concept that expands and complements the possibilities of traditional academic teaching. In addition to motivational factors, it offers the advantage that learners can study at their own pace and set individual priorities. However, it also became clear that digital self-study units should be introduced sufficiently and ideally combined with phases of direct exchange. While courses had to be developed that take place entirely online during the coronavirus pandemic, the targeted, selective use of digital tools appears to be much more promising in the long term. Blended learning represents such a combination of digital and face-to-face learning and has proven to be a promising concept in project work that significantly enriches university teaching.

Fig. 11: Implementation of Renzulli's enrichment phase model in the process of self-directed learning, incorporating the self-learning mode Deutsche Kurrentschrift (German cursive script) (illustration: Friederike Lasch CC BY 4.0 Int.).

In a group of twelve eighth and ninth grade students, the self-learning module Deutsche Kurrentschrift developed in DigitalHerrnhut was tested and evaluated for use in schools. As part of a thesis on "Promoting self-directed learning through the digital self-learning module 'German Kurrentschrift' in talent-promoting teaching" (cf. Fig. 11 and [13]), an evaluation of its implementation in school teaching was carried out using a detailed questionnaire. This focused on the practical application of the tool, the quality of the content taught, and possible areas of application for future learning structures.

A key finding was the high level of motivation among young people working with the self-learning module. Eight out of nine learners said they would like to explore such digital learning environments more often. The virtual excursion in which the module is embedded was highlighted as a stimulating learning environment. Learning Kurrent script as a concrete skill also seemed to offer a greater incentive than purely content-based engagement. This motivating effect was also evident in the fact that individual students proactively inquired about additional practice material. The evaluation also showed that the contextualization of (linguistic) historical topics was successful and aroused lasting interest. Even after completing the self-study module, the students continued to show great interest in delving deeper into the Moravian Church and its topics. In addition, the evaluation also revealed that the usability of the self-study module was rated highly and that the learners had virtually no problems finding their way around the virtual environment on their own. Only the use of the self-learning module on smartphones was described as somewhat problematic – an example of the importance of not losing sight of the learners' hardware requirements in addition to adequate digital teaching materials. With regard to the acquisition of skills, efficient learning of Kurrent script was observed. All students reported that they had significantly improved their ability to read German Kurrent.

Despite the positive results, areas with potential for improvement were also identified. Some students found the clarity of the materials in the self-study modules, especially in the introductory videos, to be too dense and sometimes overwhelming. While it can be said that, on the whole, the self-study module developed for academic teaching could also be used profitably in schools, it is clear that this sometimes requires additional support for young people in order to avoid overwhelming them. In this context, open educational resources, which are not only available for reuse but also for editing, offer a decisive advantage. These enable the transfer of teaching materials designed for a specific context by allowing them to be adapted to a different field of application.

In summary, the results of the evaluation show that digital self-learning modules, such as the one tested for German cursive writing, are promising tools for promoting talent in a school context. They not only promote the acquisition of skills and motivation, but also open up new avenues for individualized, project-oriented, and practical learning, from which students with a particular talent or commitment to a specific subject can benefit in particular. On the one hand, this provided additional opportunities to test and evaluate the teaching materials that had been developed. On the other hand, their use in schools represents a valuable opportunity to disseminate academic content in a broader social context.

However, the two brief surveys presented here indicate, at best, a trend that will need to be supplemented in the future by qualitative evaluations (e.g., guided interviews or focus groups in combination with reliable tests of learning progress).

5. Work in the virTUos project network

The exchange with the other subprojects in virTUos not only had a stimulating effect on the design of DigitalHerrnhut's project activities, but also promoted the adaptation of various concepts and teaching approaches in other virTUos projects. For example, virtual excursions were integrated into the TUTORING hybrid and Praktika Hybrid projects as supplements (see the articles in this volume). Such synergy effects illustrate the added value offered by interdisciplinary collaborative projects such as virTUos. In addition to networking, the exchange across disciplinary boundaries also promotes innovation and the transfer of teaching concepts and methods. With regard to overarching issues that are also relevant to DigitalHerrnhut, the following aspects were identified in collaboration with other subprojects:

- Good cooperation requires a shared interest in a subject and/or the use of specific tools that are examined for their potential in different teaching environments.
- Workshop-style exchange formats are essential, as they allow for open discussion of the potential and limitations of learning environments after testing.
- The heterogeneity of the institutions involved, organizational processes, technical objectives, university teaching requirements, and the resulting materials and tool environments can quickly lead to confusion at each of the levels mentioned. Solidly financed coordination with strategic objectives is helpful, but success also requires the commitment of all those responsible and involved.
- Not being able to work together in person during the first phase of the project was a challenge to which even DigitalHerrnhut did not always have adequate answers. Although collaborative work using digital tools worked well in principle, the lack of physical co-presence was a considerable disadvantage for motivation to work together. The central question that arose for DigitalHerrnhut was: How do we make co-presence valuable?
- Many limitations (i.e., structural, mostly institutional obstacles of a legal or curricular nature) cannot be overcome by technical innovation, motivating classroom design, or

resorting to internationalization. For this reason, the project and consortium identified long-term change processes[h] that lead to innovation in higher education teaching as part of lifelong learning.

6. Conclusion and outlook

As this brief report on the project activities in DigitalHerrnhut clearly shows, the choice of appropriate collaboration and dissemination platforms is ultimately crucial for communication, connectivity, and the reusability of project results. In addition to the virtual excursions, the blog environment *hypotheses* was of particular importance to us, as it not only enabled ongoing documentation throughout the project, but also developed into a publication venue with scientific standards during the project period. It is ideally suited for broad dissemination for research and teaching.

The largely positive experiences gained during the project clearly demonstrate the added value offered by hybrid teaching on the one hand and interdisciplinary collaborative projects on the other. Interdisciplinary, internationally networked work is not only in keeping with the times in a dynamically changing, globalized society—as the project work in virTUos once again showed, it also results in a wide range of synergies and inspiration for the respective subprojects. Furthermore, experiences in such contexts represent an important learning environment that promotes a variety of skills from which students benefit in their professional and personal development.

The concepts and materials developed in DigitalHerrnhut will be reused and further developed within the *Moravian Knowledge Network* project hub. These have already been firmly established in the Master's program *in Digital Humanities* at TU Dresden, and the teaching and digitization cooperation with South Africa will continue beyond the end of the project. This makes it possible to consolidate project results and continue to use the teaching concepts and materials developed, making them accessible to broader target groups.

Literature

[1 Lasch, A & Wolf, M. 2025. Grammarographic scholar networks in transition. In: S. Hartmann, S & Schnee, L (Eds.). Historical Grammar(s). Berlin, Boston, 7–25. DOI: 10.1515/jbgsg-2025-0003

[2 Ruhland, Th. 2017. Between grassroots scholarship and commerce: The Herrnhut South Asia Mission's trade in natural products. In: Förschler, S & Mariss, A (Eds.): Actors, Animals, Things: Approaches to Natural History in the Early Modern Period. Cologne, 29–45. DOI: 10.7788/9783412508678-002.

[3] Hetjens, D, Lasch, A, Schuppe, R C. 2022. DigitalHerrnhut. New approaches to historical linguistics through digitally supported learning environments – a workshop report. In: Meier, J (ed.). Language History and Education. Berlin, Boston, 129–146. DOI: 10.1515/jbgsg-2022-0009.

[4] Assmann, A. 2016. Forms of forgetting. Göttingen.

[5 Hetjens, D et al. 2022. Virtual Excursion Kleinwelka. In: Lessons Learned 2. DOI: 10.25369/ll.v2i1.39.

[6] Lasch, A. 2024. ImagoFolio. A concept for digitization on a small budget without (too many) compromises in quality. MKNetwork. DOI: 10.58079/126g6.

[7] Lasch, A. 2025. ImagoFolioPlus – Practical experience and expanded setup. MKNetwork. DOI: 10.58079/13jgd.

[8] Schuppe, R C. 2025. ImagoFolio introductory video – Getting started with mobile and affordable primary digitization. MKNetwork. DOI: 10.58079/14at6.

[9] Lasch, A. 2025. ImagoFolio put through its paces in practice and in endurance testing – 50,000 pages digitized! MKNetwork. DOI: 10.58079/14hia.

[10] Yakutina, S. 2025. Creating a website with Streamlit using the example of "Digitaler Gottesacker Herrnhut" (Digital Cemetery Herrnhut). Digital Humanities. https://dhgsw.hypotheses.org/390.

[11] MKNetwork Editorial Team. 2025. Journal of a Visit to South Africa – digital. MKNetwork. DOI: 10.58079/1428d.

[12] Hollmann, S. 2025. Missionary movements in the Moravian Church. Visualization of Christian Ignatius Latrobe's journey to South Africa. Dresden University of Technology, (currently still) unpublished master's thesis in the field of digital humanities.

[13] Lasch, F. 2024. How do you learn Kurrent? Promoting self-directed learning through the digital self-learning module "Deutsche Kurrentschrift" in talent-promoting teaching based on Joseph S. Renzulli's Enrichment Triad. University of Münster, unpublished diploma thesis.

[14] Lasch, A. 2025. TU Dresden Campus Classics 2025 in Kleinwelka. MKNetwork. DOI: 10.58079/146fc.

Internet sources

[a MKNetwork blog: dhh.hypotheses.org.

[b] Botany and Mission Blog:botmis.hypotheses.org/ .

[c] Virtual excursion Kleinwelka: my.matterport.com/show/?m=5WpgKHFywvS.

[d] MKNetwork Wikidata: wikidata.org/wiki/Q113620869.

[e] MKNetwork FactGrid: database.factgrid.de/wiki/Item:Q1321521.

[f] Self-study courses Wikiversity:de.m.wikiversity.org/wiki/Kurs:Sprachgeschichte(n)_des_Deutschen._Eine_modulare_Einf%C3%BChrung_auf_Basis_Herrnhuter_Missionsnarrative_im_Kontext_postkolonialer_linguistischer_Studien .

[g] Twillo OER: twillo.de/edu-sharing/components/collections?id=daa873e5-8533-434e-a0fe-c88a5ac1333c.

[h] virTUos prospects: tu-dresden.de/interdisciplinary/virtuos/vision.

Lessons Learned 5, 2 (2025)
Submitted: September 19, 2025
Accepted: December 19, 2025

DOI: https://doi.org/10.25369/ll.v5i2.104
ISSN: 2749-1307

Creative freedom for students as a driver of innovative university teaching – A reflection

L. Kilz*, A. Jantos, M. Krohn, L.M. Langesee

Center for Interdisciplinary Learning and Teaching, TU Dresden, virTUos

Abstract

The *sTUDents* subproject within the framework of *virTUos* tested two formats that involve students as active co-creators: the *digital skills license* and the *creative digital workshop*. In line with the students-as-partners approach, they promote digital and personal skills through self-determined, collaborative, and reflective learning. The results show that creative freedom strengthens motivation and self-efficacy, while clear structures ensure participation. This creates a model for sustainable, student-centered teaching.

Das Teilprojekt *sTUDents* im Rahmen von *virTUos* erprobte mit dem *Führerschein für Digitalkompetenzen* und der *Kreativen Digitalwerkstatt* zwei Formate, die Studierende als aktive Mitgestaltende einbinden. Im Sinne des Students-as-Partners-Ansatzes fördern sie digitale wie personale Kompetenzen durch selbstbestimmtes, kollaboratives und reflexives Lernen. Die Ergebnisse zeigen: Gestaltungsspielräume stärken Motivation und Selbstwirksamkeit, während klare Strukturen Partizipation absichern. Damit entsteht ein Modell für zukunftsfähige, studierendenzentrierte Lehre.

*Corresponding author: lydia.kilz@tu-dresden.de

This article was originally submitted in German.

1. Preliminary remark

Higher education teaching is undergoing change. Increasing digitalization and the rapid development of artificial intelligence not only pose technological challenges, but also fundamentally change how teaching is organized, content is conveyed, and learning processes are designed, thus placing new demands on higher education [1]. At the same time, the expectations and roles of students themselves are changing. The traditional division of roles, with teachers as knowledge mediators and students as passive recipients, is increasingly being questioned [2]. Instead, concepts such as "students as partners" are coming to the fore, which take students seriously as equal partners and actively involve them in the design of teaching formats, curricula, and learning processes [3]. The focus is less on formal participation and more on a cultural shift towards shared responsibility, mutual trust, and co-creative collaboration [4]. This opens up deeper learning processes, increased motivation, and strengthened self-efficacy. As part of the virTUos project funded by the Foundation for Innovation in Higher Education (StIL), the sTUDents subproject created an experimental space to bring these ideas to life. Two formats were designed so that students are not only participants but also co-creators of their learning processes. They implement their own topics, choose methods, try out digital forms of expression, and develop individual and collaborative artifacts. The goal was to design learning spaces that enable resonance, promote digital skills in an authentic way, and strengthen confidence in one's own creative abilities.

Based on these two formats and against the backdrop of digital transformation, which requires new skills, roles, and a changed understanding of learning, this article reflects on the conditions under which student co-creation in teaching can succeed.

2. sTUDents in virTUos

The sTUDents subproject is part of the cross-disciplinary project virTUos (virtual teaching and learning at TU Dresden in an open-source context), which is funded by StIL [5]. The aim of the overall project is not only to implement innovative teaching and learning concepts on a selective basis, but to integrate them strategically into curricula, examination regulations, and university teaching practices. Students are active partners and co-creators in the concrete development of formats. This opening up of university development processes to the student perspective is in line with the fundamental conviction of virTUos. In this context, the sTUDents subproject positions itself with a special focus on student-centeredness and the promotion of digital skills [6]. The aim is to work with students to develop teaching formats in which they not only receive content, but can also actively shape their learning processes. In line with the students-as-partners approach and in close cooperation with student employees, innovative teaching formats were designed, tested, evaluated, and further developed [6]. Student feedback is incorporated into the design of the formats on an ongoing basis, rather than just at the end. Two formats exemplify the student co-design process in sTUDents:

1. The *Digital Competence License* [7] is a certificate course that supports students in systematically developing their digital skills.
2. The *Creative Digital Workshop* is a semester-long course in which students translate their own topics and interests into creative digital formats.

The following describes how participatory learning spaces were designed using the two formats and how these contributed to strengthening students' digital self-competence, collaborative skills, and confidence in their own creative abilities.

3. Examples of successful student participation based on the digital skills license and the creative digital workshop

The digital skills license was designed as a certificate course in the sTUDents subproject to strengthen students' digital competence. It is based on the European reference framework DigComp 2.2 [8] and pursues a deliberately student-centered approach. A detailed description of the didactic concept and evaluation has already been published elsewhere [7];

the course will therefore be considered from a higher-level perspective below in order to later highlight the influence of student co-design and participation within the framework of virTUos.

The course did not focus purely on teaching digital tools, but rather on actively, self-directed, and collaborative engagement with digital challenges in studies, everyday life, and work. It was based on a realistic case study in which students in interdisciplinary groups took on the role of experts advising a fictional university on the digital transformation process [7]. The course consisted of six tasks that built on each other. Beginning with the joint structuring of the group work, the students worked step by step on various aspects of digital transformation and developed digital solutions within the case study, for example in the form of texts, podcasts, infographics, or videos [7]. The course was didactically anchored in the concept of virtual collaborative learning, which combines problem-based learning with digital, interdisciplinary group work [9;10;11]. Throughout the course, students reflected on their group processes, used synchronous and asynchronous collaboration tools (e.g., MS Teams), and documented their learning progress on a shared platform [7]. The accompanying evaluation, consisting of self-assessments and focus group interviews, showed that participants not only expanded their digital skills but also developed key interdisciplinary skills [7].

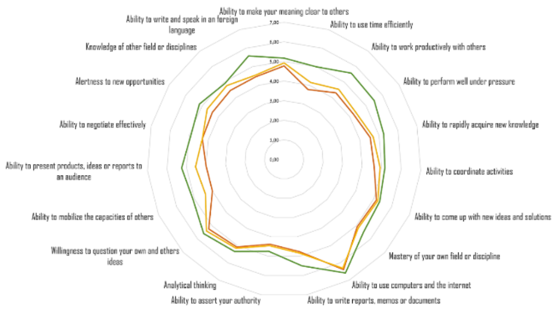


Fig. 1: Increase in self-assessed skills [7]

Figure 1 illustrates the self-assessments of the course participants' skills before (red), during (yellow), and after (green) course participation and shows a significant increase in self-assessed skills at the end of the course [7]. Collaborative skills, communication skills, self-organization, and critical thinking were promoted in the virtual group work, as was sensitivity to cultural differences and diversity of perspectives. From a meta-perspective, these results illustrate above all the impact of student participation. The active involvement of students in learning and problem-solving processes not only promoted competence gains, but also a changed understanding of roles [7]. The course thus demonstrates how digital teaching within the framework of virTUos could be transformed not only technologically, but above all didactically.

The *Creative Digital Workshop* offered students the opportunity to work on their own topics and interests in creative digital projects. The format followed a student-centered, competence-oriented approach that combined elements of project- and problem-based learning with collaborative work phases, reflective loops, and continuous feedback. The focus was not only on the result in the form of a digital artifact, but above all on the path to achieving it through a self-determined, collaborative learning process in which the participants developed content, formats, and working methods largely independently and in a self- . Teachers took on the role of learning facilitators, structuring the process through clear tasks and transparent objectives and providing support through methodological input and individual, formative feedback without dominating the learning process. Examples of the artifacts created by the student groups included a self-produced short film that addressed society's obsession with self-optimization and reflected on its psychological consequences, a travel blog that linked personal experiences with analytical perspectives on mobility, culture, and belonging, an Instagram project that used interactive film quizzes to encourage active engagement with film culture, and a podcast that critically examined the phenomenon of media addiction.

An adapted content analysis of the students' reflections showed how effectively this learning architecture impacted the development of key academic and digital skills. Students reported a significant increase in self-organization, creativity, and technical implementation skills, as well as a deeper understanding of content and design contexts. The opportunity to make independent decisions, for example about content, tools, and the distribution of roles within the team, was consistently experienced as motivating and empowering. Students particularly emphasized that the openness of the format allowed them to try things out, take on new perspectives, and identify with their own learning product. This creative freedom not only led to high intrinsic motivation, but also to an emotional attachment to their own project. The students saw their products not merely as coursework, but as an expression of their own engagement with a topic that was meaningful to them. Reflection quotes showed that pride, responsibility, and the desire for quality were central experiences in the course of the project, regardless of assessment or grading. Digital self-efficacy was also strengthened. The students gained confidence in familiarizing themselves with new tools, preparing digital content in a way that was appropriate for the target audience, and overcoming challenges together, even if not everything worked right away. Difficulties were recognized and accepted as learning moments, which not only strengthened their ability to deal with digital uncertainties, but also promoted their ability to reflect on the learning process as a whole. Last but not least, the feedback showed that structuring elements such as clear tasks, small groups, continuous feedback, and transparent communication contributed significantly to ensuring that openness did not turn into excessive demands. Overall, the Creative Digital Workshop illustrated how participatory teaching can succeed in digital contexts, namely through genuine opportunities for co-creation, guided autonomy, and a didactic design that focused on relationships, responsibility, and expressiveness.

4. Lessons learned: A reflection

For us, the sTUDents subproject within the framework of virTUos was more than just a test of new teaching formats; it was a practical laboratory for exploring what university teaching can look like when students are not just participants but active co-creators. The experiences gained from the Digital Competence Driving License and Creative Digital Workshop formats have yielded key insights that go beyond the respective courses and which we understand as lessons learned for participatory, future-oriented university teaching.

1. <u>Creative freedom is the key to genuine participation</u>

When students are given the opportunity to choose content, methods, media, and forms of expression themselves, they not only develop creativity, but also a sense of responsibility and commitment. Both formats showed that when students were able to decide what they wanted to learn and how, they identified more strongly with the learning process and regarded the resulting product as "their own." , the opportunity to help shape learning paths was described by many as empowering, motivating, and meaningful. Creative freedom activates a sense of responsibility, which is a key factor for sustainable learning. However, these processes only succeed if they are not isolated but conceived as a didactic principle and continuously supported.

2. <u>The Students-as-Partners approach changes not only the role of students, but also the role of teachers</u>

Participatory teaching requires a fundamental change in perspective. Those who view students as partners shift the focus from imparting knowledge to joint creation. This also means that teachers must take a step back, relinquish control, and assume a moderating, supportive role. This change in role is challenging and requires trust, flexibility, and a willingness to question one's own routines. At the same time, it opens up new forms of didactic relationships. Teaching becomes a dialogue, a co-construction in which students are taken seriously as experts in their own perspectives. The Digital Competence Driving License in particular showed how productively student co-development influenced the course.

3. <u>Participation and openness need structures</u>

Open learning formats can quickly become overwhelming if guidance and support are lacking. What is intended as freedom can create uncertainty if students do not know what to hold on to. In both formats, we have learned that freedom only becomes effective when it is framed by clarity. Clear tasks, regular feedback, transparent expectations, and tangible examples help to make constructive use of the open space. This structure is not a contradiction to participation, but rather its prerequisite. Participatory formats need didactic design that leaves room for maneuver but also provides support.

4. <u>Digital and personal skills grow together</u>

In dealing with digital tools, formats, and media design, the students developed not only technical skills but also interdisciplinary competencies such as communication, teamwork, time management, reflection, and critical thinking. It became particularly clear how closely digital self-efficacy is linked to the experience of meaning, autonomy, and social support. Difficulties were not experienced as failure, but as part of an active, self-directed learning process, which strengthened resilience and confidence in one's own ability to learn.

5. <u>Reflection is the key to conscious learning</u>

A central component of both formats was the accompanying reflection on content, collaboration, decisions, conflicts, and learning paths. These reflection phases turned the experience into learning. The students not only dealt with the "what" but also with the "how" and "why" of their project, thereby developing metacognitive skills that extend far beyond the concrete artifact. Reflection not only strengthens learning in the moment, but also the applicability of what has been learned to future contexts, as well as in studies, work, and the digital space.

5. Conclusion

Our experience shows that when we enable students to truly participate in the design process, the result is not only better teaching, but also relevant, resonant, effective education. Formats such as those tested in the sTUDents subproject require courage, didactic openness, and structural support. But they are worthwhile because they show what is possible when students are not thought of as recipients but as partners and are taken seriously. It was only through the resources and freedom provided by virTUos that it became possible to really test these spaces, reflect on them, and develop them further together with students. This enabled us not only to design innovative learning formats, but also to make a concrete contribution to strengthening student-centered teaching at TU Dresden. The question is therefore no longer whether participation is possible, but how we can make it possible. And whether we are prepared to rethink university teaching in such a way that student participation is no longer considered an exception, but a fundamental principle of sustainable education.

Literature

[1] Schmohl, Tobias, Watanabe, Alice, and Schelling, Kathrin. Artificial Intelligence in Higher Education: Opportunities and Limitations of AI-Supported Learning and Teaching. An introduction to the contributions in this volume. Bielefeld: transcript Verlag, 2023.

[2] Schwinger, Doreen, Markgraf, Daniel, and Blumentritt, Marianne. The understanding of roles among teachers and students in digital distance learning. die hochschullehre. Interdisciplinary journal for study and teaching. 2022.

[3] Weimann-Sandig, Nina. Students as partners – a holistic teaching and organizational development concept. Dresden: s.n., 2023. pp. 37–41.

[4] Cook-Sather, A., Bovill, C., and Felten, P. Engaging students as partners in learning and teaching (2): practical guidance for academic staff and academic developers. 2014.

[5] virTUos. virTUos. [Online] 2025. https://tu-dresden.de/bereichsuebergreifendes/virtuos.

[6] virTUos. sTUDents. virTUos. [Online] 2025. https://tu-dresden.de/bereichsuebergreifendes/virtuos/einzelvorhaben/students.

[7] Jantos, A., Kilz, L., and Krohn, M. "Driver's license for digital skills": Presentation and evaluation of an interdisciplinary virtual collaborative learning program. s.l. : Journal for Higher Education Development, 2024, pp. 159-180.

[8] Vuorikari, R., Kluzer, S., & Punie, Y. DigComp 2.2: The Digital Competence Framework for Citizens – With new examples of knowledge, skills, and attitudes. Publications Office of the European Union. [Online] 2022.

[9] Altmann, M., et al. Design Dimensions of Virtual Collaborative Learning - Synthesizing Iterative Research. [Ed.] Thomas Köhler. Handbook of E-Learning. 2024.

[10] Jantos, A. Blended Assessment Strategy for Virtual Collaborative Learning in Higher Education. 2024a. Prüfung hoch III.

[11] Jantos, A. Didactical Design Pattern – Case Study Design for Virtual Collaborative Learning to Foster the Acquisition of Digital Competences. INTED24 – 18th annual International Technology, Education and Development. 2024b, pp. 5553-5562.

Lessons Learned 5, 2 (2025)
Submitted: October 1, 2025
Accepted: December 19, 2025

DOI: https://doi.org/10.25369/ll.v5i2.108
ISSN: 2749-1307

HybParc: Digitally supported, practice-oriented teaching and learning formats

M.-C. Willemer[1+*] , E. Bibrack[1+] , C. Perge[1] , H. Hoffmann[1, 2] , D. Pretze[3] , C. Stransky[1] , E. Lohr[1] , K. Petr[1] , F. Mauersberger[1] , I. Röder[3,4]

[1] *Dresden University of Technology, Carl Gustav Carus Faculty of Medicine, Institute of Medical Education, Medical Interprofessional Training Center (MITZ), Dresden, Germany*
[2] *National Center for Tumor Diseases (NCT), NCT/UCC Dresden, a partnership between the DKFZ, the Faculty of Medicine and University Hospital Carl Gustav Carus, Dresden University of Technology (TUD), and the Helmholtz Center Dresden-Rossendorf (HZDR), Germany.*
[3] *Dresden University of Technology, Carl Gustav Carus Faculty of Medicine, Institute of Medical Education, Dresden, Germany*
[4] *Dresden University of Technology, Carl Gustav Carus Faculty of Medicine, Institute for Medical Informatics and Biometry (IMB), Dresden, Germany*
[+] *shared first authorship*

Abstract

The HybParc project develops digitally supported, practice-oriented teaching formats for medical education. Its aim is to provide flexible, safe, and repeatable training environments that foster clinical skills. Key didactic principles include blended learning, self-directed learn-ing, and immediate feedback. Implemented self-learning units include a sensor-based 12-channel ECG, Basic Life Support with CorPatch®, and surgical suturing with AI-supported analysis. In addition, virtual reality (VR) scenarios allow complex procedures to be practiced safely. Automated feedback summaries support reflection and self-regulated learning. Eval-uations show high acceptance, particularly for sensor-based feedback and VR. Learners value immediate feedback and independent practice. Limitations include technical instability, lack of haptic feedback, and high demands on didactic integration. Published as Open Education-al Resources (OER), the materials are sustainably reusable.

Das Projekt HybParc entwickelt digital gestützte, praxisnahe Lehrformate für die medizini-sche Ausbildung. Ziel sind flexible, sichere und wiederholbare Trainingsumgebungen zur Förderung klinischer Kompetenzen. Didaktische Schwerpunkte liegen auf Blended Learning, selbstgesteuertem Lernen und unmittelbarem Feedback. Umgesetzt wurden Selbstlernein-heiten wie ein sensorbasiertes 12-Kanal-EKG, Basic Life Support mit CorPatch® sowie chirur-gische Nahttechniken mit KI-gestützter Analyse. Ergänzend ermöglichen Virtual-Reality-(VR)-Szenarien das risikofreie Training komplexer Tätigkeiten. Automatisierte Feedbackzusam-menfassungen unterstützen Reflexion und Selbststeuerung. Evaluationen zeigen eine hohe Akzeptanz, insbesondere für sensorbasiertes Feedback und VR. Geschätzt werden unmittel-bare Rückmeldungen und eigenständiges Üben. Einschränkungen bestehen durch techni-sche Instabilität, fehlendes haptisches Feedback und hohen didaktischen Integrationsauf-wand. Als Open Educational Resources (OER) veröffentlicht, sind die Materialien nachhaltig nutzbar.

*Corresponding author: marie-christin.willemer@tu-dresden.de This article was originally submitted in German.

1. Background

Heterogeneous student groups, which are particularly common in medical studies, require learning formats that take into account different levels of prior knowledge, learning styles, and learning requirements, and offer all students equal opportunities for competence development. Digital and hybrid formats create a flexible, personalized, and student-centered learning environment that enables independent knowledge acquisition and consolidation [1]. Self-directed learning describes an intentional learning process in which learners take responsibility for setting goals, planning, implementing, and evaluating their learning [2]. The integration of self-study phases and attendance training, as well as the use of digital tools for reflection and feedback, promotes needs-based learning and strengthens personal responsibility. In addition, digital learning opportunities contribute significantly to the development of digital skills, which are now considered a mandatory learning objective and a central prerequisite for future professional practice [3].

Self-directed learning is increasingly coming into focus and is understood as a complex cycle that encompasses psychological characteristics (e.g., self-efficacy, motivation), personal decisions (e.g., effort, learning strategies), assessments (e.g., self-assessment, attributions), and actions (e.g., goal setting, adjustments). Educational psychology recommendations emphasize the need for the systematic integration of such learning processes into curricula, accompanied by continuous support and feedback [4].

The German Council of Science and Humanities also highlights the central role of guided self-study as a sustainable teaching and learning format. This is closely linked to self-directed learning, which is described as a process in which learners take the initiative to identify their learning needs, formulate goals, tap into resources, select strategies, and evaluate their results [5]. Digital media offer a wide range of methodological options to support these steps. It is crucial that elements that enable and promote self-direction are specifically incorporated into the design of self-directed teaching units [2].

Feedback is a key element in this process: it enables continuous reflection on learning progress, the identification of learning gaps, and targeted improvements, which significantly increases the quality of the learning process. John Hattie emphasizes that learning is particularly effective when learners are supported in becoming "their own teachers" – by acting more independently, reflecting, finding their own learning paths, and critically evaluating their results [6].

In the context of the Medical Interprofessional Training Center (MITZ), self-directed learning has so far been implemented through self-monitoring, checklists, peer feedback, and self-assessment of practical skills [7]. Recent studies show that hybrid self-learning training courses with digital feedback systems can provide targeted support to students in their individual learning processes [8]. Building on this, further training courses are being developed that integrate digital feedback systems even more intensively to ensure continuous individual support.

Digital technologies such as video recordings, sensors, and automated analysis methods open up additional opportunities to evaluate practical skills in a standardized and objective manner. Virtual reality (VR) can also create immersive learning environments for rare or sensitive scenarios and train both operational skills and non-technical skills such as communication and clinical decision-making [9, 10]. Automated and integrated feedback—whether through software, peer reflection, or self-reflection—provides targeted support for learning processes and makes progress transparent.

On this basis, the article outlines the approaches developed in the project for designing hybrid, interactive self-learning, training, and examination courses in a medical context. The focus was on the HybParc internship and assessment format, which aimed to teach clinical practical skills more efficiently. Video recordings, sensors, and (partially) automated analyses of action sequences were used for this purpose. Conversational agents provided automated feedback, while VR offered immersive learning environments as a complementary tool. HybParc was tested at the

Carus Teaching Center (CarL) in collaboration with the MITZ of the Carl Gustav Carus Faculty of Medicine (MFD) in order to integrate hybrid, interactive courses into practical studies and training and to enrich medical education and related disciplines in the long term.

2. Project development

As part of the overall project, various innovative teaching and learning methods were developed, tested, and partially evaluated. The aim was to provide medical students with practical, safe, and repeatable learning environments that promoted both practical skills and communication skills. The approaches ranged from sensor-based self-learning units and VR scenarios to automated feedback systems for communication-related exercises. All subprojects followed a didactic guiding principle that combined blended learning, self-directed learning, and immediate feedback to sustainably strengthen learners' practical skills.

Self-learning unit: Applying a 12-channel-ECG

One focus of the project was the development of a self-learning unit for applying a 12-channel electrocardiogram (ECG) with a sensor-based feedback system. The aim was to provide learners with a teaching-independent learning opportunity that combined theoretical basics with practical application and supported self-directed learning through immediate feedback [11].

The unit followed a blended learning approach: in the online phase via Moodle, participants were familiarized with the theoretical basics, worked on orientation tasks, and watched an instructional video demonstrating the correct electrode placement. In the attendance phase at MITZ, students practiced electrode placement on a simulation dummy and received feedback through the sensor-based feedback system. Structured checklists for peer feedback were also used, creating a flexible and practical learning format that combined digital innovation with classic teaching methods.

The technical setup included a training dummy with adhesive electrodes, a PC with a monitor, and two RGBD cameras that captured both the thorax area and the extremities. The cameras delivered image data to specially developed software that recorded the positions of the electrodes, compared them with target positions, and visualized the results on a user interface. Incorrect placements were displayed immediately, including brief notes on correct positioning, so that learners could directly recognize, reflect on, and correct their mistakes.

Fig. 1: Setup for applying a 12-channel ECG

Development took place iteratively in two rounds: First, an Artificial intelligence (AI)-based approach (YOLO) was implemented that recognized electrodes using annotated image data and compared them with target positions [12]. Despite multi-stage training, this approach was not sufficiently reliable, especially when it came to position and identity recognition of the electrodes. In addition, it was not always clear to users whether an electrode was incorrectly positioned or simply not recognized.

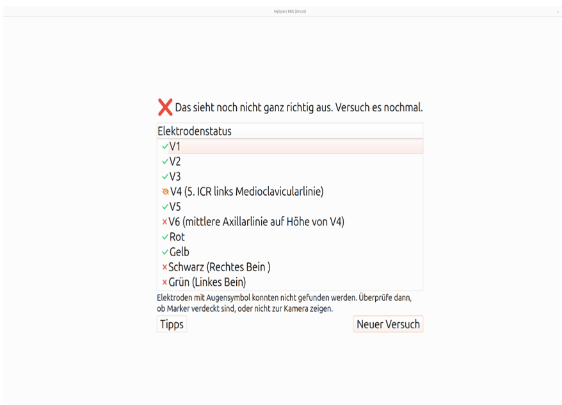


Fig. 2: Feedback on the placement of the 12-channel ECG on the user interface.

Based on these experiences, a marker-based algorithmic method was developed. Aruco markers on the manikin and electrodes enabled robust and precise detection. High-resolution cameras improved image quality, allowing the marker size to be reduced. A revised user interface visualized the results in a more transparent and understandable way, and an assistant checked the camera position at startup to avoid incorrect measurements. The "ArucoRoi" configuration tool allowed target ranges to be flexibly adjusted, which facilitated transfer to other setups.

This iterative development process resulted in a practical, robust, and transparent feedback system that combined theory, practical application, and immediate feedback, supporting learners in their professional competence.

Self-learning unit Basic Life Support

Another aspect of the project was the development of a self-learning unit on Basic Life Support (BLS). Unlike the ECG project, this unit made use of an existing device, the CorPatch®. This system enabled real-time analysis of resuscitation performance and provided audiovisual feedback, for example on the compression frequency and pressure depth of chest compressions, as well as a detailed evaluation after completion of the exercise.

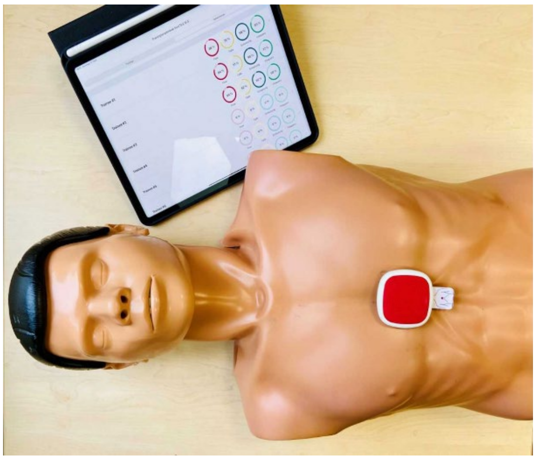


Fig. 3: CorPatch® system on the Basic Life Support dummy

The didactic structure was based on a blended learning approach: after an online phase in which theoretical basics were taught, participants practiced resuscitation skills independently in the attendance phase. The CorPatch® served as a central feedback tool, allowing learners to independently check and improve their performance.

Self-learning unit on surgical suturing techniques

Another aspect is the development of a self-learning unit on surgical suturing techniques in a blended learning format. At the end of the project, the technical setup was still in the development phase: an overhead GoPro camera continuously recorded the work area and transmitted the image data to specially developed software. The students practiced on a suture pad (vinyl/EVA) with a prepared incision using standardized suture material.

Fig. 4: Setup for surgical suturing techniques.

The software evaluated the suturing performance using AI based on image sequences that analyzed the entire suture as a video [13]. The result was reported back directly via the user interface in three assessment levels ("good," "average," "poor"). The interface also showed the current recording status and a countdown for the processing time, which reduced the mental load and increased clarity. In the future, this could lead to the creation of another self-learning unit that could be embedded in the overall didactic pattern of the project and use digital feedback systems for standardized, independent training.

VR post-mortem examination

In addition to sensor-based self-learning units, VR-based approaches were also developed. The aim was to depict complex clinical scenarios in a practical manner and offer students a safe, repeatable learning environment.

Fig. 5: Processing the VR post-mortem examination scenario with VR glasses

Medical post-mortem examination required a combination of medical, legal, and organizational knowledge [14]. Since all medical personnel must master this skill and realistic simulations are very resource-intensive, VR training was transferred from the Dorothea Erxleben Learning Center in Halle to Dresden [15]. Halle provided the technical infrastructure, while the Dresden Faculty of Medicine took care of the didactic design, adaptation, and implementation.

The VR training followed the principle of the flipped classroom: students prepared online and then went through the scenario in small groups with tutors at the MITZ. They encountered a virtual deceased person, examined postmortem changes, integrated the apartment and personal belongings into the case study, determined the time of death, filled out the death certificate, and received individual feedback. The scenario was optimized during the project period: simplified user guidance, integration of input masks, two new cases, and a controller tutorial. In the future, the VR cases could also be offered as self-learning units.

The effectiveness of VR training was examined in a randomized teaching-learning study [16]. Students from the 5th semester onwards were first tested and then assigned to either the intervention group (VR) or the control group (simulation dummy), which used the previously established teaching methods [17]. The aim of the study was to evaluate the increase in knowledge and the effectiveness of the teaching methods used. Recruitment ran until the winter semester 2025/26; the results were then to be published.

VR operating theatre scenario

To expand the digital teaching offerings, a VR scenario based on 360° images was developed at MITZ [18] that depicts the operating theatre. The aim was to give students a practical introduction to the procedures and roles in the surgical team before teaching them complex surgical techniques. Students had repeatedly expressed the need for practice-oriented training in a safe environment.

Fig. 6: Excerpt from the VR application in the operating theatre scenario

In the VR operating theatre scenario, learners were able to explore the basics of the operating theatre on their own: roles in the team, the layout of the operating theatre, and key hygiene measures such as hand disinfection. The training was supported by short videos and explanatory texts demonstrating the correct procedure for hand hygiene [19]. In this way, the scenario taught the basic procedures in the operating theatre without delving into complex surgical techniques. Learners were able to familiarize themselves with the spatial and organizational structure of the operating theatre as often as they liked and understand the interaction between the roles [18]. The application could be used independently and did not require direct instruction from tutors. It could therefore be used as a self-learning unit to support attendance teaching.

The scenario was developed in Unity and could be played on Meta Quest VR hardware.

It was based on our own videos, photos, and 360° images produced with the Insta360 X3. In a requirements analysis, Unity was selected over 3DVista and PaneoVR based on its range of functions, documentation, development time, VR compatibility, and Open Educational Resource (OER) capability.

The didactic design took several key design decisions into account:

- 360° photographs enabled an immersive experience while also being efficient to implement and easily transferable to other scenarios [20, 21].
- Navigation via predefined views reduced motion sickness and increased user-friendliness [22].
- Physical presence at the location (only head and eye movement) facilitated participation even for people with limited mobility and reduced the risk of accidents.
- Screen-space panels ensured constant readability of information, regardless of the direction of gaze.
- Haptic and auditory feedback in button interactions enhanced the perception of virtual interfaces [23].

The scenario began with an introduction to controller operation. Then, , the students went through the induction process, interacted with informative hotspots, and then entered the virtual operating theatre. There, they were able to explore aspects such as the roles in the operating theatre, the correct way to dress, and the various devices in the operating theatre at their own pace. The task took about 30 minutes, making the scenario well suited as a stand-alone self-learning unit.

Automated feedback summaries

Another subproject was in the testing phase at the end of the project and was dedicated to the automated support of feedback rounds after curricular learning units with communicative learning objectives – for example, conducting conversations in a medical context with simulation persons. The aim was to automatically transcribe the feedback session and provide participants individually in the form of summaries. After evaluating existing tools in terms of usability, speech recognition accuracy, speaker tagging, AI compatibility, and data protection, a suitable system was selected. In a simulated feedback session with eight people, requirements for piloting and potential evaluation metrics were tested.

3. Evaluation results and outcome

At the end of the project, no direct evaluation results were available for some subprojects within HybParc, as these were currently in a development and testing phase. The evaluation items varied depending on the subproject, but always included key aspects such as didactic design, acceptance, technical implementation, usability, and the subjectively perceived learning effect.

Self-learning unit: Applying a 12-channel-ECG

Within the framework of the project, all fully developed self-learning units and VR scenarios were successfully piloted and evaluated. The self-learning unit on applying a 12-channel ECG was initially tested in the summer semester of 2023 with twelve participants, consisting of medical students and trainees studying to become medical assistants. The evaluation showed a high level of acceptance of the concept, while technical weaknesses, particularly in the stability of electrode detection and color recognition, made error-free feedback difficult. The theoretical preparation was rated with an average of 1.5 (s=0.7), the content implementation with 1.6 (s=0.5), the technical implementation with 1.9 (s=0.5), and the overall grade was 1.3 (s=0.5).

The unit was offered again in the summer semester of 2024 and in the period from April to July 2025. The revised prototype showed progress but was not stable in all cases. Supplementary feedback methods such as structured checklists and peer feedback ensured that, despite technical limitations, a didactically effective learning effect was achieved. The evaluation of 16 participants resulted in an overall grade of 1.9 (s=0.9). After the unit, all participants felt able to write a 12-channel ECG independently, and 81% would recommend the unit to others. Suggestions for improvement included pathological ECG and extended detection limits.

Self-learning unit Basic Life Support

The self-learning unit on BLS was piloted in February and March 2025 with eleven participants. The CorPatch® system was used, which provided real-time feedback on frequency and pressure depth during chest compressions and then provided a detailed evaluation. All participants got along well with the system, rated the instructions as helpful, and appreciated the real-time feedback as valuable support for improving their technique.

The implementation showed that the model developed for self-learning units could be flexibly applied to different content: While the ECG project involved a technically complex inhouse development project, with BLS an existing system can be meaningfully embedded in a didactic structure.

VR post-mortem examination

The VR post-mortem examination was tested at MITZ with 73 students, 63 of whom completed a full evaluation (15). 93.1% of students reported that their confidence in performing medical post-mortem examinations had increased, and 96.8% felt more confident in completing death certificates. At the same time, 91.6% emphasized that VR training could not replace the necessary tactile feedback of real corpses. The scenario was expanded to include a self-directed learning unit that allows students to perform the individual steps independently, determine their own learning pace, and repeat content as often as they like. In the comparative study on VR post-mortem examination, which has been running since 2023 and examines the learning effect of the VR method compared to the established simulation dummy, interim results showed an increase in knowledge in both teaching formats. The advantages of the VR method lay in its interactive design and realistic perception, while limitations arose from a lack of haptic feedback and occasional technical operating problems. Self-assessments of practical skills showed that after the course, students were significantly more confident in the practical performance of post-mortem examinations and in filling out death certificates. Recruitment ran until the winter semester 25/26 and was not yet complete at the time of writing. Subsequently, statements could be made about its effectiveness compared to the traditional method.

VR operating theatre scenario

The VR-OP scenario was piloted as part of the PJ warm-up course with twelve students in their 10th–11th semester, of whom eleven provided complete feedback. The overall impression was consistently positive: seven students rated the scenario as "very good" and four as "good." The usefulness and acceptance of VR in their studies was rated as very high by the majority, and the participants reported that it was a lot of fun. Side effects occurred only in isolated cases. The feedback particularly highlighted the realistic representation of the operating theatre and the attention to detail. The technical design allowed for easy transfer to other departments, and the scenario could be used for both medical students and trainees to become surgical and anesthesia technicians. All materials, including how-to instructions, are available as OER on Twillo.

Handouts and OER

As part of the project development, instructions for using the systems were created for students and teachers. These include step-by-step instructions for preparing, setting up, operating, and maintaining the systems, including information on technical configuration and the use of mobile connections. The materials are designed to be practical in order to support teachers and students in using them independently. All instructions are available on the OER platform Twillo and can be freely accessed, downloaded, and adapted for your own teaching.

Fig. 7: QR code for the Twillo collection HybParc (https://www.twillo.de/edu-sharing/components/collections?id=b958881c-5d8a-4d38-beb4-4b237daa58f4&scope=EDU_ALL)

Conference contributions and publications

The use of sensor-based feedback was first presented at the 2024 annual conference of the Society for Medical Education (GMA) in Fribourg, where initial results were presented on the use of video recordings and sensor data in learning of applying a 12-channel ECG [24]. This was followed in 2025 by the presentation of the CorPatch® system for supporting resuscitation training at the 19th International SkillsLab Symposium in Munich [25].

At the same time, the use of VR in medical education was intensified. As early as March 2022, the VR Working Group was founded within the GMA Committee on "Digitization – Technology-Supported Learning and Teaching." Initial results were presented in 2023 at the 17th International SkillsLab Symposium in Cologne [26] and published in the same year [15].

At the 2023 GMA Annual Conference in Osnabrück, the focus was on immersive VR projects and didactic application scenarios [27, 28] , while in 2024 in Fribourg, issues of cross-location evaluation were discussed [29].

Networking within the VR Working Group proved to be an important driver for technical and didactic developments. Through exchanges between different locations, technical solutions and didactic concepts could be jointly tested, reflected upon, and further developed. In addition to questions concerning the immediate use of VR, aspects of implementation, evaluation, and sustainability also came into focus. This resulted in practical recommendations that can be applied not only to VR, but also to other digital teaching and examination formats. In addition, the work led to broad dissemination via conferences, publications, and specialist networks, making the results visible and usable for medical education in various specialist areas.

4. Discussion

The evaluations had some limitations: there were several evaluations on different topics, which were sometimes heterogeneous within the topics and did not always contain the same questions, making direct comparison difficult. The samples were limited, participation was voluntary, and the feedback could have been influenced by positive expectations of the innovative teaching methods.

Proven and less proven

The introduction of sensor-based feedback systems has proven to be particularly effective. Learners benefit from immediate, objective feedback that supports reflection and error correction and strengthens personal responsibility in the learning process. This is in line with current best practices, which emphasize the active involvement of learners and the promotion of self-directed learning as key success factors for digital teaching formats. However, the project results show that the successful use of complex technologies—such as sensor-based feedback or VR—requires a well-thought-out didactic concept, extensive testing phases, and specific personnel expertise. Only the interplay of concept, technology, and didactic expertise makes digital tools a valuable building block in teaching [30]. This finding is consistent with the experiences from cross-faculty cooperation projects, in which integration into curricula and collaboration between different disciplines are considered key factors [31].

The publication of the self-study units as open OER has enabled connectivity beyond the local context. This promotes the sustainable digitization of practice-oriented teaching and learning formats and facilitates implementation or further development by other institutions. The transfer of the VR post-mortem examination scenario to other locations demonstrates the potential for interdisciplinary dissemination and sustainable use [15].

The project results show that the threshold for the integration of digital teaching formats by other institutions should be kept as low as possible in order to enable broad dissemination and sustainable use. This is in line with the recommendations for sustainable OER strategies [32].

The VR post-mortem examination and VR operating theatre scenarios were perceived by students as offering clear added value. They enable risk-free, structured training in complex medical activities and offer the opportunity to learn about procedures and roles in the operating theatre without burdening patients or resources. Despite this, VR scenarios cannot completely replace practical experience with real corpse or in the operating theatre. In particular, the lack of tactile and olfactory feedback remains a key limitation that must be compensated for by accompanying practical exercises.

Furthermore, the use of existing structures and the combination of automated setup, AI-based evaluation, and a user-friendly interface significantly reduced the amount of work required for surgical suturing techniques. This offers an efficient solution for medical training and is transferable to other contexts. The possible applications of AI in medical education are currently still limited, as high quality standards and regulatory requirements (e.g., data protection, exam formats) must be met. The development of reliable, fair, and legally compliant AI systems remains a challenge [33].

5. Conclusion

Overall, the subprojects show that digital and AI-supported teaching formats and VR scenarios have the potential to make medical education more practical, flexible, and sustainable. In particular, immediate feedback from sensor-based systems, the use of OER for sustainable dissemination, and the practical simulation of complex activities through VR have proven successful. The greatest challenges are the didactic and technical complexity of integration and the associated close interdisciplinary cooperation, as well as the limited transferability of virtual experiences to reality. The project results provide valuable impetus for the further development of digital teaching formats and their sustainable anchoring in medical education.

Acknowledgements

We would like to thank our former employees Katja Krumm, Tom Maurice Schreiber, and Charlotte Daub, who contributed significantly to the success of the project through their reliable support, commitment, and valuable contributions.

Literature

[1] Röhle A, Bibrack E. Digital and hybrid teaching in medical education using the example of the Medical Interprofessional Training Center MITZ: Impulses and development potential. LL 2022; 2(1). DOI: 10.25369/ll.v2i1.45

[2] Dyrna J, Riedel J, Schulze-Achatz S, Köhler T. Self-directed learning in continuing vocational education and training. A handbook for theory and practice. Waxmann Verlag GmbH; 2021. DOI: 10.31244/9783830993643

[3] Medical Faculty Association. National Competence-Based Learning Objectives Catalog for Medicine: Version 2.0. Berlin; 2021. Available from: URL: https://nklm.de/menu [cited 2025 Sep 15].

Swanwick T. Understanding Medical Education. Wiley; 2013. DOI: 10.1002/9781118472361

[5] German Science and Humanities Council. Recommendations for a sustainable design of studies and teaching; 2022. DOI: 10.57674/q1f4-g978

[6] Brägger G, Rolff H-G, editors. Handbook of Learning with Digital Media. Weinheim, Basel: Beltz; 2021. (Pedagogy). ISBN: 9783407831965

[7] Willemer M-C, Bibrack E. Development and implementation of a prototype (blueprint) for digitally supported teaching units for individual self-study at MITZ [German Medical Science GMS Publishing House] . Joint Annual Conference of the Society for Medical Education (GMA) and the Working Group for the Further Development of Teaching in Dentistry (AKWLZ) 2024. DOI: 10.3205/24gma045

[8] Hendradi P, Ghani MKA, Mahfuzah S. A Literature Review of E-Learning Technology in Higher Education. JCSTS 2023; 5(1):1–7. DOI: 10.32996/jcsts.2023.5.1.1

[9] Tang YM, Chau KY, Kwok APK, Zhu T, Ma X. A systematic review of immersive technology applications for medical practice and education - Trends, application areas, recipients, teaching contents, evaluation methods, and performance. Educational Research Review 2022; 35:100429. DOI: 10.1016/j.edurev.2021.100429

[10] Bracq M-S, Michinov E, Jannin P. Virtual Reality Simulation in Nontechnical Skills Training for Healthcare Professionals: A Systematic Review. Simul Healthc 2019; 14(3):188–94. DOI: 10.1097/SIH.0000000000000347

[11] Schindler C, Felgendreff P, Settmacher U, Dahmen U. Video analysis of practical skills – a suitable tool for the further development of surgical teaching? Zentralbl Chir 2019; 144(6):606–13. DOI: 10.1055/a-1030-4676

[12] Redmon J, Divvala S, Girshick R, Farhadi A. You Only Look Once: Unified, Real-Time Object Detection; 2015. DOI: 10.48550/arXiv.1506.02640

[13] Hoffmann H, Funke I, Peters P, Venkatesh DK, Egger J, Rivoir D et al. AIxSuture: vision-based assessment of open suturing skills. Int J Comput Assist Radiol Surg 2024; 19(6):1045–52. DOI: 10.1007/s11548-024-03093-3

[14] Schmeling A. AWMF Guidelines Register No. 054/002 Class: 1 Guidelines of the German Society for Legal Medicine: Rules for conducting medical post-mortem examinations. 4.0th ed. Münster. Available from: URL: https://register.awmf.org/assets/guidelines/054-002l_S1_Regeln-zur-Durchfuehrung-der-aerztlichen-Leichenschau_2023-03.pdf [cited 2025 Sep 15] .

[15] Klus C, Krumm K, Jacobi S, Willemer M-C, Daub C, Stoevesandt D et al. External post-mortem examination in virtual reality—scalability of a monocentric application. Int J Legal Med 2024; 138(5):1939–46. DOI: 10.1007/s00414-024-03229-9

[16] Richter C, Hoyer S, Lessig R, Stoevesandt D, Schwarz K, Biolik A et al. Current trends in cadaver examination training for medical students. Rechtsmedizin 2020; 30(5):318–24. DOI: 10.1007/s00194-020-00400-5

[17] Flössel U, Clas S, Willemer M, Sommer M, Poweleit G, Schulze R et al. Using simulation mannequins and actors in training for external post-mortem examinations—experiences from use in medical students and police officers. J Forensic Leg Med 2021; 77:102102. DOI: 10.1016/j.jflm.2020.102102

[18] Speidel R, Schneider A, Walter S, Grab-Kroll C, Oechsner W. Immersive medium for early clinical exposure - knowledge acquisition, spatial orientation and the unexpected role of annotation in 360° VR photos. GMS J Med Educ 2023; 40(1):Doc8. DOI: 10.3205/zma001590

[19] Liehn M, Lengersdorf B, Steinmüller L, Döhler R. OP-Handbuch. Berlin, Heidelberg: Springer Berlin Heidelberg; 2021. ISBN: 978-3-662-61100-5

[20 Ariya P, Wongwan N, Worragin P, Intawong K, Puritat K. Immersive realities in museums: evaluating the impact of VR, VR360, and MR on visitor presence, engagement and motivation. Virtual Reality 2025; 29(3). DOI: 10.1007/s10055-025-01201-5

[21] Pieterse AD, Hierck BP, Jong PGM de, Ginn TF, Hamoen EC, Reinders MEJ. User experiences of medical students with 360-degree virtual reality applications to prepare them for the clerkships. Virtual Reality 2023; 27(2):1381–9. DOI: 10.1007/s10055-022-00731-6

[22] Cherni H, Métayer N, Souliman N. Literature review of locomotion techniques in virtual reality. IJVR 2020; 20(1):1–20. DOI: 10.20870/IJVR.2020.20.1.3183

[23] Faeth A, Harding C. Emergent effects in multimodal feedback from virtual buttons. ACM Trans. Comput.-Hum. Interact. 2014; 21(1):1–23. DOI: 10.1145/2535923

[24] Bibrack E, Willemer M-C, Hoffmann H. The use of video recordings and sensor data to analyze action sequences in the context of self-directed learning – Design and piloting of a self-learning unit for writing a 12-channel ECG [German Medical Science GMS Publishing House] . Joint Annual Meeting of the Society for Medical Education (GMA) and the Working Group for the Further Development of Teaching in Dentistry (AKWLZ) 2024. DOI: 10.3205/24gma005

[25] Serdack A, Willemer M-C. Resuscitation made easy: CorPatch® provides feedback so you always stay on the pulse! [German Medical Science GMS Publishing House] . 19th International SkillsLab Symposium 2025. DOI: 10.3205/25isls62

[26] Daub C, Krumm K, Stoevesandt D, Klus C, Peter L-M, Schmidt U et al. VR-based cadaver examination. Transfer and modification of a digital course for medical students from Halle to Dresden [German Medical Science GMS Publishing House] . 17th International SkillsLab Symposium 2023. DOI: 10.3205/23isls30

[27] Willemer M-C, Krumm K, Teistler M, Flägel K, Junga A, Schulze H et al. Gallery Walk in Virtual Reality – immersive insights into VR projects in medical education [German Medical Science GMS Publishing House] . Annual Meeting of the Society for Medical Education (GMA) 2023. DOI: 10.3205/23gma294

[28] Speidel R, Willemer M-C, Romeike BF, Junga A, Schulze H, Hätscher O et al. From potential to added value – World Café on the didactic use of virtual reality [German Medical Science GMS Publishing House]. Annual Conference of the Society for Medical Education (GMA) 2023. DOI: 10.3205/23gma315

[29] Flägel K, Willemer M-C, Mergen M, Junga A. Evaluation of VR applications in medical education – from examples to a cross-location evaluation concept [German Medical Science GMS Publishing House] . Joint Annual Meeting of the Society for Medical Education (GMA) and the Working Group for the Further Development of Teaching in Dentistry (AKWLZ) 2024. DOI: 10.3205/24gma206

[30] Kern P, Unzner J, Kern U. Digital tools for transforming university teaching – University Forum on Digitalization; 2017. Available from: URL: https://hochschulforumdigitalisierung.de/digitale-tools-zur-transformation-der-hochschullehre/ [cited 2025 Sep 15] .

[31 DiF Medicine Working Group. Digital transformation in medical education. A guide from the Working Group on Digitalization in the Disciplines: Medicine: Working Paper No. 74. Berlin: Edition Stifterverband – Verwaltungsgesellschaft für Wissenschaftspflege mbH Available from: URL: https://hochschulforumdigitalisierung.de/wp-content/uploads/2023/11/HFD_AP_74_Medizin.pdf [cited 2025 Sep 16] .

[32] Atenas J, Ebner M, Ehlers U-D, Nascimbeni F, Schön S. An Introduction to Open Educational Resources and Their Implementation in Higher Education Worldwide. Weizenbaum Journal of the Digital Society 2024; 4. DOI: 10.34669/WI.WJDS/4.4.3

[33] Tolks D, Keller J. Generative AI in medical education; 2024 Available from: URL: https://hochschulforumdigitalisierung.de/generative-ki-in-der-medizinischen-ausbildung-revolution-oder-routine [cited 2025 Sep 16].

Lessons Learned 5, 2 (2025)
Submitted: September 22, 2025
Accepted: January 8, 2026

DOI: https://doi.org/10.25369/ll.v5i2.105
ISSN: 2749-1307

Programming for the Humanities and Social Sciences

Y. Frommherz*, S. Meier-Vieracker, A. J. Matz

Chair of Applied Linguistics, Institute of German Studies and Media Cultures, Faculty of Language, Literature, and Cultural Studies, TU Dresden

Abstract

The ongoing digitization in the humanities and social sciences (*HSS*) enables and requires the use of new, particularly quantitative, methods of analysis. Programming skills give researchers the most flexible way of working with data. However, these are not typically taught in HSS degree programs, and existing teaching/learning materials usually require prior technical knowledge. For this reason, the *virTUos* subproject *ExDiMed* has developed low-threshold, modular self-learning materials for teaching coding skills in the programming language Python, which are specifically tailored to the needs and requirements of HSS students. The content, in the form of interactive Jupyter Notebooks, is available to learners and teachers as OER and has been successfully tested and refined at TU Dresden over six semesters in a flipped classroom seminar. With the advent of generative AI, the course has been expanded in an exploratory manner to sensitize students to the constructive use of AI in coding. Our evaluation shows that teaching basic programming skills has become more relevant in the age of AI, as the latter can only act as a catalyst for coding practice if students already have the basics. Our teaching/learning concept is now firmly established in the *Digital Humanities* master's program at TU Dresden and will continue to be developed after the end of the project.

Die fortschreitende Digitalisierung in den Geistes- und Sozialwissenschaften (*GSW*) ermöglicht und erfordert den Einsatz neuer, insbesondere quantitativer Analysemethoden. Den flexibelsten Umgang mit Daten erhalten Forschende durch Programmierkenntnisse. Typischerweise werden diese aber nicht in GSW-Studiengängen vermittelt und bestehende Lehr-/ Lernmaterialien setzen meist technisches Vorwissen voraus. Deshalb hat das *virTUos*-Teilprojekt *ExDiMed* niedrigschwellige, modular aufgebaute Selbstlernmaterialien zur Vermittlung von Codeskills in der Programmiersprache Python entwickelt, die sich spezifisch an den Bedarfen und Voraussetzungen GSW-Studierender orientieren. Die Inhalte in Form interaktiver Jupyter Notebooks stehen Lernenden wie Lehrenden als OER zur Verfügung und wurden an der TU Dresden während sechs Semestern in einem Flipped Classroom-Seminar erfolgreich erprobt und verfeinert. Mit dem Aufkommen generativer KI wurde das Angebot explorativ erweitert, um Studierende für konstruktiven KI-Einsatz beim Coden zu sensibilisieren. Unsere Evaluation zeigt, dass die Vermittlung grundlegender Programmierkenntnisse in Zeiten von KI an Relevanz gewonnen hat, da letztere nur dann als Katalysator der Codepraxis wirken kann, wenn Studierende bereits über Basics verfügen. Unser Lehr-/Lernkonzept ist mittlerweile im Masterstudiengang *Digital Humanities* an der TU Dresden verankert und wird auch nach Projektende weiterentwickelt.

*Corresponding author: yannick.frommherz@tu-dresden.de
This article was originally submitted in German.

1. Introduction

The humanities and social sciences (*HSS*) have undergone a digital turn in recent years [1], [2], [3], [4], which is likely to be further accelerated by recent leaps in the development of generative AI [5], [6], [7]. Scientists in these disciplines now have access to large amounts of digital data (e.g., social media corpora or OCR data), which both enable and require the use of quantitative analysis methods. Moving beyond low-threshold tools that allow specific, predefined evaluations (e.g., corpus analysis software such as *SketchEngine*), programming skills enable HSS researchers to flexibly access and preprocess large quantities of data that are relevant to their research, analyze it, and prepare it for dissemination [8].

However, given the traditionally qualitative focus of many HSS programs, quantitative methods in general and programming skills in particular are not typically part of the corresponding curricula. Against this background, the subproject *Experimentierraum Digitale Medienkompetenz* (*ExDiMed*) of the *virTUos* consortium in 2021 set out to develop a target-group-oriented teaching/learning format that imparts precisely these skills to HSS students, enabling them to fully exploit the potential of the digital turn [8].

Specifically, during the project period, we developed and tested materials that teach programming skills in Python as a fundamental digital media competence. As the de facto scientific standard, this relatively easy-to-learn programming language offers the possibility of solving research questions and application problems from the HSS in a needs-oriented manner [8], [9].

This article reflects on the work carried out within *ExDiMed*, beginning with the specific needs and requirements of HSS students, followed by our self-learning materials based on latter, their testing in a flipped classroom seminar, and the integration of generative AI, which has emerged in the meantime. We conclude with an outlook. Throughout the project, iterative feedback from learners on our approach and the specific materials was incorporated into their further development (see diagram of the work process in Fig.1). In line with the title of this journal, we would like to present the most important *lessons learned* from our project.

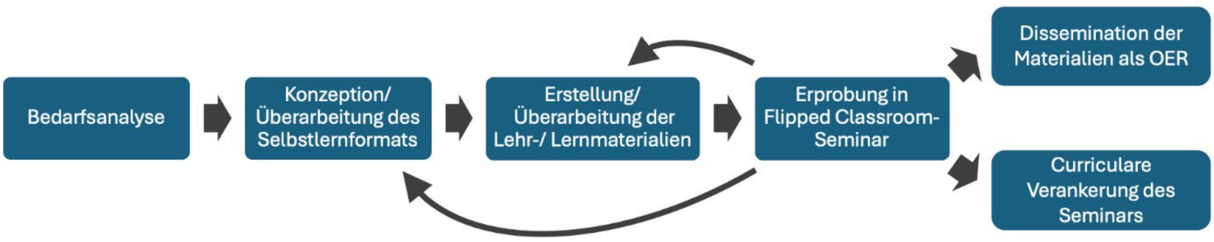


Fig.1 : Schematic representation of the iterative work process.

2. Starting Point

High-quality introductions to programming that are also freely available on the internet are widely available in various formats, from classic textbook-like websites to YouTube tutorials and interactive online courses. Apart from notable exceptions such as [Programming Historian](), however, these are almost exclusively aimed at learners with a certain affinity for technology, mathematics, and logic. Explanations often require relevant prior knowledge, and examples and exercises are mostly numerical in nature (e.g., outputting the Fibonacci sequence). However, our target group, HSS students, generally have no prior knowledge of programming and little technical know-how in general. To the contrary, there are often reservations about computational work. Apart from the importance of content that is as free of prerequisites as possible (see below), the initial focus in developing our teaching/learning concept was therefore on the question of which format would be most effective in imparting programming skills to the given target audience.

3. Open-Source Self-Learning Materials

While our target group is united by the fact that they often have little technical experience and text data is generally very important to them, the various HSS are thematically and methodologically diverse. For example, history students have different concepts and interests than those studying linguistics. Beyond the subjects, all students also have individual needs and requirements. In order to take this diversity into account and address as broad an audience as possible within the HSS, we have opted for *self-learning materials* in the format of Jupyter Notebooks, which are also *modular* in structure.

Once students have downloaded our freely accessible content from GitHub, they can work on it flexibly whenever and wherever they want and, crucially, at their own pace. This allows them to repeat individually challenging passages as often as necessary.Feedback obtained from pretesters as well students of the seminar confirmed that learners greatly appreciate this flexibility.

Jupyter Notebooks are a suitable format because they elegantly and unobtrusively interweave code with text blocks (see Fig. 2). The latter contain explanations and formulate tasks and cannot be edited by learners. Code fields, on the other hand, are either empty (e.g., for exercises, see Fig. 3) or already contain code that students can expand ("Complete the code"), modify ("Insert relevant parameters" or "Find the error"), and, in any case, execute. In contrast to traditional textbooks, which require that code be copied exactly, and script-based tutorials, which must first be executed in the command line, learners in our interactive notebooks immediately experience the effects of the given code or specific changes to it. The division of code into several small blocks (with text in between, if necessary) further sensitizes learners to the incremental nature of programming: a problem is solved step by step, and after each block it is immediately apparent whether the code delivers the desired (interim) result. Our teaching/learning format thus combines self-directed knowledge acquisition with immediate application. Embedded graphics and videos, which convey a realistic picture of exploratory trial-and-error coding, further create a multimodal learning experience.

Bedingte Anweisungen

Wir widmen uns als Erstes den bedingten Anweisungen und definieren dafür einen simplen string. Führ wie immer die Zelle aus, um `sentence` zu initialisieren.

```
sentence = "Der morgige Tag wird schön."
```

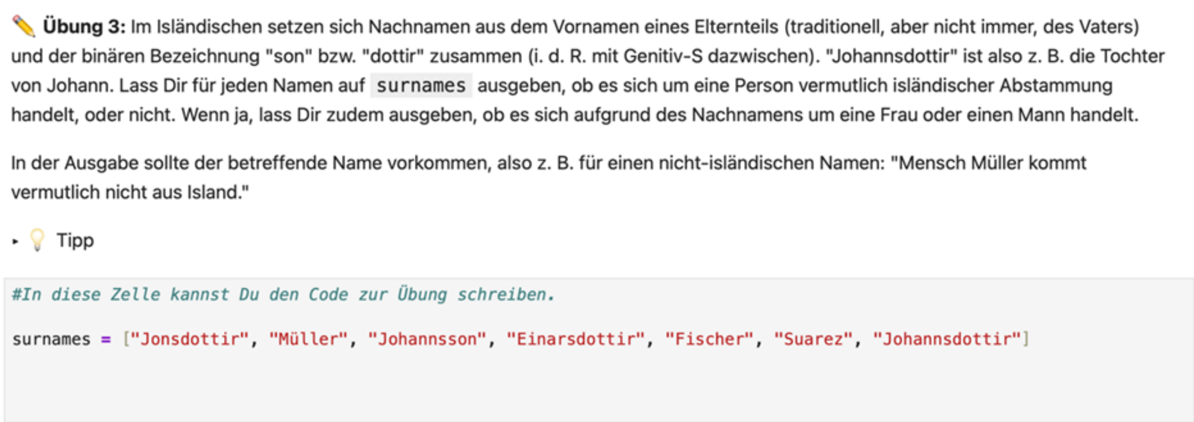
Eine bedingte Anweisung wird mit `if` eingeleitet, z. B.:

```
if sentence.startswith("Der"):
    print("Der Satz fängt mit einem Artikel im Maskulinum an.")
```

```
Der Satz fängt mit einem Artikel im Maskulinum an.
```

Natürlichsprachlich formuliert liest sich der obige Code: "Wenn der Satz mit 'Der' anfängt, dann geben wir '...' zurück."

Fig. 2: Excerpt from a Jupyter notebook consisting of text and code blocks that introduce conditional statements. The code blocks are executed.



✏️ **Übung 3:** Im Isländischen setzen sich Nachnamen aus dem Vornamen eines Elternteils (traditionell, aber nicht immer, des Vaters) und der binären Bezeichnung "son" bzw. "dottir" zusammen (i. d. R. mit Genitiv-S dazwischen). "Johannsdottir" ist also z. B. die Tochter von Johann. Lass Dir für jeden Namen auf `surnames` ausgeben, ob es sich um eine Person vermutlich isländischer Abstammung handelt, oder nicht. Wenn ja, lass Dir zudem ausgeben, ob es sich aufgrund des Nachnamens um eine Frau oder einen Mann handelt.

In der Ausgabe sollte der betreffende Name vorkommen, also z. B. für einen nicht-isländischen Namen: "Mensch Müller kommt vermutlich nicht aus Island."

▸ 💡 Tipp

```
#In diese Zelle kannst Du den Code zur Übung schreiben.

surnames = ["Jonsdottir", "Müller", "Johannsson", "Einarsdottir", "Fischer", "Suarez", "Johannsdottir"]
```

Fig. 3: Example of an exercise on conditional statements, which is thematically derived from the HSS. Optionally, a hint can be displayed that suggests a suitable method (`endswith`).

As mentioned, our notebooks follow a modular structure. We distinguish between a basic module and advanced modules. In the former, students acquire the theoretical and practical foundations of programming with Python, i.e., knowledge of variables, operators, data types, control structures, useful functions and methods, and how to handle external data. With our target group in mind, explanations, examples, and exercises are deliberately taken from the HSS and designed to be practically relevant (e.g., in *Nathan the Wise* the distribution of contributions per character is analyzed , see also Fig. 3). Even concepts that are supposedly generally understood, such as working memory or file paths, are explained explicitly. In addition, we illustrate potentially counterintuitive techniques using metaphors borrowed from everyday life – for example, *indexing* using the idea of numbered houses along a street, where specifically odd house numbers can be "addressed" using the *step* parameter (`musterstrasse[0:20:2]`). Our teaching experience in recent years has shown us that materials for teaching programming skills to HSS students must be designed to be as low-threshold as possible so that learners are not deterred. The fact that our contents are in German, unlike most other introductions to programming, also contributes to their accessibility for our target group.

Beyond the specific content, we ultimately try to get learners interested in programming in three ways. First, right at the beginning, we explicitly motivate the use of programming skills in the HSS by using examples to show what can be achieved in these disciplines with the help of code, which would be very time-consuming or even impossible to implement with a manual approach. Second, we introduce algorithmic thinking before getting into the specifics of Python. This is the ability to 1) analyze a given problem precisely, 2) find expedient steps to solve it, 3) operationalize these steps, i.e., formulate a complete and correct algorithm, 4) test this algorithm on both typical and atypical cases, and 5) improve its efficiency [4, p. 95]. Internalizing this fundamental approach to a (programming) problem seems to be more important than the effective syntax and semantics of the respective programming language [4, p. 90]. Results from an iteratively designed programming course, in which only one parameter was adjusted from the previous course, suggest that even a short unit on algorithmic thinking leads to better programming skills [9]. This is consistent with our experience that learners experience a kind of "aha" moment when they become aware of this completely logical way of thinking. Third, we try to proactively prevent disappointment and dropouts by making it clear to learners at various points in our notebooks that they will often fail, but that this is really quite normal (see Fig. 4)

.

▾ 🔍 **Exkurs: Hilfe holen**

Bis zu diesem Punkt bist Du sicherlich auf das ein oder andere Problem gestoßen, das Du nicht selbst lösen konntest. Vermutlich hast Du in diesen Fällen eine KI konsultiert oder Hilfe bei Google gesucht. Das sind genau die richtigen Strategien! 😄

In den seltensten Fällen bist Du mit Deinen Programmierproblemen alleine, weshalb es im Internet meist bereits viele Lösungsvorschläge dazu gibt. Dies trifft besonders auf Python zu, da die Programmiersprache sehr weit verbreitet ist. Diese Hülle und Fülle an Hilfestellung zu Python im Internet ist denn auch der Grund dafür, warum KIs wie chatGPT oder GitHub Copilot ziemlich zuverlässig Hilfe leisten können. Schließlich basiert ihr Output auf Trainingsdaten, die zu einem großen Teil aus dem Internet stammen.

Lass dir bei Problemen zunächst von KI helfen – in aller Regel ist dies am effizientesten. Überprüf aber stets, ob die vorgeschlagene Lösung Dein Problem wirklich behebt und Du den Code nachvollziehen kannst. Falls nicht, kannst Du Dir den Code von der KI erklären lassen oder eine simplere Version erbitten.

Fig.2 : Excerpt from a notebook on dealing with errors and problems, in which we also engage in implicit expectation management.

Building on the basic notebooks, additional self-contained notebooks introduce data analysis with `pandas`, regular expressions, web scraping, and tagging (e.g., lemmatization or sentiment analysis). This allows learners from the various HSS to put together a modular programming course that is relevant to them. Suppose a student wants to enrich an existing language corpus with additional information such as word types or syntactic dependencies. In that case, she can specifically expand her Python skills in the area of tagging. Her fellow student, who wants to compile his very own data set from the internet, can complete his skill set with a focus on web scraping.

In addition to the actual notebooks, we offer extensive additional content. Although the teaching notebooks already contain numerous exercises (see Fig. 3), we provide additional ones (and solutions, of course) for each topic, as we have found that students learn best through independent, creative application of theory. There are also materials on topics such as using the command line, Git(Hub), data visualization, and training your own basic language model.

As mentioned, all materials are stored in a separate GitHub repository and referenced as Open Educational Resources (*OER*) under a CC--BY-SA license on the platforms twillo and Wikiversity. They are also available to teachers – thanks to their modular structure, our materials can be used as-is or flexibly supplemented with additional content.

4. Testing in Flipped Classroom Seminars

Since the 2022/23 winter semester, the materials described above have been used in a seminar regularly offered by the Chair of Applied Linguistics. In the spirit of exchange between the individual *virTUOs* subprojects, we also held a one-time joint course with *DigitalHerrnhut*, in which we prepared and analyzed Herrnhut texts for linguistic-historical research using the simultaneously acquired programming skills.

Our seminar is designed as a flipped classroom format in the spirit of blended learning [10], [11], [12]. Asynchronous and synchronous learning phases are didactically interlinked, with students working on their notebooks primarily asynchronously – flexibly in terms of time, place, and pace – and the synchronous, spatially co-present sessions serving for recapitulation and *joint* practice and coding (see example seminar schedule in Fig. 5). Collaborative learning settings have been shown in various studies to be conducive to teaching programming skills [1], [9], [13]. In our seminar, the lecturer solves more complex and particularly illustrative programming problems in a frontal manner, but always with the involvement of the students. Here, too, the incremental and iterative practice of coding becomes clear, while at the same time care is taken to cultivate an error-tolerant mindset.

Datum	Zeit	Synchron	Asynchron (nach Sitzung)
16.10.	13:00-14:30	Installation & Algorithmisches Denken	„Einführung“
23.10.	13:00-14:30	„Einführung“ rekapitulieren	„Datentypen“
30.10.	13:00-14:30	„Datentypen“ rekapitulieren	„Kontrollstrukturen“
06.11.	13:00-14:30	„Kontrollstrukturen“ rekapitulieren	„Funktionen und Methoden Teil 1“
13.11.	13:00-14:30	„Funktionen und Methoden Teil 1“ rekapitulieren	„Funktionen und Methoden Teil 2“
27.11.	13:00-14:30	„Funktionen und Methoden Teil 2“ rekapitulieren	Vorbereitung Programmieren mit KI
04.12.	13:00-14:30	Programmieren mit KI	„Input und Output Teil 1“
11.12.	13:00-14:30	„Input und Output Teil 1“ rekapitulieren	„Input und Output Teil 2“
18.12	13:00-14:30	„Input und Output Teil 2“ rekapitulieren	„Datenanalyse Teil 1“
08.01.	13:00-14:30	„Datenanalyse Teil 1“ rekapitulieren	„Datenanalyse Teil 2“
15.01.	13:00-14:30	„Datenanalyse Teil 2“ rekapitulieren	*„Reguläre Ausdrücke“*
22.01.	13:00-14:30	Vorbereitung Mini-Hackathon	*„Tagging“*
29.01.	13:00-17:00	Mini-Hackathon	Vorbereitung Projektarbeit
05.02.	13:00-14:30	Vorbereitung Projektarbeit	

Fig.3 . Sample seminar schedule from the 2024/25 winter semester, showing the integration of asynchronous and synchronous learning phases in line with the flipped classroom concept. This seminar was also used as a test bed for the integration of generative AI (see below).

On the other hand, we implement settings that promote collaboration among students. At the beginning of each semester, we create peer groups consisting of two or three students – with different levels of prior knowledge, if possible – who are to work together in synchronous sessions throughout the seminar. The highlight of collaboration among students is a *mini-hackathon* at the end of the semester. For four hours, participants devote themselves to a data set they have chosen themselves, develop questions that interest them, and set about operationalizing these questions with the help of code. At the end of the mini-hackathon, they present their results and reflect on the process. Such mini-hackathons enable students to co-construct ideas and solutions that they might not have developed on their own [1]. Over the course of the semester, various corpora were analyzed, such as stenographic Bundestag minutes, user comments on the Instagram project *@ichbinsophiescholl* [14], soccer game statistics, and newspaper articles. The first dataset, for example, was analyzed with regard to the distribution of interjections in parliament by political groups and individual members of parliament. Although students can apply their growing Python skills throughout the semester in thematically isolated exercises, the mini-hackathon is the first time they are used on a larger and more holistic scale. Most importantly, however, coding is guided by the interests of the students themselves, which has a positive effect on their motivation. In addition to these collaborative components of the seminar, gamified aspects such as knowledge quizzes are particularly popular, as they offer a break during the session and seem to be appealing due to their competitive nature (see Fig. 6). The newly acquired programming skills are ultimately applied in the final assignments following the seminar. Typically, students complete their own small research project for this purpose – from data collection (e.g., using web scraping) to data preparation (e.g., using regular expressions) and evaluation (e.g., with `pandas`) to visualization of the results (e.g., with `matplotlib`). Many students report that their projects have enabled them to make another big leap in their skills, partly because they have now turned to more complex code, driven by their own individual interest in knowledge. Over the course of the semester, many high-quality exam papers were submitted, including a linguistic paper on Helvetisms and Austriacisms in German-language newspaper articles, a historical paper on mapping the Digital Herrnhut cemetery, and an visual studies paper comparing historical mass production strategies with digital reproduction methods.

The flipped classroom format of our seminar, which is fundamentally derived from our overarching self-learning concept (see above), has proven itself over the last six semesters. Although some students were occasionally overwhelmed by having to work through most of the learning content on their own, the majority of participants appreciated the format or at least pragmatically recognized that the only way to really learn programming is by coding, coding, and coding again—and that simply has to be done *independently*. Apart from the fact that weekly sessions would not be sufficient for this, neither the teacher nor collaborative exchange with peers can substitute this for learners. These elements, which are anchored in the synchronous parts of the seminar, offer important support for the individual learning process, but cannot replace it. At the same time, the past few years have shown that synchronous sessions on more complex topics towards the end of the seminar should definitely last longer than two hours, if only because the exercises are much more time-consuming at this stage compared those covering introductory content. A complete block seminar that bundles all synchronous parts into a few full-day units has not proven successful, however, as students' mental capacity is limited and the independent programming practice that is so central to the course seems to be less established than in a course that spans the entire semester.

The seminar described above is now part of the curriculum of the new Master's program in *Digital Humanities* at TU Dresden, but students from other disciplines, including various teacher training programs, also regularly enroll. The seminar is continuously being improved, not least with regard to generative AI. Its emergence in the middle of the project raised new questions and necessitated adjustments, which are described below.

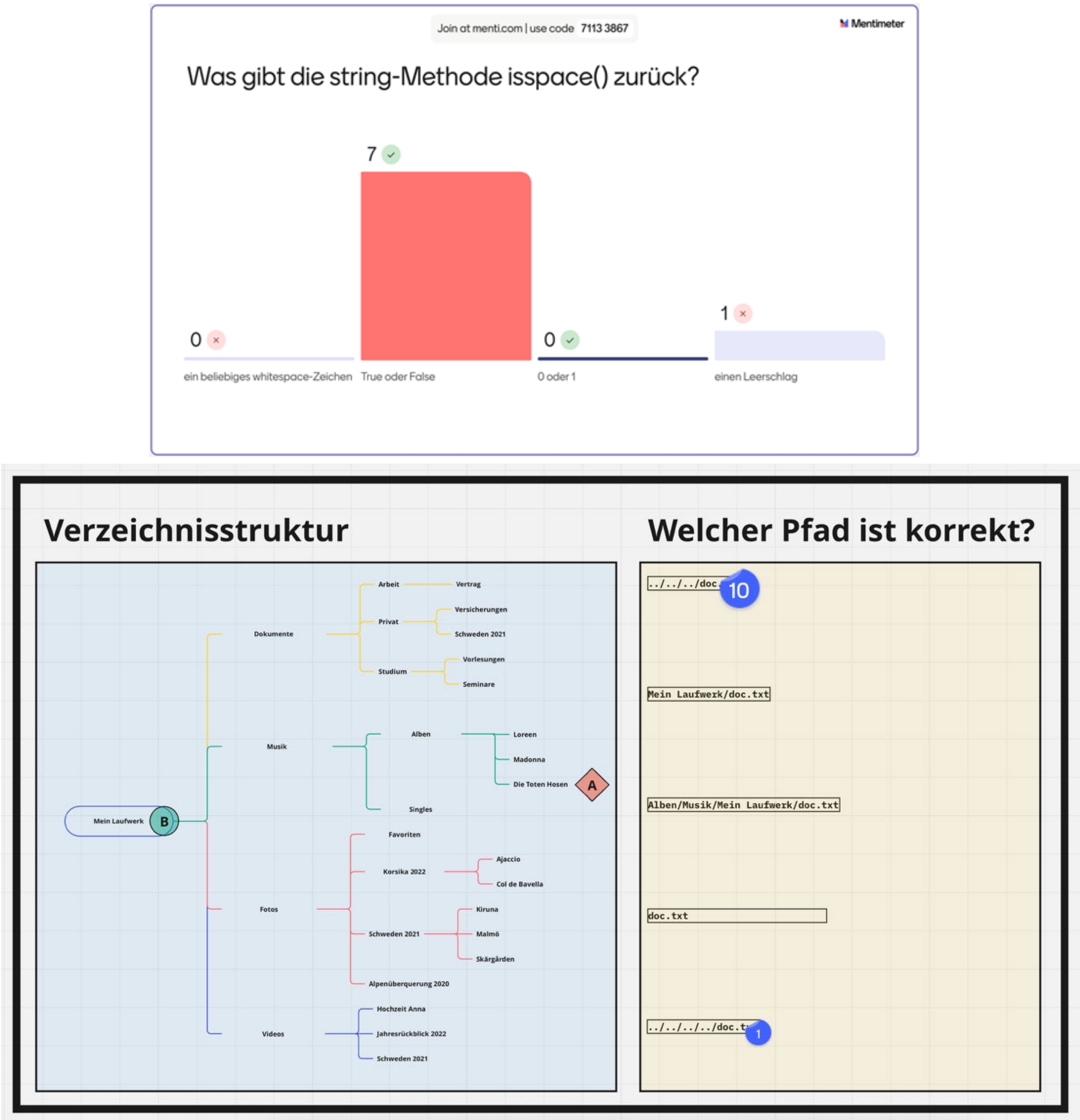


Fig.4 : Gamified seminar components: knowledge quiz on string methods (top; implemented with mentimeter.com) and on relative file paths for navigating from a given directory A to directory B (bottom; miro.com).

5. Generative AI

Current generative AI tools such as *chatGPT* or *Google Gemini* are now capable of generating programming code fully automatically and mostly error-free [15]. Once this became apparent, we were faced with the fundamental question of whether learning to program was still worthwhile for HSS students. For three reasons, we were fundamentally convinced that programming skills in the disciplines in question are not superfluous in the face of powerful AI, but on the contrary, may be more relevant than ever. First, experience to date has shown that our target group rarely considers code – even AI-generated code – as a problem-solving strategy due to the technical inhibitions described above and generally low digital literacy. Against the backdrop of the digital turn in the HSS, a low-threshold introduction is therefore likely to remain essential in order to familiarize such students with the analysis methods that have become relevant [8]. Second, generative AI can only be used if meaningful prompts are formulated. However, programming-related prompt engineering requires an understanding of when code is useful, what code can (and cannot) do, and

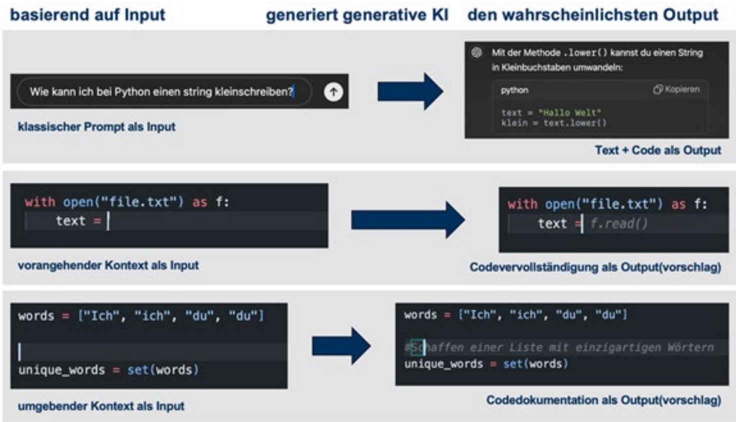


Fig.5 : Theoretical input on how generative AI works.

knowledge of the relevant terminology. Learners need these same skills to be able to evaluate generated output and take action in the event of faulty AI code. These skills too need to be taught in a way that is appropriate for the target group. Thirdly, generated code must always be executed. Some AI tools allow code to be executed in virtual environments. However, once local files are used, which will soon become unavoidable when programming for research purposes, a separate *functioning* development environment (*IDE*) is required, for which the generated code usually has to be adapted, e.g., with regard to file paths. In our experience, however, setting up such an IDE represents a major entry barrier that needs to be overcome through appropriate learning offerings.

If programming skills in the HSS and their teaching in higher education have not become obsolete as a result of generative AI, the next question is how a teaching/learning format such as ours needs to be adapted to the new conditions that AI creates for programming. In order to explore the meaningful integration of AI, we used our seminar in the winter semester 2024/25 as a test bed.

A survey at the beginning of the seminar revealed that students used generative AI in many ways, but not for programming. As we anticipated, the reasons given were a lack of basic knowledge about prompting and evaluating output, as well as a fear of errors in the AI code. Since we assumed that certain basic knowledge must be in place before AI can be used profitably for programming, we scheduled a corresponding introduction for the middle of the semester (see seminar plan of the testbed seminar in Fig. 5). We first used theoretical input to ensure that all participants had the same level of understanding of how generative AI works: Based on input – whether in the form of a classic prompt or code context – the AI suggests the most likely output (see Fig. 7). We then demonstrated the probabilistic basis of generative human and artificial intelligence using natural language cloze texts and incomplete code, which the students were asked to complete individually. Unsurprisingly, depending on the "input," certain "outputs" were more likely than others, just as is the case with generative AI "behind the scenes" (see Fig. 8).

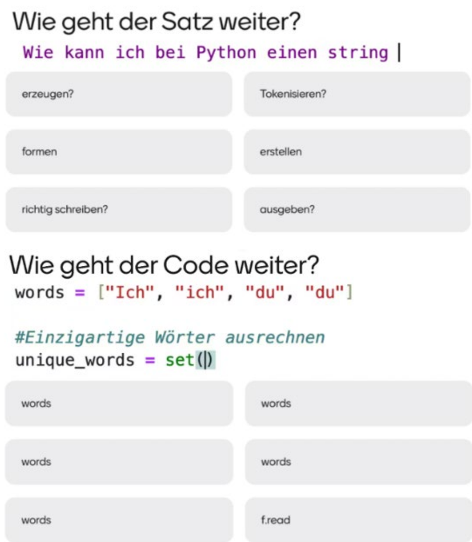


Fig.6 : Raising awareness of the probabilistic basis of generative AI. Students were asked to complete the sentence/code individually. The screenshot shows some of their answers.

We then differentiated between four use cases in which generative AI can be used constructively: code generation "from scratch," debugging, commenting or documenting code, and having code explained. Each type was then practiced using examples and employing both "general" AI such as *chatGPT* and AI optimized for coding, *GitHub Copilot*. As the seminar progressed, as well as for the mini-hackathon and final assignments, students were free to decide whether and how to use generative AI. The instructor continuously demonstrated its use in synchronous sessions.

After the seminar, the tested AI integration was evaluated by externally moderated focus groups to gather practical experiences from the students [5]. According to this, students rated both the type and timing of the introduction in the middle of the semester as very useful and also appreciated the self-determination in the use of the tool. Most students reported that they would never have started programming without our low-threshold introduction, but now felt capable of using AI competently. The primary areas of application for AI turned out to be the correction of syntactic errors and code documentation. Students also like to have code "broken down". i.e., explained. At the same time, it was reported that completely AI-generated code is often too complex and creates new problems, e.g., by way of dependencies. Not least because of this, interacting with AI sometimes takes longer than finding a solution on one's own. Diverging attitudes toward AI use in peer groups and individual inhibitions (self expectations; fear of making mistakes; fear of losing one's own creativity; the feeling of cheating) also seem to stand in the way of (increased) use of generative AI in programming. Another interesting finding was the recurrent statement that students preferred to ask the lecturer rather than the AI, as the former reacted in a more human way by embedding his answers in the real seminar context.

It is undisputed that code remains a central scientific problem-solving strategy, also in the increasingly digital HSS. Generative AI proved to be a helpful catalyst for learning and applying programming skills in our test seminar. However, as we assumed, it became clear that basic knowledge must first be available in order for learners to benefit from generative AI in their programming practice. This confirmed that low-threshold, target group-sensitive teaching of programming skills in higher education is very relevant, especially in times of powerful AI. Only in this way can the potential of the digital turn described at the beginning be effectively exploited. Accordingly, the tested form of AI integration into the seminar was retained in the 2025 summer semester. The teaching/learning materials were also revised to point out the possibility of AI use at appropriate points (see also Fig. 4).

6. Outlook

By way of our contents and seminars, *ExDiMed*'s goal was to enable learners from various HSS programs with no prior knowledge to address issues relevant to them in a digitally competent manner – from obtaining their own data to data preprocessing, evaluation, and visualization. Numerous good final assignments, as well as, e.g., programming-intensive master's theses, and feedback from learners over six semesters, show us that we have come a long way toward achieving this goal, at least for the HSS at TU Dresden.

While both the content creation and the seminar have been largely carried out by one single research assistant, a handover to new teaching staff is currently taking place, who will continue developing both the materials and the course after the end of the project. To this end, all processes, such as the handling of the GitHub repository, are currently being documented. In addition to creating new advanced modules, the focus in the future will be on the ongoing onboarding of new developments in generative AI. Beyond TU Dresden, we hope that our materials will be used by lecturers from the HSS at other German-speaking universities in their teaching, either in their entirety to teach the basics for subsequent subject-specific content, or by using individual advanced modules to supplement an existing course.

Acknowledgements

The *ExDiMed* project is funded by the *Stiftung Innovation in der Hochschullehre* as part of the *virTUos* network.

Literature

[1] L. Beck und A. Chizhik, „Cooperative learning instructional methods for CS1: Design, implementation, and evaluation“, ACM Trans. Comput. Educ., Bd. 13, Nr. 3, S. 10:1-10:21, Aug. 2013, doi: 10.1145/2492686.

[2] H. Snee, C. Hine, Y. Morey, S. Roberts, und H. Watson, „Digital Methods as Mainstream Methodology: An Introduction“, in Digital Methods for Social Science: An Interdisciplinary Guide to Research Innovation, H. Snee, C. Hine, Y. Morey, S. Roberts, und H. Watson, Hrsg., London: Palgrave Macmillan UK, 2016, S. 1–11. doi: 10.1057/9781137453662_1.

[3] Deutsche Forschungsgemeinschaft, „Digitaler Wandel in den Wissenschaften“, Okt. 2020, doi: 10.5281/ZENODO.4191345.

[4] F. Jannidis, H. Kohle, und M. Rehbein, Hrsg., Digital Humanities. Eine Einführung. Stuttgart: Metzler, 2017.

[5] Y. Frommherz, A. J. Matz, und S. Meier-Vieracker, „KI-gestütztes Programmierenlernen – Erprobung und Erfahrungen eines Lehr-Lernkonzepts“. Zugegriffen: 14. August 2025. [Online]. Verfügbar unter: https://fis.uni-bamberg.de/handle/uniba/107576

[6] G. Punziano, „Adaptive Epistemology: Embracing Generative AI as a Paradigm Shift in Social Science“, Societies, Bd. 15, Nr. 7, S. 205, Juli 2025, doi: 10.3390/soc15070205.

[7] S. Schiller-Stoff, L. E. Münzer, C. Dittmann, und S. Sagadin, „Der Einfluss von AI-Pair-Programmers auf die Digital Humanities: Potentiale und Limitationen“, in Book of Abstracts DHd 2025, Bielefeld, 2025. doi: https://doi.org/10.5281/zenodo.14887461.

[8] Y. Frommherz und J. Langenhorst, „Digitale Kompetenzen für Geistes- und Sozialwissenschaftler:innen. Vorzüge eines Blended Learning-Formats für die Vermittlung von Programmierkenntnissen.“, Lessons Learn., Bd. 2, Nr. 1, Juli 2022, doi: 10.25369/ll.v2i1.37.

[9] T. Koulouri, S. Lauria, und R. D. Macredie, „Teaching Introductory Programming: A Quantitative Evaluation of Different Approaches“, ACM Trans. Comput. Educ., Bd. 14, Nr. 4, S. 1–28, Feb. 2015, doi: 10.1145/2662412.

[10] S. Seufert und P. Mayr, Fachlexikon e-lerning: Wegweiser durch das e-Vokabular. in managerSeminare. Bonn: ManagerSeminare May, 2002.

[11] E. Schoop, H. Bukvova, und C. Lieske, „Blended-Learning arrangements for higher education in the changing knowledge society“, in Proceedings of the International Conference on Current Issues in Management of Business and Society Development, Riga, Lat., Dresden: TU Dresden, 2010. [Online]. Verfügbar unter: https://nbn-resolving.org/urn:nbn:de:bsz:14-qucosa-26183

[12] M. Kerres, Mediendidaktik: Konzeption und Entwicklung mediengestützter Lernangebote. München: OLDENBOURG WISSENSCHAFTSVERLAG, 2013. doi: 10.1524/9783486736038.

[13] G. Braught, T. Wahls, und L. M. Eby, „The Case for Pair Programming in the Computer Science Classroom“, ACM Trans. Comput. Educ., Bd. 11, Nr. 1, S. 2:1-2:21, Feb. 2011, doi: 10.1145/1921607.1921609.

[14] S. Meier-Vieracker, „‚LIEBE SOPHIE‘ – ADRESSIERUNG UND INVOLVIERUNG IN INSTAGRAM-KOMMENTAREN AM BEISPIEL DES PROJEKTES @ICHBINSOPHIE-SCHOLL“, Dez. 2023, doi: 10.48694/KORDAF.3849.

[15] A. Ziegler u. a., „Productivity assessment of neural code completion“, in Proceedings of the 6th ACM SIGPLAN International Symposium on Machine Programming, San Diego CA USA: ACM, Juni 2022, S. 21–29. doi: 10.1145/3520312.3534864.

Lessons Learned 5, 2 (2025)
Submitted: September 24, 2025
Accepted: January 12, 2026

DOI: https://doi.org/10.25369/ll.v5i2.106
ISSN: 2749-1307

From in-person to digital: Lessons learned from tutor training

P. Thamm*, J. Müller

Center for Interdisciplinary Learning and Teaching, TU Dresden

Abstract

The diverse study landscape requires flexible and scalable qualification modules for tutors, whose work is central to the quality of teaching and the methodological and didactic development of student teachers. The *TUTORING hybrid* project builds on existing experience and innovative developments in digital higher education. It identifies, analyses and develops hybrid teaching and learning scenarios in an interdisciplinary manner to make them usable across universities. Key milestones include developing a certificate course on OPAL in a flipped classroom format for the initial training of subject tutors; the 'seminar room of horror'; the 360-degree learning environment; and the digital escape room, all of which enable practical, interactive learning. Additionally, the Open Minds course was developed to teach the fundamentals of open educational resources. The developed content was disseminated via platforms such as Twillo, Videocampus Sachsen and YouTube, as well as at national and international conferences. This article also reflects on the challenges and lessons learned during the project period, particularly with regard to the implementation of the formats and adaptation to changing needs.

Die heterogene Studienlandschaft erfordert flexible und skalierbare Qualifizierungsbausteine für Tutor:innen, deren Arbeit eine zentrale Rolle für die Qualität der Lehre und die methodisch-didaktische Entwicklung studentischer Lehrender einnimmt. Das Projekt *TUTORING hybrid* knüpft an bestehende Erfahrungen und innovative Entwicklungen in der digitalen Hochschullehre an, identifiziert hybride Lehr-Lern-Szenarien, analysiert diese didaktisch und entwickelt sie interdisziplinär weiter, um sie universitätsübergreifend nutzbar zu machen. Zu den zentralen Meilensteinen zählen der Aufbau eines Zertifikatskurses auf OPAL als Flipped-Classroom-Format zur Basisqualifizierung von Fachtutor:innen, der „Seminarraum des Schreckens", die 360-Grad-Lernumgebung sowie der digitale Escape Room, die praxisnahes, interaktives Lernen ermöglichen. Ergänzend wurde der Open-Minds-Kurs entwickelt, der die Grundlagen von Open Educational Resources vermittelt. Die entwickelten Inhalte wurden über Plattformen wie twillo, Videocampus Sachsen und YouTube sowie auf nationalen und internationalen Tagungen sowie Konferenzen verbreitet. Der Beitrag reflektiert zudem Herausforderungen und Learnings aus der Projektlaufzeit, insbesondere die Umsetzung der Formate sowie die Anpassung an veränderte Bedarfe.

*Corresponding author:pauline.thamm@tu-dresden.de
This article was originally submitted in German.

1. Idea and starting point

The starting point is a study landscape characterized by heterogeneous prior knowledge, variable participation conditions, and different didactic requirements. Although existing face-to-face and online offerings (including the OPAL learning platform and virtual learning environments) expanded rapidly during the pandemic, their systematic integration, didactic foundation, and sustainable implementation remain the focus. This creates the need for scalable, flexible qualification modules that combine digital self-study phases with interactive, in-person components and are accessible as Open Educational Resources (OER)/Open Educational Practices (OEP).

Tutorial work plays a central role in the implementation of such flexible qualification approaches. It is an essential component of university didactics and significantly contributes to teaching quality assurance [1]. As links between teachers and students, tutors develop their didactic and communicative skills while supporting the learning processes of their peers [2]. To ensure the long-term quality of student-led teaching formats, universities must provide tutors with targeted methodological and didactic training. Only then can tutorial work reach its full potential [3]. This is where the *TUTORING hybrid* project comes in (see Fig. 1). Building on the experiences of the original *TutorING* project and the developments in digitally supported university teaching within the framework of virTUos. The aim is to systematically identify hybrid teaching and learning scenarios, for example in tutorials, exercises, or practicals, analyze them didactically, and develop them further in an interdisciplinary manner.

Beyond local implementation, the developed formats are to be made available across universities as OER and OEP and at the same time anchored in the HYBRID strategy of the Technical University of Dresden (TUD). In this way, *TUTORING hybrid* contributes to the quality assurance, scaling, and visibility of tutorial-based teaching.

Fig. 1: Logo of TUTORING hybrid

The focus is on developing the skills of teaching staff: working together in an interdisciplinary team, create practical qualification modules that are iteratively tested, adapted, and transferred to the university context. Tutors play a key role in this process. As both students and teachers, they combine perspectives, develop themselves further, and at the same time act as multipliers of innovative teaching ideas.

The basic idea behind *TUTORING hybrid* is therefore to design innovative hybrid scenarios by and with students, to develop them further through university teaching impulses, and to disseminate them as open educational practices.

Milestones and project results

In 2022, which was still marked by the effects of the pandemic, the focus was on establishing digital learning environments. Gather.Town [4] was used to create a virtual teaching and learning environment for basic methodological and didactic training for all subject tutors. This environment was tested for the first time in a hybrid learning setting in the summer semester of 2022 (see Fig. 2).

Fig. 2: Online implementation of basic training in the 2022 summer semester

At the same time, the systematic identification and didactic analysis of innovative teaching and learning scenarios began. A particular highlight was the annual "Best Tutorial Competition," which recognized outstanding teaching concepts developed by student tutors at TUD. These concepts will serve as a flagship for *TUTORING hybrid* in the future (see Fig. 3).


Die Kür zum »Besten Tutorium« des Sommersemesters 2021

Tutorienarbeit leistet einen elementaren Beitrag für die Sicherung und Weiterentwicklung der Qualität der Lehre

Fig. 3: Excerpt from the TUD university journal in the 2021 summer semester

One example of this innovative strength is the peer tutor Johannes Reimer from the Department of Civil Engineering. He reflected on his teaching design and prepared it in a way that makes it accessible and usable for others. Using OBS, he created a teaching video, among other materials, that illustrates the added value of OER and OEP in student teaching. He published these materials via Videocampus Sachsen, YouTube, and the OER platform twillo [5], making them permanently available.

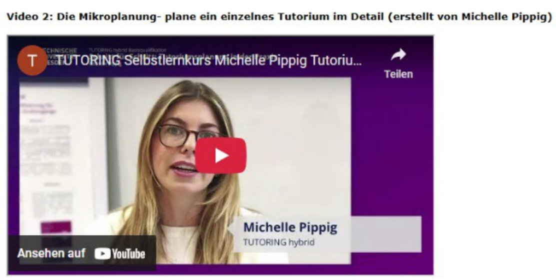


Fig. 4: Instructional video "Tutorial planning in practice" by Michelle Pippig

On this basis, hybrid qualification modules were further developed that firmly integrated the topic of OER/OEP. Workshops and continuing education formats were prepared digitally or conducted in a hybrid format. The result was instructional videos on fundamental topics, such as the role and expectations of tutors, as well as the didactic micro- and macro-planning of tutorials. These videos are also available as open educational resources (see Fig. 4).

2. The certificate course for basic methodological and didactic qualification

The core of *TUTORING hybrid* is the basic qualification for all subject tutors at TU Dresden. It forms the basis for an optimal start in student teaching. In interdisciplinary groups, participants reflect on what it means to be a tutor, learn how to plan an exercise through peer discussion, and receive practical advice from experts.

After the pandemic, the basic qualification for subject tutors was offered in person once again. Meanwhile, Pauline Thamm, a peer tutor from the Department of Teacher Education at Vocational Schools, developed an online certificate course on the OPAL learning platform in 2023. She collaborated closely with the *TUTORING hybrid* team to refine it continuously (see Fig. 5). Having participated in the original basic qualification in Gather.Town, Thamm experienced the strengths and weaknesses of digital learning formats firsthand. Building on these experiences and the team's didactic expertise, they developed a comprehensive self-study course that teaches the basics of tutoring in a student-centered way.

Fig. 5: Insight into the certificate course

Building on this, the *TUTORING hybrid* subproject developed a qualification model that combines digital self-study phases with a two-day face-to-face event. The aim is to offer tutors methodological and didactic training that is flexible, practical, and well-founded. The implementation is based on the flipped classroom approach [6]. First, the tutors work through digital self-study modules on the OPAL learning platform before participating in the face-to-face qualification event. During this phase, key fundamentals are taught and reinforced through workshops and group exercises.

The flexibility of the format offers particular added value: while the digital content can be worked on anytime, anywhere, the face-to-face sessions create space for exchange, discussion and help consolidate learning. This promotes independent learning and active engagement with the content.

Gamification elements such as storytelling are integrated into individual modules of the course to illustrate didactic concepts. It is also supplemented by instructional videos and best practice examples that facilitate transfer into one's own practice. The course comprises a total of nine modules covering different topics and is also available in English.

The nine modules of the digital course cover key aspects of tutor qualification:

- **Module 1 – Preliminary considerations:** Examination of psychological fundamentals and your own understanding of your role (e.g., moderator, learning coach, etc.). Also covers motivation and activation of students, supplemented by reflection and writing tasks.
- **Module 2 – Teaching and learning spaces:** Practical tips on organizing physical, digital, and hybrid spaces, supported by checklists and technical equipment tips.
- **Module 3 – Planning a tutorial:** Introduction to macro and micro planning using the Didactic Mobile [7], supported by instructional videos and planning tables.
- **Module 4 – Encouraging interaction:** This module presents methodological and didactic approaches to promoting interaction, illustrated by good and bad practice videos, storytelling, and a collaborative wiki.
- **Module 5 – Material collection:** Collection of supplementary resources, checklists, and OER examples; with interactive self-test to review knowledge and raise awareness of open educational practices.
- **Module 6 – Diversity:** Reflection on diversity awareness, equality, and inclusive methods; checklists and tasks to promote diversity-sensitive tutorial design.
- **Module 7 – Overcoming challenges:** Case studies of typical difficult situations in tutorials, which are worked through and reflected on in interactive tasks.
- **Module 8 – Discover the 360° course room:** Exploration of a virtual course room to become familiar with digital teaching and learning settings.
- **Module 9 – Observation:** Introduction to collegial observation; tutors organize peer observations and reflect on their teaching practices with each other for personal development.

By publishing on twillo, the course can be used nationwide in the tutorial network beyond TUD and adapted for other areas and target groups.

Upon completion, participants receive a certificate credited with ECTS points as part of the General Qualification (AQUA), which recognizes the tutors' commitment.

The *TUTORING hybrid* subproject has shown that the quality of hybrid formats is not achieved through the additive integration of digital elements, but rather through the consistent interlinking of self-study, online, and face-to-face phases. Formats in which basic content is worked out in advance in a self-directed manner and applied to authentic tasks in face-to-face sessions are effective. To scale proven processes, compact "micro-recipes" (one-page process maps with time structures, material lists, and links) are recommended, as they enable quick transferability to different subjects.

3. The seminar room of horror

Another milestone of the subproject was the design and testing of the "Seminar Room of Horrors" (SdS) as part of the Hybrid Lab in April 2023. The SdS is based on the "Room of Horrors" concept [8], which is well-established in the fields of medicine and nursing. This concept involves simulation training to raise awareness of patient safety risks. A realistic room is recreated with specific errors and risks that participants must identify and correct.

Fig. 6: Insight into the SdS as a face-to-face format

This principle has been adapted for tutor qualification: In everyday teaching, especially in hybrid teaching and learning settings, tutors encounter typical challenges that they usually only experience in practice. Originally launched (see Fig. 6) and evaluated as a face-to-face training room, the format was further developed into a 360-degree learning environment in Matterport [9] (see Fig. 7). In this environment, tutors can virtually experience and reflect on common challenges in teaching, such as organizational disruptions, technical issues, and didactic pitfalls, in a realistic setting.

Building on this, the digital escape room was developed in 2025 by Sabrina Hänsel, who contributed both her student perspective and her media technology expertise to the project. Based on experience with the face-to-face classroom and the 360-degree learning environment, the web-based format allows tutors to address typical challenges in teaching in a practical, interactive manner and develop independent solutions.

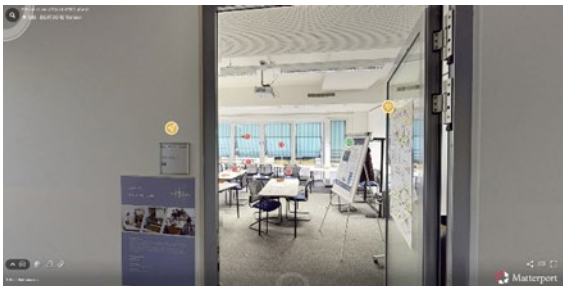


Fig. 7: 360-degree learning environment of the SdS

The escape room combines problem-based learning [10], flow experience [11], and low-threshold testing opportunities within a realistic 3D environment (see Fig. 8). It addresses subject-specific and interdisciplinary skills, such as self-organization, flexibility, stress resilience, and communication.

The format enables location- and time-independent learning, encourages experimentation with new solutions, and allows participants to practice their role as tutors. This represents an innovative approach to qualifications that combines digital flexibility with active, practical learning.

Fig. 8: The current development as a digital escape room

Simulations, such as scenario-based exercises and escape room activities, were particularly valuable in preparing tutors for their first sessions. These simulations allowed tutors to practice roles, interventions, and incident management risk-free.

4. The Open Minds course

Fig. 9: Logo of the VCL course Open Minds

In the summer semester of 2025, the Virtual Collaborative Learning (VCL) course "Open Minds: Discover the possibilities of freely available educational resources for your studies" was conceptually developed and implemented on OPAL in cooperation with the project partner *sTUDents* (see Fig. 9).

The course teaches participants the basics of OER and OEP. The aim is to qualify participants both in knowledge transfer (understanding concepts, legal frameworks, and licensing) and in practical application (research, use, and creation of their own OER).

Course content at a glance:

- Introduction to the basics and advantages of OER and OEP.
- Legal framework and licensing.
- Research and use of suitable OER in your own subject area.
- Development and publication of your own OER products.

Special features:

- Combination of theoretical input with practice-oriented tasks.
- Focus on sustainable teaching and learning practices and collaborative processes.
- Integration of gamification elements such as storytelling, badges, time pressure, escape rooms, feedback, etc.
- Promotion of creativity through the creation of innovative OER materials.

The course thus provides important impetus for anchoring OER/OEP in higher education teaching and contributes to the promotion of open, sustainable, and future-oriented teaching and learning cultures.

5. The Open Minds course

The licensing of OER teaching materials and familiarization with technical requirements and innovative applications took up a lot of energy and time during the project period. The support of subject matter experts was particularly valuable, for example in introducing new digital formats. In cooperation with the Saxon State Library – Dresden State and University Library (SLUB), the OER symposium was also beneficial. The insights gained there were directly incorporated into the project and made it possible to provide a portfolio of materials via the twillo platform, thus opening it up to the outside world.

Students greatly appreciate this offering, such as the template for peer observation in tutorials, which can be used independently in a peer or buddy format. In addition, students actively contribute by providing materials they have created themselves, such as the contributions by tutor Joceline Mutscher. Although teachers and tutors must first familiarize themselves with the topic of OER/OEP, they recognize its high added value for teaching.

Personnel changes during the project period also posed a challenge. While these changes meant that milestones could not always be worked on continuously, they also brought new perspectives and expertise. The dynamic nature of the project transfer ultimately proved to be a success factor.

Particularly important in this context were the numerous collaborations and public relations activities that students such as Anne Seipel (WHK in the *TUTORING hybrid* project) actively supported. These activities allowed the project to continuously align with the students' needs. Among other things, these collaborations resulted in mentor training offered in both face-to-face and digital formats within the fields of civil engineering and chemistry/food chemistry.

Our project also received a positive response from the nationwide network for tutorial work. The materials developed, particularly the self-study course for all subject tutors, continue to serve as best-practice templates and are still used regardless of the subject area. Due to staffing limitations in tutorial work, these flexible qualification formats are valuable because they are easily accessible to other network partners.

The project's content was published at numerous conferences to disseminate it and raise public awareness. We were actively involved in conferences and meetings such as the German Society for Higher Education Didactics (DGHD), the Society for Media in Science (GMW), the Mobile Learning Conference, the Education and New Developments Conference (END), the European Conference on Games-Based Learning (ECGBL), the Workshop on e-Learning (WeL), the University Future Festival (UFF), TURN, and the Higher Education and Adult Education Research Conference (HUEBF). These conferences resulted in various abstracts, posters, papers, and manuscripts publishing project results for a broad audience. The T*U*-

TORING hybrid team appreciates the recognition of the topics and target groups covered. Twillo also honored one of the materials created as OER of the Month, which further underscores the success and visibility of the devolped content (see Fig. 10).

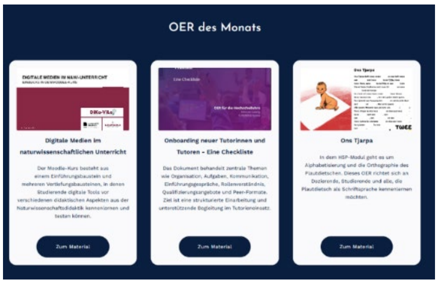


Fig. 10: Onboarding material as OER of the month, screenshot from the twillo website

One challenge arose with the Coffee Corner format established in 2022 (see Fig. 11). The 30-minute online offering via Zoom was initially tested in the morning hours (8:30–9:00 a.m.), then at noon, and finally in the afternoon. The short thematic presentations on topics such as evaluation, exam preparation, stress management, presenting tutoring activities in job applications, and icebreaker methods, offered space for exchange and feedback in the form of lectures or workshops. While demand was high in the aftermath of the pandemic, the following years saw a significant change: students increasingly wanted in-person offerings. Given the stress of their studies and part-time jobs, they were hardly able to take advantage of the fixed online time slots.

Fig. 11: Advertising poster for Coffee Corner Week, created with Canva Pro

The key lesson learned from this is that online formats work very well under certain conditions, but may need to be removed from the range of services on offer depending on needs and changing contexts. Therefore, flexibility, ongoing needs assessment, and adaptation are crucial for the long-term effectiveness of training programs. Additionally, interdisciplinary collaboration proved to be particularly beneficial: the active participation of students from different departments enabled a valuable change of perspective that complemented the training modules in a meaningful way.

6. Continuity and outlook

Currently, tutorial work at TUD is secured through a half-time budget position and continues to rely on third-party funding projects to enable the existing offerings. The fundamentals of the qualification for subject tutors remain in place, as does the new flipped classroom format with an integrated self-study course and digital applications. The OER materials developed continue to be used within the team and in the nationwide tutorial network, providing a solid basis for the sustainable development of tutorial work.

There is considerable potential for the future, such as the further development of challenging situations in teaching as a VR scenario to create more immersive training and educational offerings. At the same time, existing structural constraints must be taken into account. These include, among other things, unfunded or insufficiently funded tutor positions, declining funding, and limited time capacities of students. The recognition and appreciation of tutorial work also varies greatly between departments, which makes it difficult to implement and maintain the programs on a sustainable basis. In addition, internal evaluation results show a high demand for subject-independent qualifications for subject tutors. However, it is difficult to integrate these programs into students' everyday lives because students are under increasing pressure and are overwhelmed. One possible approach would be to create fixed periods or days on which both teachers and students have the opportunity to participate in further training activities, so that it is not perceived as an additional burden or anchored in their respective contractual situations. Structural conditions directly impact participation and the success of the programs.

Acknowledgments

The project team would like to express its sincere thanks to all former and current project staff, as well as to our student and research assistants. Without your commitment, expertise, and active support, this project would not have been possible in its current form. Each task completed, each idea, and each creative contribution has significantly contributed to the success of *TUTORING hybrid*, and for this we offer our sincere thanks.

Literature

[1] Network for Tutorial Work at Universities (2018). The Future of Tutorial Work at Universities. Position paper.
[2] Zitzelsberger, O., et al. (2019). Qualification of subject tutors from an interdisciplinary perspective.
[3] Schulze-Reichelt, F. (2019). Identification of conditions for successful tutorial teaching in the context of university entry. Back to square one! Findings and perspectives on university entry, pp. 209–228.
[4] https://www.gather.town/,abgerufen on 09/19/2025.
[5] https://www.twillo.de/, accessed on 09/19/2025.
[6] Kenner, A., & Jahn, D. (2016). Flipped Classroom – University teaching and tutorials turned upside down. In A. Eßer, H. Kröpke & H. Wittau (Eds.), Tutorial work in discourse III: Qualification for the future (pp. 35-58). WTM Verlag. URN: urn:nbn:de:0111-pedocs-129621 - DOI: 10.25656/01:12962.
[7] Knoll, J. (2007). Course and seminar methods. A training book on designing courses and seminars, working groups, and discussion groups. Weinheim, Basel: Julius Beltz GmbH & Co. KG.
[8] Karner, S. & Warnecke, F. (2023). Simulative learning in the Room of Horrors. Practical book with case studies for generalist nursing training (1st edition). Stuttgart: Verlag W. Kohlhammer.
[9] https://matterport.com/, accessed on 19.09.2025.
[10] Joinson, A. N. (2001). Self-disclosure in computer-mediated communication: The role of self-awareness and visual anonymity. European Journal of Social Psychology, 31 (2), 177–192. https://onlinelibrary.wiley.com/doi/10.1002/ejsp.36
[11] Csikszentmihalyi, M. (1990). Flow: The Psychology of Optimal Experience. Harper & Row.

Lessons Learned 5, 2 (2025)
Submitted: 10.11.2025
Accepted: 12.01.2026
DOI: https://doi.org/10.25369/ll.v5i2.112
ISSN: 2749-1307

From face-to-face internships to blended learning formats

J. Knöbel*, S. Odenbach

Chair of Magnetic Fluid Dynamics, Measurement and Automation Technology, Institute of Mechatronic Engineering, Faculty of Mechanical Engineering, TU Dresden

Abstract

This article documents the iterative development and evaluation of the internship in the Measurement and Automation Technology module in the Mechanical Engineering and Process and Natural Materials Engineering degree programs at the Faculty of Mechanical Engineering at Dresden University of Technology.
In response to the coronavirus pandemic, the traditional laboratory practical course was converted via the intermediate stage Praktika@home into a blended learning format, the core element of which is a mobile experiment kit based on Arduino. Accompanying evaluations have shown that the switch to a blended learning concept has significantly increased student engagement. However, ongoing analysis also revealed challenges that needed to be addressed for the successful development of the teaching/learning concept. In conclusion, it has become clear that systematic, evaluative support is essential for the development of new teaching/learning concepts. Future development goals include the integration of a digital twin for multimedia processing and the dissemination of the format to other engineering disciplines such as electrical engineering.

Dieser Beitrag dokumentiert die iterative Entwicklung und Evaluierung des Praktikums im Modul Mess- und Automatisierungstechnik in den Studiengängen Maschinenbau sowie Verfahrens- und Naturstofftechnik der Fakultät Maschinenwesen der Technischen Universität Dresden.
Als Reaktion auf die Corona-Pandemie wurde das klassische Laborpraktikum über die Zwischenstufe Praktika@home in ein Blended Learning-Format überführt, dessen Kernelement ein mobiler Experimentierkoffer auf Arduino-Basis bildet. Im Rahmen von begleitenden Evaluierungen hat sich gezeigt, dass der Wechsel hin zu einem Blended Learning-Konzept das Engagement der Studierenden signifikant steigern konnte. Allerdings zeigte die fortlaufende Analyse auch Herausforderungen, deren Behandlung für eine erfolgreiche Entwicklung des Lehr-/Lernkonzepts wichtig war. Im Fazit hat sich gezeigt, dass eine systematische, evaluierende Begleitung für die Entwicklung neuer Lehr-/Lernkonzepte zwingend erforderlich ist. Zukünftige Entwicklungsziele umfassen die Integration eines digitalen Zwillings zur multimedialen Aufbereitung sowie die Dissemination des Formats auf andere ingenieurwissenschaftliche Disziplinen wie die Elektrotechnik.

*Corresponding author: jette.schwick@tu-dresden.de

This article was originally submitted in German.

1. Introduction

The Measurement and Automation Technology (MAT) course is a two-semester module that starts in the winter semester. The module consists of two semester hours per week (SWS) of lectures, one SWS of computer exercises, and one SWS of practical training and is part of the mechanical engineering and process and natural materials engineering programs at the Faculty of Mechanical Engineering at TU Dresden. It is attended by approximately 350 students annually (as of the 2025/26 winter semester).

A central element of this course and the subject of this article is the practical training, which is designed to familiarize students in their 5th and 6th semesters with experimental work in measurement technology. They need this experience in their practical training, which follows in the 7th semester in the form of a specialized internship.

In the classic design of the module, due to the large number of students, which amounted to up to 800 participants per semester in the 2010s, the internship was designed as an internship with large groups at prefabricated test benches, where students carried out and evaluated a series of experiments in a three-hour attendance phase (Fig. 1).

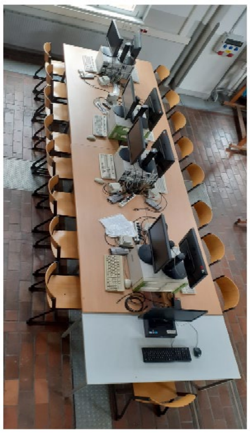


Figure1 : Typical arrangement of the classic classroom internship (here, measurement dynamics) for 16 participants and one supervisor before the pandemic phase

Such mass practicals have the major disadvantage that they do not encourage the active participation of the students themselves and therefore have little learning effect. At the same time, changing such practicals when there are large numbers of students involves considerable risks, which usually means that the practicals are continued in their existing form, despite the known shortcomings.

When, at the beginning of the 2020 summer semester (SoSem), the established mass internships could no longer be carried out for hygiene reasons due to the coronavirus pandemic, a situation arose that forced changes to the internships (Chapter 2), as students had to complete the corresponding exams in order to continue their studies despite the pandemic restrictions. A major advantage in this situation was that the students had already been taught at the chair in the first part of the MAT course in the 2019/20 winter semester (WiSem). This meant that they could draw on material they had already learned to design initial experiments that they could carry out using resources available in their households. The term Praktika@home was introduced for the experiments at home.

Supervising the first Praktika@home via available chat services proved to be inefficient and extremely problematic. Despite these difficulties in supervision, the results of the first reports showed that the students had carried out and evaluated extensive investigations with a high level of commitment, often exceeding the required level.

As the restrictions on face-to-face teaching were only slowly lifted in the following semesters and the students were able to be introduced to practical work much more intensively in the internships that could be carried out at home than the mass internships of previous semesters had allowed, the concept was further developed (Chapter 2).

A key factor in this further development was the introduction of experiment kits based on Arduino microcontrollers, which allow experimental work with real measurement technology.

In the meantime, on-campus operations have been restored for almost 2.5 years, but the Praktika@home concept is being continued due to its success. The entire internship has now been completely converted to a blended learning format (combining the advantages of on-campus study with the advantages of studying at home). The various stages of this development and its conception within the framework of an evaluation-based development concept will be presented below, with a particular focus on the evaluation analysis, which is discussed in detail in Chapter 3.

The outlook section will show how such a concept can be kept up to date through the use of modern technologies and what opportunities, but also difficulties, may arise when disseminating such concepts to other subjects (Chapter 4).

2. Development steps

Before the pandemic, MAT practicals were conducted as traditional laboratory practicals. Students prepared independently and, after a brief introduction, the experiment was carried out, evaluated, and recorded within a three-hour period.

The advantage lay in the use of high-quality equipment that enabled precise and reproducible measurements. The disadvantages were the very limited attendance time and the low learning effect with insufficient preparation, as motivation for self-study was often low. Another didactic problem was that the actual interconnection of the components, such as in the strain measurement (DM) experiment, was done via slots, which made it abstract and impossible to experience [1].

Phase 1 – from the laboratory to the home environment

The first phase was the immediate response to the contact restrictions imposed during the pandemic starting in the summer semester of 2020.

While the lecture could be held on YouTube and the exercise could be conducted online via Matrixchat, the practicals presented a greater hurdle [1].

In the face-to-face practical course, 16 students worked together in groups of two, which resulted in about 110 practical course units for a total of 600 students. Each of these was led by a tutor. Due to social distancing rules, only three to four participants were allowed in the practical training rooms at the same time in the 2020 summer semester, which would have resulted in at least 450 practical training units in theory. This was impossible to organize in terms of space and personnel. Nevertheless, the practical training was and is essential for knowledge acquisition and practical experience. It was also not possible to cancel internships that were part of the curriculum, and postponing them to later semesters was unacceptable due to the unpredictability of further developments and the associated additional burden on students [1].

For this reason, a large part of the internships were digitized and adapted to the home environment—with the ulterior motive of preserving important practical work for the students. At the same time, strengthening the students' motivation to engage intensively with the content was an important aspect from the outset and remained significant in the subsequent phases.

Figure2 : Students in an empty student dormitory conducting the camera characterization experiment [1]

The three experiments that were regularly conducted in the summer semester are those on measurement dynamics (MD), control loops (CL), and programmable logic controllers (PLC). When transferring to the Praktika@home concept, care had to be taken to ensure that, in the case of software-supported experiments, every operating system was capable of implementing the content and that the materials for practical experiments were freely available in the home environment. The control loop experiment was therefore omitted in the first implementation phase due to the complexity of transferring it to the home environment. The missing experiment was replaced by an experiment on digital image processing, in which a camera was characterized in terms of its resolution (Fig. 2). The camera of a cell phone, tablet, or laptop could be used for this purpose. In addition, a razor blade or, alternatively, a knife blade was required, i.e., objects that could be assumed to be accessible to at least one of the students.

Instead of an introduction by the tutor, there was an introductory video [V1-V4] for each experiment. The students had approximately three weeks to complete each experiment. Halfway through, they were able to ask questions and discuss problems via a TU Dresden Matrix chat room, with 60 students at a time. The resulting transcripts were also uploaded digitally to the OPAL teaching/learning platform.

There was 100% participation in the practical experiments. In addition, the students were well prepared for the consultation in the Matrix chat rooms and asked much targeted questions. Subsequently, the logs to be submitted contained far more content than was required [1].

However, the evaluation in Chapter 3 shows that the implementation of the consultations was associated with greater difficulties.

Phase 2 – Design and establishment of the Arduino case

Since the pandemic continued to have a massive impact on teaching even after the 2020 summer semester, the experiments for the subsequent 2020/21 winter semester also had to be planned without in-person attendance. At this point, the idea of establishing Praktika@home as a new teaching/learning model in the long term was already included in the planning, as the first pandemic semester had shown that students were unusually engaged with the internship content, which led to better learning outcomes [1].

For capacity reasons and due to serious delivery problems with electronic components caused by the blockade of the Suez Canal in March 2021, the experiment program had to be regularly adjusted and adapted to the availability of experiments until the 2022/23 academic year. An accompanying evaluation (Chapter 3) has supported this development process since 2022.

An overview of the development of the experiment compilation is shown in Table 1.

Table 1: Overview of the development of MAT internship experiments.

Semester	Experiment
Summer semester 20	MD DBV SPS
WiSem 20/21	DBV MD VPF
SoSem 21	MK RK SPS
WiSem 21/22	MD MK VPF
SoSem 22	DM RK SPS
WiSem 22/23	From here on, experiments as in WiSem 21/22 – face-to-face meetings
SoSem 23	
WiSem 23/24	Introduction of theme days

Key

The entire module spanning two semesters is highlighted in color.

- *MD - Measurement dynamics*
- *DBV - Digital image processing*
- *PLC - Programmable Logic Controller*
- *MK - Measurement chain*
- *RK - Control loop*
- *DM – strain measurement*
- *Color change – one academic year/module each MAT*

In the 2020/21 winter semester, due to the aforementioned lead times, the two experiments on digital image processing and measurement dynamics already established in the 2020 summer semester had to be used again, which meant that the corresponding lecture content had to be shifted between the two semesters. In addition, there was an experiment on experimental design and error calculation (VPF), in which students were asked to set up a pendulum and use it to determine the acceleration due to gravity [1].

With funding from the TU Dresden's FOSTER (Funds for Student Research) program, the second phase of internship development was implemented with a view to the coming summer semester. The FOSTER program provides financial support for research projects carried out by students or initiated by teachers with the aim of introducing students to scientific research at an early stage, strengthening their interdisciplinarity, and thus promoting young scientists.

Building on the experiences of the first phase, a more didactically sustainable and scalable system was designed for implementing various experiments on a common hardware basis. At the heart of the experimental kit developed (Fig. 3) is the Arduino UNO microcontroller. The kit also contains various sensors and actuators [5]. This ensures that real-world experimentation can continue, and by working with the Arduino, students learn not only the actual learning objectives of the experiments, but also how to build electrical circuits and control and program those using computers [1].

Figure 3: Experiment kit with the Arduino, sensors, actuators, and cables (current contents)

In order to familiarize students with the Arduino, introductory experiments were developed and placed at the beginning of the practical experiments. Simple circuits are set up in which LED's serve as central components. Participants learn how to control them using the Arduino and how to program the lighting duration and frequency.

The following section focuses on the development of experiments on control loops and strain measurement in the 2022 summer semester as an example to show the effort involved in developing experiments that students can carry out at home with the materials provided.

Before the pandemic, the **control loop** experiment consisted of a plexiglass tube in which water was moved by a pump and the water level was determined by a pressure sensor (Fig. 4 l.). The development of the Praktika@home experiment involved considerable technical and methodological challenges. The first prototype consisted of a high-temperature tube and a hair dryer fan, which was used to move a Styrofoam ball. An ultrasonic sensor was used to detect its position. The target distance could be controlled with a potentiometer [5]. Holes in the tube caused pressure losses that counteracted the non-linear relationship between ball distance and motor power. The result is a linear relationship between motor power and ball height, which can be controlled with a PID controller. This corresponds to the learning objective of the original experiment with the water pump.

Figure 4: Original control loop experiment (submersible pump) (left) and components of the first prototype control loop for Praktika@Home (right) [5]

In the next step, the Styrofoam ball was moved using an Arduino controller with the aid of a PC fan with a suitable holder in a Plexiglas tube instead of a high-temperature tube (Fig. 4 r.). Distance measurement with an ultrasonic sensor, as in the prototype, was adopted and integrated into the Arduino controller. Except for the tube, the materials were included in the borrowed case. The Plexiglas tubes were distributed separately to the students present in Dresden. Alternatively, there was a DIY version for those who were unable to return to Dresden from their home countries due to travel restrictions, for example [5]. Here, too, outstanding student versions were created in DIY projects (Fig. 5).

Figure 5: Student-built control loop experiment [5]

In the 2021/22 winter semester, the experiments were redesigned so that previously developed experiments could be reused. In order to restore the original didactic concept of the lecture, an experiment for **strain measurement** was designed in parallel for the 2022 summer semester.

For implementation in the suitcases, bending beams were developed, each carrying five strain gauges (SG) that can be connected in different ways in Wheatstone bridge circuits (Fig. 6). This also allows students to experience the advantages of using bridge circuits for improving measurement signals and suppressing crosstalk.

Basic programs for the microcontroller were provided for all Arduino experiments in order to keep programming requirements to a minimum.

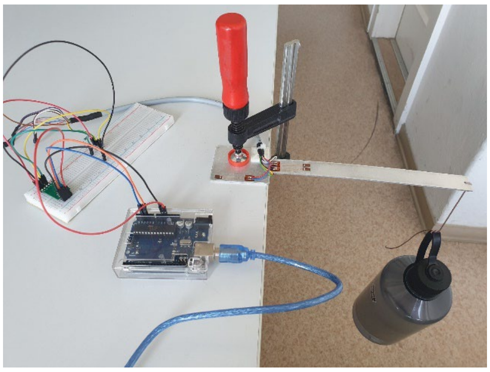


Figure 6: Overall setup of the strain measurement experiment for home use

In addition to the design, this phase included the logistical challenge of assembling, packaging, and securely distributing the cases, as well as organizing the return process.

The switch to the Praktika@home experiments resulted in significantly higher student engagement and a more positive perception of the practical course material, as described in detail in Chapter 3 on evaluation. Students used the time available at home to engage with the experimental content more intensively than usual [1].

One positive effect was the reduction in the amount of time and personnel required for on-site tutoring.

Phase 3 – Back to face-to-face learning

With the easing of contact restrictions, student counseling was moved back from the Matrix chat rooms to face-to-face sessions. As already mentioned, the didactic concept of the Praktika@home experiments with the suitcase remained unchanged, which meant that the challenge was to provide students with suitable teaching/learning formats for the consultations accompanying the practical training. A key aspect here was that, after two years of isolation, the students had to be motivated to attend face-to-face events again.

This development took place in several stages, which will not all be described in detail here. The end result is currently the concept of so-called theme days, where students not only work on direct questions about the experiments, but also on lecture content on their own.

There are a total of three theme days per semester. Each theme day covers a practical training topic (MD, MK, VPF, DMS, RK, SPS) (see Table 1).

Figure 7: Students visualizing their group work on a pinboard

For each theme day, students are given various tasks to complete at home using the Arduino kit. A total of five task complexes are distributed around the respective practical training topic. Each of these five task complexes is worked on by four independent groups of two. On the attendance days, these four groups are brought together for discussion rounds. They compare their answers, visualize them on pinboards (Fig. 7), and present them to the whole group (Fig. 8). In this way, all students in the plenary session learn about all five task complexes. With this system, up to 40 students can participate in a theme day.

Figure 8: Students in group work; control loop experiment

In these face-to-face sessions, students acquire not only subject-specific skills but also interdisciplinary skills relating to exchange within a group and the visualization and presentation of results. The theme days thus integrate the so-called 21st century skills [9] directly into a subject-specific course.

In a second round of tasks, the discussion groups are assigned further tasks that build on the results achieved so far and specifically address potential problems in the internship. These tasks are completed and presented in the same way as in the first round (Fig. 9).

Figure 9: Face-to-face event Theme day

3. Evaluation

The drastic changes described above, from traditional laboratory internships to a blended learning format, were accompanied by an evaluation based on the design-based research approach starting in the 2022 summer semester. This approach combines the development and evaluation of innovative teaching/learning approaches and is carried out in several iteration cycles, as shown in Figure 10 [6].

Figure 10: Iteration steps of the design-based research approach

The primary objective of the evaluation was to determine, from the students' perspective, the basic acceptance of the new teaching/learning concept, the time spent by the students, and the learning success achieved through the internships in order to gain insights for the further development of the teaching/learning concepts. The survey was conducted using a questionnaire containing closed questions and free text fields, which was created using the limesurvey program [8]. The survey was usually conducted at the end of each internship cycle and was therefore both summative and formative in nature [4].

Evaluation of the DMS internship (fall semester 2022)

The first run of the blended learning internship trial on the topic of strain measurement (DM) in the summer semester 2022 served as the initial design for the design-based research approach and focused the evaluation on the support services offered. At that time, this included digital consultation (interim discussion), checking the protocols submitted after the interim discussion, and a debriefing.

The results of the evaluation showed an urgent need to revise the supervision concept. Only 53% of students agreed that their questions had been answered during the consultation. For their part, the supervisors stated that the concept of the interim meeting at that time required them to respond spontaneously and adequately to unpredictable questions [4].

Furthermore, it became apparent that the planned debriefing did not succeed as intended. The necessary review of the protocols could not be carried out in the short time frame between submission and debriefing, which meant that the basis for individual feedback was lost. In addition, there was little demand for this supervision service among students.

Another point of criticism that emerged from 40% of all free comments was that students felt the internship required too much time. Students reported needing an average of 18 hours for the DM experiment, which was significantly more than the 11 hours specified in the module description.

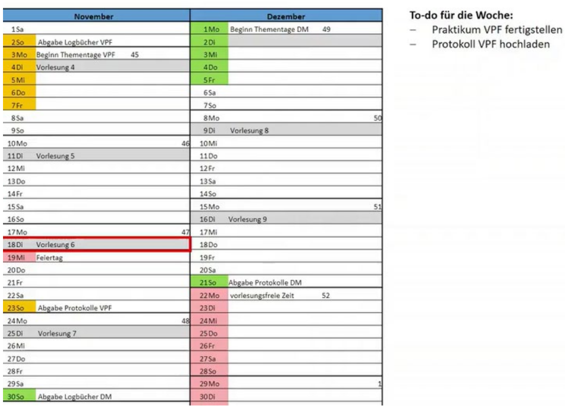
This high time expenditure was closely related to technical and structural problems. 52% of the students reported having had major difficulties in completing the internship tasks. Among other things, this was due to the difficulty of reproducing the results because of an unstable measurement system, which led to multiple repetitions of entire test series. An error in the Arduino program provided caused deviations between measurement data and theoretical values, which required a lot of time for troubleshooting. With regard to the exam performance, the analog form of the protocol was rejected by the students. Despite the difficulties, the group work was evaluated positively. 85% of the students stated that they found it easy to contribute to the group work, and 77% agreed that the group work had enabled them to engage intensively with the content.

Redesign and its evaluation (WiSem 2022/23)

The critical results of the initial design led to targeted adjustments in the next iteration. In order to improve supervision, logbooks (based on the concept of reading logs [6]) were introduced as a central element for accompanying and structuring the self-study phase. Students were asked to note their questions in the logbook and upload them before the consultation appointment. This enabled the supervisors to prepare specifically and collaboratively create a catalog of questions and answers. The aim was to relieve the burden on those responsible and create a uniform quality standard. The consultation was designed to be student-centered by using the questions actually asked by students in their logbooks as the basis for the face-to-face session. The debriefing was completely omitted due to low demand and to reduce the workload of the supervisors.

To reduce the criticized time expenditure, the task of "investigating interference" was shortened from three to only two interference factors. In addition, students were allowed to freely choose the bridge circuit, eliminating the time-consuming comparison between quarter and full measurement bridges. To support time management, the "semester overview" was newly introduced to highlight important dates and recommended tasks (to-dos) for the respective week.

This has become a permanent feature of the lecture (Fig. 11).



November		Dezember	
1Sa		1Mo	Beginn Thementage DM 49
2So	Abgabe Logbücher VPF	2Di	
3Mo	Beginn Thementage VPF 45	3Mi	
4Di	Vorlesung 4	4Do	
5Mi		5Fr	
6Do		6Sa	
7Fr		7So	
8Sa		8Mo	50
9So		9Di	Vorlesung 8
10Mo	46	10Mi	
11Di	Vorlesung 5	11Do	
12Mi		12Fr	
13Do		13Sa	
14Fr		14So	
15Sa		15Mo	51
16So		16Di	Vorlesung 9
17Mo	47	17Mi	
18Di	Vorlesung 6	18Do	
19Mi	Feiertag	19Fr	
20Do		20Sa	
21Fr		21So	Abgabe Protokolle DM
22Sa		22Mo	vorlesungsfreie Zeit 52
23So	Abgabe Protokolle VPF	23Di	
24Mo	48	24Mi	
25Di	Vorlesung 7	25Do	
26Mi		26Fr	
27Do		27Sa	
28Fr		28So	
29Sa		29Mo	1
30So	Abgabe Logbücher DM	30Di	

To-do für die Woche:
- Praktikum VPF fertigstellen
- Protokoll VPF hochladen

Figure 11: Semester schedule with the tasks to be completed each week.

The adjustments to the support concept showed a significant improvement. Student agreement with the statement "My questions were answered during the consultation" rose from 53% to 78%. This trend was also reflected in the free-text comments, with a significant decrease in criticism that questions were not answered during the consultation. The use of logbooks was particularly successful in improving supervision and the design of the consultation [4].

Although supervision was improved, the high workload (21.6 hours on average) remained the biggest point of criticism. Other learning obstacles identified were: high workload (36% of responses), implementation of the experiment (23% of responses), effort/handling of Excel (11% of responses), as many students are inexperienced in using the program and feel uncertain when errors or deviating results occur. Analysis of these challenges led to the realization that the blended learning format places new demands on students. It requires more planning and organization of their own work processes as well as coordination of partner work compared to conventional laboratory internships with fixed time slots. In addition to the pure acquisition of knowledge, a major challenge now lies in the acquisition and application of so-called 21st century skills [9] such as independence, teamwork, initiative, and creativity in problem solving, competence in dealing with media and technologies, and communication skills.

Evaluation Academic Year 2023/24

There are still six internships, three per semester. In the winter semester, students work on the topics of experimental design and error calculation (VPF), strain measurement (DM), and measurement chain (MK), and in the summer semester, they work on measurement dynamics (MD), programmable logic controllers (PLC), and control loops (RK). The evaluation in the following chapters refers only to the internships in the winter semester, i.e., VPF, DMS, and MK.

Many positive assessments were given, but weaknesses that need to be addressed also became apparent. Overall, the excessive amount of time required and the complexity and difficulty of the experiments were criticized. The unstable circuit was criticized, especially in the DM experiment.

Recommendations for action regarding the measurement chain practical, in particular regarding the wording in the logbook and the protocol, were drawn up and implemented.

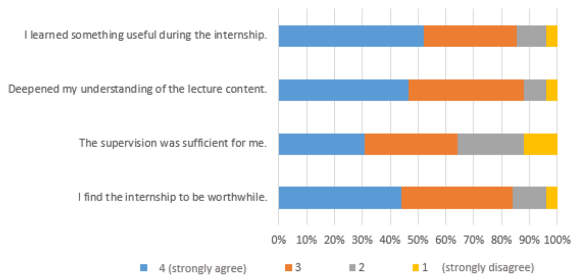


Figure 12: Student assessments of the DM 2023/24 internship

Over 70% of participants found the internship useful and learned something useful (Fig. 12). The consultation was criticized mainly in the free comments, as the students felt that their questions were not answered sufficiently. The consultation was abolished the following year and replaced by theme days (see Chapter 2, Phase 3). Students appreciate the wide range of options available (consultation, exercises, videos, instructions, etc.) and benefit from this variety [3].

Evaluation of theme days (academic year 2024/25)

The results of the most recent evaluation, from the 2024/25 academic year, show that the theme days were very well received by students as a new element of supervision within the framework of internships and that they enjoyed them (Fig. 13).

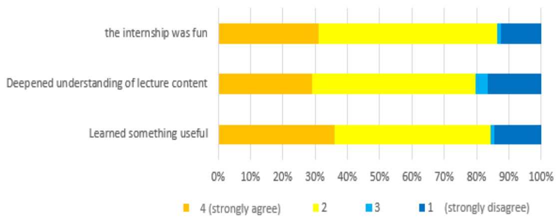


Figure 13: Student assessments of the VPF theme day

Nevertheless, some points should be addressed for revision. While the evaluation of the protocol and logbook improved compared to the previous year, the evaluation of the protocol and logbook decreased from the first to the third internship. The free comments made it clear that the tasks should be formulated more precisely.

The students were still unable to make a sufficient connection to professional practice.

The time required increased significantly from the first internship (mean = 6.4 hours) to the second internship (mean = 9.8 hours) to the third internship (mean = 17 hours). The total time required for the module is 33.2 hours.

The students also rated the achievement of the learning objectives as decreasing from the first to the third internship.

About 40% of the students used the introductory videos. The Arduino guide was used extensively, especially during the second internship (over 80%). Nevertheless, the students would like to see a better introduction to using the Arduino. The use of the Excel data streamer rose from about 25% during the first internship to over 60% in the second and third internships.

The perception of enjoyment and the deepening of lecture content also decreased from theme day one to theme day three.

The protocol continued to receive some negative criticism in the open comments. Students complained that the internship guidelines needed to be much more precise.

Another positive observation was that while over 50% of participants would have liked additional support in the 2023/24 academic year, this figure fell to less than 20% in the 2024/25 academic year.

Compared to the previous year, the introductory videos were not viewed as much.

By changing the tasks for the internship, an improved introduction to Arduino was already achieved in the 2025/26 winter semester, and it was noticeable in the ongoing internships that the students were able to deal much better with questions that required the use of Arduino.

4. Outlook

Dissemination in electrical engineering

One goal of the overall development of a new and, according to the evaluation, successful teaching/learning concept for modern science/technology internships is the dissemination of the blended learning format in the form of a combination of Praktika@home and theme days to related engineering disciplines. Currently, new Arduino experiments specializing in electrical engineering have been developed in collaboration with student assistants in order to establish a modified practical course in electrical engineering.

Although the new methods obviously pursue better learning outcomes and modern technologies, the actual introduction of the blended learning format in electrical engineering requires extensive restructuring of the current practical courses and the associated training of lecturers and professors.

Digital twin

Based on Prof. Lasch's "DigitalHerrenhut" project [10], a physical Arduino learning space is currently being digitally mapped by creating a digital twin using a 360° camera. This virtual image enables browser-based, navigable exploration of the learning space and the Arduino experiments (similar to Google Street View) from home (Fig. 14). Inside the room, the experiments from the suitcase lab are visualized and presented in multimedia format.

Students can view each experiment individually (Fig. 15) and access related documents (protocol, logbook, detailed PDF descriptions) as well as YouTube video tutorials [V1-V4]. A key technical challenge is the secure technical solution for authentication, as is currently the case with the materials on the Opal teaching/learning platform. The optimal and secure technical integration is currently being developed. The current status of the twin can be viewed online [11].

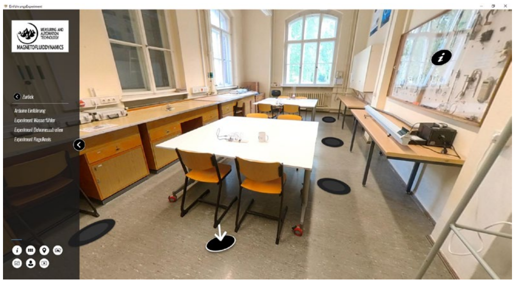


Figure 14: Screenshot: digital twin MAT internship. The 'walkthrough' and exploration is done using points on the floor. Navigation bar on the left-hand side.

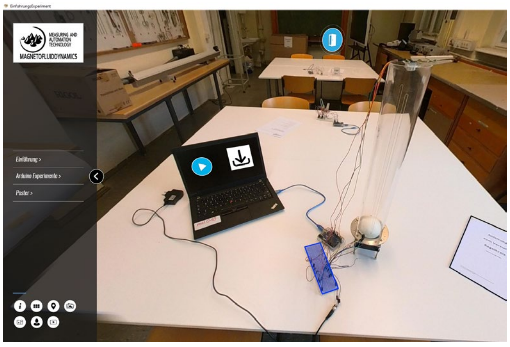


Figure 15: Screenshot: Control loop experiment – options for downloading materials (PDF, Excel), viewing photo and video details of the experimental setup, and YouTube video

Evaluation remains an integral part of the MAT module – especially for the practical, but also for the lecture and exercise. This allows elements to be improved and new elements to be reviewed in order to maximize learning success for students.

Acknowledgements

Thank you to all students of the Measurement and Automation Technology module who participated in the survey.

We would like to thank the FOSTER program at TUD (promoting excellence) for its financial support in developing the experiment kits, and the virTUos project run by the Foundation for Innovation in Higher Education, which enabled the practical training courses and their supervision formats to be developed.

We would also like to thank the Faculty of Mechanical Engineering, which provided the necessary equipment for recording the digital twin.

Literature

[1] S. Odenbach, J. Morich, L. Selzer (2021): Praktikum ohne Präsenz - geht das?, Lessons Learned Bd. 1, 1/2

[2] B. Schlegel, M. Ludwig (2022): Erkenntnisse aus der Tutorienarbeit unter pandemischen Bedingungen

[3] B. Schlegel, C. Wermann, S. Odenbach (2022): Evaluation zur Wirksamkeit der Lehre im Modul Mess- und Automatisierungstechnik, Lessons Learned; Bd. 2 Nr. 2

[4] C. Wermann, B. Schlegel, S. Odenbach (2022): Entwicklung und Auswertung der Evaluation von Praktika@home, Lessons Learned; Bd. 2 Nr. 2

[5] L. Selzer, B. Bust, J. Morich, S. Odenbach (2022): Regelkreisversuch- „vom Prototyp zur Massenwahre", Lessons Learned Bd. 2, Nr. 1

[6] C. Wermann, S. Odenbach (2023): Blended Labs in den Ingenieurwissenschaften – die Entwicklung einer Alternative zu Laborpraktika nach dem Design-Based-Research-Ansatz, Lessons Learned; Bd. 3 Nr. 2

[7] B. Schlegel, B. Watzka (2023): Wie gut ist meine Lehre (wirklich)? Studentisches Feedback konstruktiv nutzen, Lessons Learned; Bd. 3 Nr. 2

[8] Limesurvey-Umfragetool https://bildungsportal.sachsen.de/umfragen/

[9] Partnership for 21th Century Learning – A Network of Battelle for Kids (2019). https://www.battelleforkids.org/net-works/p21/frameworks-resources (20.11.2025)

[10] https://tu-dresden.de/bereichsuebergreifendes/virtuos/einzelvorhaben/digitalherrnhut (09.12.2025)

[11] https://my.matterport.com/models/44Sy5jsjCC7?section=media (09.12.2025)

Youtube-Videos:

[V1] Versuch „Digitale Bildverarbeitung": https://youtu.be/LHhgr0nVBQI

[V2] Versuch „SPS": https://youtu.be/59xzLzSklWw

[V3] Versuch „Messdynamik": https://youtu.be/m-v4U2nx25Q

[V4] Versuch „Versuchsplanung und Fehlerrechnung": https://youtu.be/GzEDpFrs7tU

Lessons Learned 5, 2 (2025)
Submitted: September 16, 2025
Accepted: January 13, 2026

DOI: https://doi.org/10.25369/ll.v5i2.102
ISSN: 2749-1307

DikoLint: Design, communication, and interculturality in virtual learning settings – lessons learned from a subproject of virTUos

L.-M. Langesee

Center for Interdisciplinary Learning and Teaching, TU Dresden

Abstract

The DikoLint subproject, embedded in the STiL-funded joint project virTUos at the Technical University of Dresden, aimed at the systematic further development of Virtual Collaborative Learning (VCL) in international teaching contexts. The focus was on the didactic modeling of complex case scenarios, the intercultural qualification of student e-tutors in tandem structures, and the development of feedback and intervention indicators for proactive learning support. The project was supplemented by the integration of digital tools such as conversational agents and gamification elements. The results show a high transfer potential to other virtual, interdisciplinary, and international teaching formats, especially COIL settings. DikoLint thus makes a substantial contribution to the strategic further development of the VCL framework and supports universities in the professional, sustainable, and internationally compatible design of digital learning offerings.

Das Teilprojekt DikoLint, eingebettet in das STiL-geförderte Verbundvorhaben virTUos an der Technischen Universität Dresden, zielte auf die systematische Weiterentwicklung von Virtual Collaborative Learning (VCL) in internationalen Lehrkontexten. Im Zentrum standen die didaktische Modellierung komplexer Fallszenarien, die interkulturelle Qualifizierung studentischer E-Tutor:innen in Tandemstrukturen sowie die Entwicklung von Feedback- und Interventionsindikatoren für eine proaktive Lernbegleitung. Ergänzt wurde das Projekt durch die Integration digitaler Tools wie Conversational Agents und Gamification-Elementen. Die Ergebnisse zeigen ein hohes Transferpotenzial in andere virtuelle, interdisziplinäre und internationale Lehrformate, insbesondere COIL-Settings. DikoLint leistet damit einen substanziellen Beitrag zur strategischen Weiterentwicklung des VCL-Frameworks und unterstützt Hochschulen bei der professionellen, nachhaltigen und international anschlussfähigen Ausgestaltung digitaler Lernangebote.

*Corresponding author: lisa-marie.langesee@tu-dresden.de
This article was originally submitted in German.

1. ntroduction

The increasing digitization of university teaching brings with it not only technical challenges, but above all didactic and organizational ones. Virtual collaborative learning environments (VCL) are considered forward-looking teaching formats in higher education that enable students to actively participate in learning processes across locations [1]. At the same time, they place high demands on didactic design, support from teachers, and the social and intercultural skills of participants [2].

Against this background, the subproject DikoLint (Anchoring Digital, Collaborative Learning in International Teaching at TUD) was initiated at the Technical University of Dresden as part of the STiL-funded joint project virTUos. The aim was to develop, test, and optimize systematic standards and model solutions for virtual teaching and learning settings. The focus was particularly on the further development of didactic design patterns and the development of intercultural and digital skills among student e-tutors.

In addition, the iterative development of support instruments—such as feedback indicators and digital tools—was intended to achieve a sustainable improvement in quality in virtual teaching practice. The subproject thus sees itself as a contribution to the professionalization and standardization of VCL scenarios in international contexts.

2. Virtual Collaborative Learning

Virtual Collaborative Learning is a learner-centered approach in higher education based on problem-oriented learning [3]. Students work together in small, often interdisciplinary groups to solve real-world case studies – usually using digital collaboration tools and in both synchronous and asynchronous phases. The aim is to promote not only technical skills, but also social, intercultural, and digital skills [4].

A VCL project typically comprises four central design elements: (1) a realistic case study with authentic tasks, (2) a suitable technical platform to support collaboration, (3) professional didactic support, e.g., by qualified e-tutors, and (4) the use of learning analytics to evaluate and control learning processes.

The groups usually consist of four to six people, with heterogeneity in terms of culture, prior knowledge, and perspectives being expressly desired in order to enable multi-perspective problem solving. Active participation by all members is encouraged through role allocation, structured tasks, and a high degree of self-organization. The combination of case work, digital cooperation, and interdisciplinary exchange specifically prepares students for complex challenges in their future professional lives [4].

Figure 1 graphically illustrates the four key components of a VCL.

Fig. 1: Components of a VCL.

3. Results from the subproject DikoLint

The DikoLint subproject has produced key results in several development cycles that have contributed to improving the quality and systematization of virtual collaborative teaching and learning scenarios. The four key components are explained in more detail below:

1. Subject-specific adaptable design models for case scenarios

Based on the concept of didactic design patterns, subject-specific models were developed that enable the structured and theory-driven creation of case studies. These patterns were designed to be applicable across domains and adaptable to the respective disciplinary requirements. The patterns provide didactic guidance for the design of realistic, complex case studies and promote collaborative problem-solving processes. They cover aspects such as degree of complexity, role distribution, task interdependencies, and requirements for communication and decision-making pro-cesses. The patterns have enabled standardization to be achieved while still allowing room for individual adaptation. The procedure for creating a case study is individual and must be adapted to the target group. The presentation by Jantos et al. (2024) [9] provides a good insight into the process.

2. E-tutor tandems to promote intercultural and digital skills

A key innovation of DikoLint was the introduction of a tandem model for training student e-tutors. Two tutors – ideally with different cultural backgrounds – were assigned to each international student team. The e-tutors came from Germany, Albania, and Ukraine. These tandems worked closely together, regularly exchanged ideas about group dynamics and didactic interventions, and supported each other in their professional development. The focus was on building intercultural sensitivity, targeted reflection on diversity, and the acquisition of digital support and moderation skills. The combination of collegial consultation, peer learning, and practical application led to a significant increase in competence and contributed to the professionalization of e-tutoring practice.

3. Development of intervention and feedback indicators

To ensure the quality of support in virtual scenarios, indicator-based tools were developed for e-tutors. These are designed to enable proactive support of learning processes and help to systematically determine appropriate times for interventions as well as the form and content of feedback. The indicators include criteria for assessing group communication, work progress, role assumption, and conflict management. The toolkit was tested iteratively in the project and continuously refined. It now provides a differentiated basis for didactic action in digital contexts and supports consistent and transparent support practices [8].

4. Integration of digital tools: conversational agents and gamification

To promote motivation and engagement, conversational agents and gamified elements were experimentally integrated into the learning scenarios. Conversational agents were used, for example, to answer frequently asked questions or to remind users of deadlines, and were received positively for the most part, although their integration required a great deal of didactic planning. Gamification elements such as points, progress bars, or playful challenges were used in a moderate form to increase activity, especially in asynchronous phases. Experience has shown that the use of digital tools is particularly effective when they are closely linked to learning objectives and embedded in a didactically sound manner. However, the integration of technical innovations remains a dynamic area of development that requires continuous evaluation and adaptation [7].

A supplementary quantitative evaluation from the DikoLint context [5] shows that the platform functions used in virtual collaboration are widely accepted. In particular, the use of audio/video calls, file storage, and group chat functions was rated as suitable by over 94% of participants. At the same time, over 50% of students wanted more transparency with regard to assessment and formative feedback, especially in comparison with other groups. This feedback underscores the relevance of the feedback and intervention indicators developed in the project.

The use of gamification was assessed differently: while the majority of participants in the English-language module tended to reject it, their German-speaking counterparts were more open to it. These results provide important insights for the differentiated design of digital motivational elements. It also became clear that clear expectation management and transparent communication about supervisory roles, especially for e-tutors, contribute significantly to satisfaction.

In summary, it can be said that the DikoLint subproject has made a significant contribution to the further development of the VCL framework. The systematic development of didactic models, qualification through tandem models, the introduction of structured feedback indicators, and the experimental integration of innovative tools have produced concrete models of action that not only increase the quality of digital learning processes but also promote the professionalization of those involved. Particularly noteworthy is the successful combination of didactic theory and practical implementation, which results in a highly transferable and adaptable framework.

These results substantially expand the existing VCL concept by opening up new perspectives on role understanding, supervision, digital interactions, and structural standardization. Especially in international contexts, they offer starting points for not only enabling virtual collaboration, but also for designing it in a didactically sound and sustainable manner.

These findings form the basis for the transferability of the approaches developed in the project to other contexts and formats, as outlined in the following section.

4. Transferability of results

The concepts, methods, and tools developed in the DikoLint subproject can be transferred to a large extent to other virtual collaborative teaching contexts. This applies in particular to Collaborative Online International Learning (COIL) formats, but also to other international or interdisciplinary online teaching and learning scenarios. The modularity of the developed building blocks and their orientation toward generic didactic principles enable flexible adaptation to different institutional, cultural, and curricular conditions.

Particularly noteworthy are:

- **Didactical Design Patterns:** These enable the systematic design of case studies in different disciplines. Their openness to different thematic focuses and their structuring character support rapid and high-quality implementation, even in new contexts.
- **Tandem qualification of e-tutors:** The combination of intercultural and digital competence development in a peer learning approach is not only innovative but also scalable. The tandem approach can be easily transferred to new languages, subject cultures, and organizational forms.
- **Feedback and intervention indicators:** These provide a sound basis for quality assurance in support services. They enable e-tutors to take data-driven, reflective, and adaptive action in very different contexts.

Furthermore, the experience gained in the project shows that transferability applies not only at the methodological level, but also at the structural and organizational levels. For example, role distributions, process structures, or qualification concepts for tutors can serve as blueprints for other universities or international partner projects.

Through the targeted combination of theoretically sound and practically proven elements, DikoLint contributes to the scalability and internationalizability of VCL formats. The models developed enable the sustainable, quality- and inclusion-oriented further development of digital learning environments and make an important contribution to the future viability of higher education in globally networked contexts.

5. Lessons Learned

The analysis of the DikoLint project has shown that key success factors for virtual collaborative learning settings can be clearly identified and are effective across different contexts. In particular, continuous support from qualified e-tutors, clear didactic structuring via design patterns, and sensitive handling of cultural diversity have proven to be crucial for successful international collaboration.

In the course of the project, it became clear that purely technical solutions alone are not sufficient to enable sustainable learning. Rather, it depends on didactic embedding, clear communication structures, and transparent role distribution. Iterative reflection on group dynamic processes, supported by defined feedback and intervention indicators, has established itself as an effective means of quality assurance.

It also became apparent that the combination of innovation (e.g., through the use of conversational agents) and proven pedagogical principles (such as the promotion of self-organization and personal responsibility) forms a viable basis for sustainable teaching formats. The findings from DikoLint thus not only provide practical knowledge for the further development of the VCL framework, but also strategic impetus for universities that want to expand their international teaching offerings in a didactically sound manner.

6. Conclusion

The DikoLint subproject has made an important contribution to the strategic development of virtual collaborative teaching formats as part of the virTUos joint project. The aim was to develop didactically sound, interculturally compatible, and technologically viable models for international university teaching – and this goal was achieved in key areas.

In particular, the combination of scientifically sound design principles with concrete, tried-and-tested methods represents real added value. The developed didactic design patterns, the tandem model for e-tutors, indicator-based feedback systems, and the reflective use of digital innovations such as conversational agents provide a whole repertoire of tried-and-tested measures. These building blocks not only strengthen the quality of individual courses, but also offer universities a structured orientation framework for the long-term integration of VCL formats.

It is particularly noteworthy that DikoLint is not only a further development of existing formats, but also provides new impetus for international digital teaching. The project shows that VCL should be understood not only as a methodological tool, but also as a strategic element of internationalization and digitization in higher education teaching.

Thanks to the transferability of the concepts developed, DikoLint can also have an impact beyond the specific project framework. Universities working on the qu ality, scalability, and sustainability of their virtual and international teaching offerings will find a wide range of starting points here. The Didactical Design Patterns can be used for this purpose [6].

Overall, the project confirms that the combination of good didactic design, intercultural sensitivity, and targeted use of technology is the key to successful virtual cooperation formats. DikoLint provides a consistent, practical, and connectable model that contributes to the further development of the VCL framework and provides universities with long-term support on their way to sustainable, international teaching practices. DikoLint offers valuable experience and clearly structured approaches that enable the sustainable further develop-ment of virtual and intercultural learning contexts. Its clear transferability and proven success factors, such as design patterns, tandem qualification, and proactive communication, make the project a source of inspiration for future virtual collaboration projects.

Acknowledgements

The DikoLint subproject was made possible by the generous support of the Foundation for Innovation in Higher Education. We would like to express our sincere thanks to the foundation for its financial support and the trust it has placed in our research and development. Without this support, it would not have been possible to implement the measures described and generate the insights gained in this form.

Literature

[1] Bates, A. (2015). Teaching in a Digital Age. IRL @ UMSL. https://irl.umsl.edu/oer/6

[2] Ware, P. (2013). Teaching comments: intercultural communication skills in the digital age. Intercultural Education, 24(4), 315–326. https://doi.org/10.1080/14675986.2013.809249

[3] Tawileh, W., Bukvova, H. & Schoop, E. (2012). Virtual Collaborative learning. In IGI Global eBooks (S. 380–410). https://doi.org/10.4018/978-1-4666-2515-0.ch014

[4] Altmann, M., Langesee, L.-M., Jantos, A., Cool, S., & Müller, C. (2024). Design Dimensions of Virtual Collaborative Learning – Synthesizing Iterative Research. In Handbuch E-Learning (106. Erg.-Lfg. Februar 2024), S. 99–119.

[5] Berger, V., Langesee, L.-M., Altmann, M., & Schmidt, S. (2023). Lessons Learned aus der Iterativen Weiterentwicklung von Kollaborativer Online Lehre. In T. Köhler, E. Schoop, N. Kahnwald, & R. Sonntag (Eds.), GeNeMe 2022 Proceedings (pp. 98-103). TUDpress. https://doi.org/10.25368/2023.15

[6] https://patterns.im.wiwi.tu-dresden.de/start

[7] Volkmann, N. & Schmidt, S. (2022). Design pattern for conversational agents handling data-driven requests. Workshop Gemeinschaften in Neuen Medien (GeNeMe) 2022. TUDpress - Verlag der Wissenschaften

[8] Altmann, M. & Arnold, M. (2024). Designing formative feedback in collaborative online international learning. Human Systems Management, 1–18. https://doi.org/10.3233/hsm-230100

[9] Jantos, A., Kilz, L., & Krohn, M. (2024). „Führerschein für Digitalkompetenzen“: Vorstellung und Evaluation eines interdisziplinären Virtual Collaborative Learnings. Zeitschrift für Hochschulentwicklung, 19(2), 159–180. https://doi.org/10.21240/zfhe/19-2/08