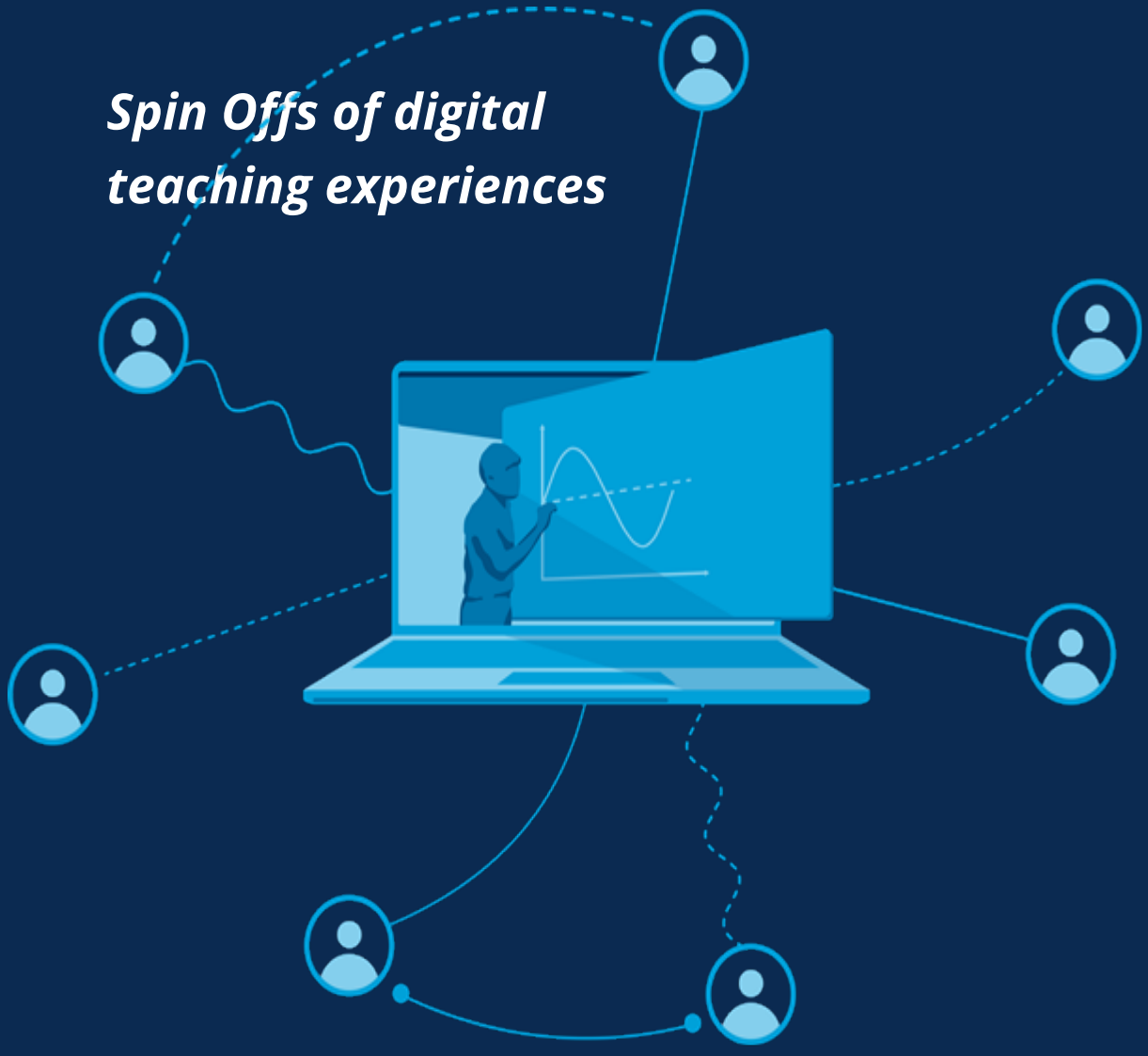
TECHNISCHE UNIVERSITÄT DRESDEN

Lessons Learned

Spin Offs of digital teaching experiences



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FAKULTÄT MASCHINEN WESEN

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.

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Faculty of Mechanical Engineering,
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Contact:

Prof. Dr Stefan Odenbach

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

Editorial

When the third ***Lessons Learned Conference*** was held at TU Dresden in fall of 2021, it was unclear not only in Dresden but at many universities in Germany what form the winter semester would take. The only certainty was that there would be no complete return to the form of teaching that had existed before the pandemic. Therefore, the teachers had the complex task of preparing for a semester that would either take place in the already known purely digital form or alternatively could be designed as a hybrid semester.

It had already become clear during the preparation of the semester that the implementation of a hybrid form would be accompanied by extreme additional technical and personnel burdens. At the same time, it was clear to all teachers that the enrollment of a further year in a purely digital form of university teaching after two years of pandemic and thus for the affected freshmen after two years of digital school structure would lead to considerable structural as well as learning and teaching difficulties.

In this area of tension and against the background that the staff members at the chairs were fatigued by the immense additional workload of the digital semesters, numerous complex and essential questions arose that had to be discussed during the conference. Accordingly, this third issue of the ***Lessons Learned Journal*** will naturally report on new developments in teaching formats, but will also address the question of the extent to which the newly developed formats from the digital era can be embedded in hybrid structures, if necessary. Thus, this issue of the journal comes very close to the original intention of the ***Lessons Learned Conferences*** and thus also of the ***Lessons Learned Journal***, namely the question to what extent novel teaching structures can find their way into the further development of teaching after the pandemic. With this transition from purely digital structures to structures that combine presence, digital elements and novel teaching formats, the modernization process of teaching at universities will continue and be raised to a new level.

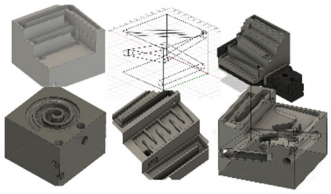
At the time of this issue's publication, most of the 2022 summer semester is behind us. After the pandemic, this was the first semester in which most universities in Germany were able to return to largely face-to-face teaching. Thus, the academic exchange between learners and between learners and teachers could be improved again. The fourth Lessons Learned Conference and thus the following issue of the Journal in fall will show for the first time to what extent the newly developed teaching formats have really found their way into regular teaching.

However, the return to face-to-face teaching in no way means that the modernization process that was initiated is over or even obsolete. On the contrary, the momentum of the past two years must now be used to vigorously drive forward, consolidate and evaluate the process of modernizing university teaching that has already begun.

With this in mind, we hope that reading the third issue of the ***Lessons Learned Journal*** will provide you with many ideas for shaping your teaching, and we look forward to the fourth ***Lessons Learned Conference*** and the fourth issue of the Journal planned for fall.

Stefan Odenbach

Range of topics

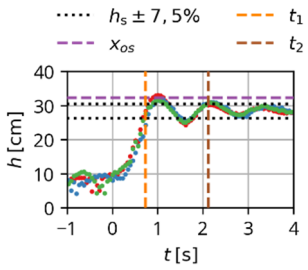


The further development of the formats, which were tested in the first Corona phase in quasi emergency operation, into modernized academic teaching has been one of the challenges of Corona semesters 2 and 3 and will be with us for a long time to come

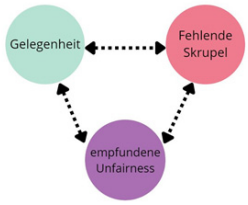
Novel formats

Exercise operation - in all its forms, from tutor training to the actual operation of exercises to online task pools - is one of the great challenges of hybridized teaching

Exercise operation



A wide variety of formats - from digital solutions to home-based practicals - were established in the field of practical exercises right at the start of the Corona crisis, and these now need to be further developed.



From the first day of digital semesters, the issue of cheating on online exams has been a pervasive topic. Here, we shed light on causes and consequences for the first time.

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Coping with teaching under corona conditions at one of the smaller universities

H. Witte*, T. Helbig, C. Hönemann, S. Lutherdt, S. Wenzel

Group of Biomechatronics, Faculty of Mechanical Engineering, Institute for Mechatronic System Integration (IMSi), Interfaculty Institutes for Micro- and Nanotechnologies (IMN), Life Science Technologies (LiSTec) and, Intelligent and Interactive Immersive Media and Technologies (I4MT), Technische Universität Ilmenau.

Abstract

Die Technische Universität Ilmenau versucht auch unter „Corona-Zwängen“ durch Kontakteinschränkungen in Kombination mit begrenzten Lehrkapazitäten Seminare, Übungen und Praktika angemessen durchzuführen und die Lehre nicht zu vorlesungslastig werden zu lassen. Die Seminar- und Praktikumsräume gaben jedoch auch unter intensiver zeitlicher Raumbewirtschaftung von 7 Uhr bis 21 Uhr „zentral“ wie durch die Fachgebiete bei Einhaltung der Hygienevorschriften keine ausreichenden Kapazitäten zur Durchführung in Präsenz her.
Der Beitrag berichtet daher über von uns getestete Möglichkeiten zur Umsetzung der etablierten Lehrformate in Onlineformate. Zusätzlich werden Lösungen zur sicheren Realisation von Präsenzprüfungen unter Pandemie-Bedingungen dargestellt.

The Technical University of Ilmenau tries to conduct seminars, exercises and practical courses appropriately even under "corona constraints" due to contact restrictions in combination with limited teaching capacities and not to let the teaching become too lecture-loaded.
The seminar and practical course rooms, however, did not provide sufficient capacities for the implementation in presence even under intensive time management from 7 a.m. to 9 p.m. "centrally" as by the departments in compliance with the hygiene regulations.
The article therefore reports on possibilities tested by us for the conversion of established teaching formats into online formats. In addition, solutions for the secure realization of face-to-face examinations under pandemic conditions are presented.

*Corresponding author: Hartmut.Witte@tu-ilmenau.de

1. Framework

Prior to the first Corona wave, digital instruction at our university was tried out only sporadically under experimental clauses. GOLDi [1] has gained visibility across the university. Like many other institutions, we as the people forming "the university" were thus forced to move rapidly at the beginning of the first corona wave and were not adequately prepared for the situation. In this regard, due to the process of reviewing data privacy security and legal aspects, the decision which videoconferencing system to use as the "backbone" of online teaching was made rather late and then became mandatory for classroom use for all of us. In the selection process, there was no participation of users or of usability experts, who are well represented among the university. experts.

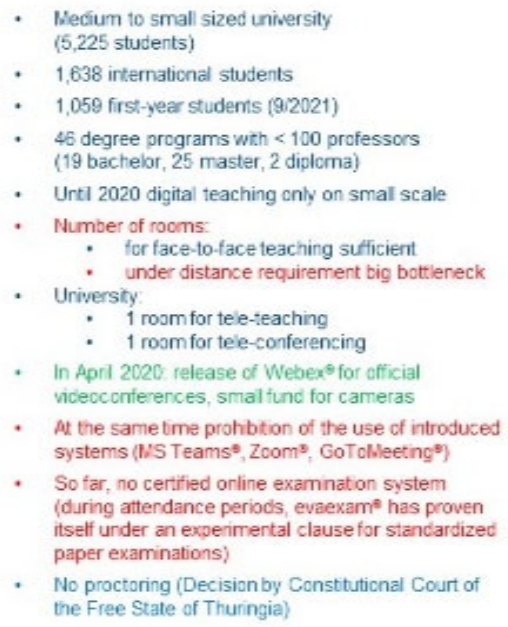

Fig. 1: Framework conditions for digital teaching at Technische Universität Ilmenau at the beginning of Corona pandemic.

Since many groups had already established other videoconferencing systems on their own initiative and had prepared the lessons in time for the start of lectures, the short-notice changeover resulted in considerable friction losses and significant additional work. The situation was similar during the audit period. For reasons of data protection and legal certainty, the existing Moodle communication platform was used as a tool for conducting examinations in accordance with the rules, the limited usability of which also led to unnecessary additional work for examiners and examinees. In the next term, these organizational problems mostly were eliminated.

Support for the introduction of educational software (or integration as far as already used by individual subjects before the pandemic) did not take place due to lack of resources. For further details, see Fig. 1.

Therefore, measures of teaching unit self-support should be reported below.

2. The largest problem: converting face-to-face internships into online formats

In biomechatronics, practical experiments naturally also contain a bio-component on the object side. Due to the support of "Biomedical Engineering" course alongside the "Biomechatronics" course and in view of the job profiles of both courses, non-invasive observation experiments with measurements on humans are also carried out, whereby the test subjects are the students themselves in turn - anyone who wants to carry out investigations on humans must know the perspective of the test subject from their own experience. This is the only way to ensure a user-oriented design of experiments with humans (ensuring biocompatibility), starting with the aspects "stress/strain" (teaching content of our occupational science courses) and "reasonableness". If interested, our students learn about observational experiments with animals in qualification theses supervised together with the Institute of Systematic Zoology and Evolutionary Biology at FSU Jena (e.g. as a preparation for the construction of bio-inspired robots).

All of these experiments have so far only been feasible in the presence of people and could not be realized under contact prohibition. The following example illustrates the adaptation to pandemic conditions (Figs. 2, 3).

In three experimental parts, working capability is first established in the use of an Arduino®-µC (reading in sensor data); the prior knowledge of the students varies greatly here due to the lack of suitable training units in the

courses of study. Then the familiarization with a commercially available demonstrator for a single-joint exoskeleton (EduExo®) with EMG sensors takes place. In the third part, the Arduino® training is supplemented by the control of actuators, a control loop is set up that lets the EduExo® follow the arm movements of the subjects.

Fig. 2: Practical course "Fundamentals of Biomechatronics" in presence: Design of a control loop for controlling an exoskeleton with EMG data.

Fig. 3: Supplementing the control loop for controlling an exoskeleton with EMG data by means of a remote connection (IP4).

A fourth part was added to the experiment for online use.

The system is connected via IP to a remote measurement and control computer. Depending on the conditions provoked by Corona pandemia, either the online access can be made directly via the university internal (IP4) network or, if the university buildings are off-limits, via VPN from the student home office. The combination of both variants and the possibility to compare them due to the presence of the supervising internship assistant near the hardware at the university leads to animated discussions about the observed latency times and the state of broadband expansion in Germany.

In the next extension, a control option via a mobile terminal (G5 standard) will follow. The overall construct will also continue to be used during presence times.

Lesson learned: "Corona" as an innovation impulse

While the mechatronic part of the training was relatively easy to adapt to online teaching by using mechatronic solutions, the Bio-X part posed significantly larger problems.

For both of the above-mentioned courses of study, anatomical and physiological knowledge is the professional basis. Therefore, since the foundation of the department in 2002, lessons tailored to the target group of engineers have been offered. Until about 2010, anatomical demonstrations in the dissecting room of Anatomical Institute at FSU Jena (two of the FG staff members had extensive experience in supervising courses in macroscopic and microscopic anatomy) were offered on a voluntary basis. Due to newly emerging insurance restrictions (conducting student missions outside the Bologna Excel® table of curricular events; risk of accidents in the dissection room), we had to switch to the use of abattoir material for independent dissection by students in 2010. Insurance coverage has been reinstated for performances in our teaching rooms.

The view into other institutions, which is necessary for interdisciplinary teaching, was thus once again successfully prevented.

Fig. 4: Knee joint - top: Anatomical demonstration on the dissection room - bottom: independent dissection on slaughterhouse material (pig).

The preparation is performed in groups of three students (holding and positioning the material, preparation, assisting with the preparation), with the roles being regularly exchanged (Fig. 4).

Under the spacing requirements of Corona Prevention, implementation was not possible.

As a substitute, the use of software for the virtual dissection of a human being (f/m - this deserves special mention, most products even today only offer the male anatomy) was tested and found to be very helpful by all participants (Fig. 5).

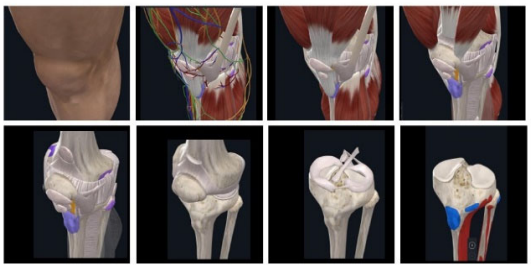

Fig. 5: Knee joint - independent virtual dissection on humans (f/m) in Complete Anatomy ® (Elsevier), own screenshots.

The acquisition took place in January 2022 (the time of the conclusion of this article), now only data protection hurdles have to be overcome for the deployment (advised from summer term 2022, then two years will have passed since the beginning of the pandemic).

From summer term 2022 the change from study subjects (3 LP) to study modules (5 LP) is complete. The new module "Anatomy and Physiology" will consist of lectures and an additional offer of virtual (!) dissection on humans. The module "Human Serving Systems" will also offer focused virtual dissection on humans as a preparation for and accompaniment of practical courses and will be supplemented by dissection on slaughterhouse material.

Lessons learned:

- Objective constraints are inventive and accelerate developments that have been planned for a long time. - Digitization requires the cooperation of all stakeholders to achieve the goal.
- The triad - "theory - practice in presence - both accompanied by software" - promises maximum learning effect (also through subject-specific addressing of students in different ways with focus according to individual preferences).
- The already occurred arithmetical increase of the teaching scope (previously four hours of teaching per week = 2 x 3 LP = 6 LP, now 5 LP, leading to 20% more workload for students) with the same teaching capacity (thus also 20% more teaching capacity required) will foreseeably be offset with the "lower effort for digital teaching" (corresponds to the starting position of all "digital naives").
A small university like ours thus runs the risk of becoming undercritical in terms of human resources and therefore also in terms of subject matter due to shrinkage.

3. Adaptation of lectures and seminars to online conditions

Various technical problems are associated with the compulsion to use video conferencing systems. Here, we can only refer to the different user orientation in the development of

such commercial solutions for the industry. The readers will be able to contribute their own experiences in dealing with the five "big" offers after the pandemic. None of the systems is really adapted to the needs of teaching. Ob-

jectively, "hybrid" teaching is particularly burdensome: face-to-face lectures in the lecture hall (which is too small for pandemic conditions) and their simultaneous online transmission. The lectures with two dates per week were divided into a "Monday group" and a "Thursday group" (attendance days). The (subjective) stress of the lecturers could be reduced in view of teaching rooms not equipped for this after optimization by using two transmission chains (laptop video-audio beamer and laptop video-internet), but the use of a "virtual board" (iPad to MacBook) leads to a similar stress level as playing a "hooked" organ. The "Pingo" queries during lectures, which were common in presence, were completely skipped; this would have required two people to operate the technology.

After the cancellation of the face-to-face classes for larger groups, the again online-only lectures were video-documented and made available via "Moodle" to avoid any disadvantages for the students who had meanwhile started attending other courses on the other date of the week.

It should also be noted that for mobility-impaired instructors, transporting two complete sets of computer equipment to each event date causes significant physical strain.

Biomimetics has become a routine method in those twenty years since the bionics competence network "BioKoN" was founded, thanks to the high level of commitment of the German biomimetics community.

With the onset of the pandemic, the long-time lecturer in the subject "Technical Biology and Bionics" had to retire prematurely due to health reasons. As he lived this course due to the didactic skills of the PhD biologist from the descriptive presentation "on the object" to excursions into nature, the takeover of the course by "non-biologists" was inevitably connected with a change of the didactic concept (see Fig. 6).

Since a partial integration of the contents of the subject into the new modules "Biologically oriented methods of engineering" and "Biomechatronics" is planned soon, the technical-biological part with the example considerations and the presentation of the bionics-oriented transfer methods incl. VDI guidelines was shortened to about half the scope in the terms until then, and agile methods (e.g. an adapted Scrum model) were introduced and applied in the other half. The participants first worked out concepts for "products" proposed by the group(s) "naively" and then step by step in three to four "sprints" (Fig. 6).

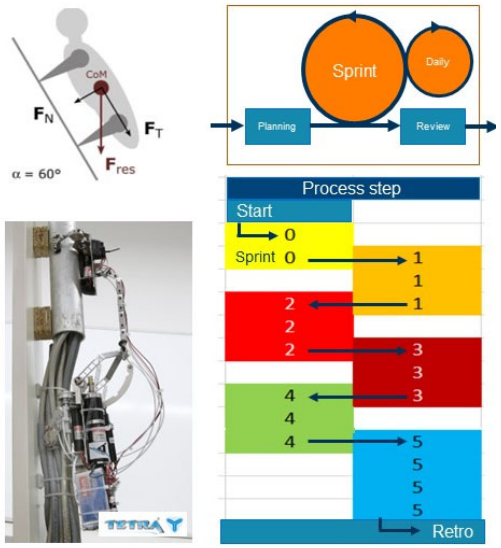

Fig. 6: "Technical biology and bionics" of climbing (left) complemented by group work with agile methods (right).

Due to the necessity of the guidance by a "Scrum Master" the personnel expenditure was doubled, in the end even more than doubled, because from week to week an adjustment to the course of the group work had to be prepared and followed up. The initial skepticism of the students trained in "waterfall methods" only slowly subsided, but in "learning by doing" more than half of the participants could be convinced to include agile methods in their repertoire in the future. In the first master's year, in which participants of the event are represented, we already see significant improvements in group work; previously it took about one semester longer until group work ran routinely.

Lessons learned:

Once again, it is shown that the direct linking of theory and one's own application of the

methods presented results in the greatest learning success (acquisition of knowledge and skills on an equal footing). "Alienation effects" are equally well-known means of motivation. Didactic concepts do not have to become "completely different" "because of digitization," but their implementation must be adapted.

4. Presence tests under corona conditions

In the first "corona semester", there were still face-to-face examinations. Organizational and technical adjustments were necessary to comply with hygiene regulations (see Figs. 7, 8).

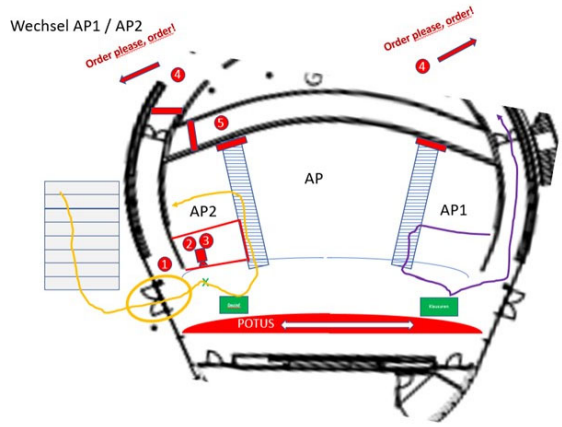

Fig. 7: Planning of inlet, feed-through and outlet during presence testing while avoiding contacts with distances < 2.50 m during the overall process: application of methods of logistics, production planning and control

The further examinations took place in "Moodle" as "Examination-Moodle", developed by the Computer Center of Technische Universität Ilmenau using a different spectrum of Moodle functions and orientation on guidelines of personal data protection and the codified examination regulations. The problems of missing possibilities for "proctoring" could not be compensated, there was nothing to be noticed of social loneliness of the students in view of the exam results, at least exam-related (obviously the students had learned very diligently in large groups in intensive information exchange).

Fig. 8: Admission to presence examinations avoiding contacts with distances < 2.50 m between examiners and students (with simultaneous control of the distances in the queue by "Chief Whips"). Realization of suitable devices and setups for identity control without computer-usable data storage (restriction to entry in attendance list on paper).

5. Unresolved issues

We have all suffered the problem of the "tile wall" (or also the "black hole") to a greater or lesser extent. Especially with larger groups of Bachelor students, the gray tiles proved to be increasingly "hardened" as the pandemic progressed; even after intensive requests by the instructors, no eye contact was made even by the questioners - most participants did not even have a video camera ready.

The well understandable argument was "If we all turn on the camera, the bandwidth is not sufficient". A technical evaluation would be desirable for this.

There is an increasing divorce into well-functioning social clusters and extensive segregation of lone wolves.

For online teaching, analogous to "netiquette", a (at least informal) code is urgently needed to counteract the social deprivation of all participants.

6. Lessions learned

In addition to what has been discussed so far, a number of other observations can be made, questions can be formulated from those and, in some cases, hypotheses can be derived.

- The initial problems with support from the employer provokes the "now more than ever" attitude of the teaching engineers and awakens creativity and the joy of experimentation ("We've wanted to ... for a long time").
- Long-planned changes in teaching ("We don't have time for that now") are triggered.
- The exchange between teachers and students becomes more subject-related, but there is hardly any reduction in the personal distance.
- In some cases, students do not identify with "my" university and "my" teachers. Exception: in the case of 1:1 supervision of qualification theses.
- Student grant requirements have increased sharply - problem with teaching capacity, research falling by the wayside.
- Our experience under pandemic conditions: the grade may be dropped - attendance at "less important" events decreases.
- Group formation works without problems, especially for exams via social media (which is prohibited), but not for the entry in planning lists for the organization of studies and thus relieving teachers.
- Students are still keen to experiment, but the typical initiative of engineering students is on the wane
  ("Just 'try it out!" is replaced by "Where's the animator here?")
- The versatile gifted students "take off". The "promotion of the gifted" only works when students are seeking contact and is not as pronounced among engineering students as it is in other courses of study. "Best selection" takes on a social Darwinian character.
- Corona discipline among students (as far as observable on campus) is higher than among many employees.
- Mystery: why is "home 3D printing at university" highly attractive during attendance times, but hardly in demand under home office conditions despite accessibility of the labs? Has "Corona" established "home 3D printing"?

Without reasonable tools for online exams, online teaching primarily is entertainment.

7. Bogus solutions and solutions: Awakenings

As always at universities, money is not everything, but without money everything is nothing. This applies equally to personnel capacities and infrastructure.

At the beginning of the pandemic, the lighthouse project for digitized teaching at Ilmenau University of Technology was "SIMGAM" (simulations and games in the self-learning phases of a blended learning basic course). The project is funded by the joint program "Fellowships for Innovations in Digital University Teaching" of the Donors' Association for the Promotion of Sciences and Humanities in Germany and the Thuringian Ministry of Economics, Science and Digital Society with 50,000 € for 12 months. Anyone who has the illusory giant Mr. Tur Tur in their mind's eye when they think of "lighthouse" is certainly not entirely wrong.

Why us and our institution were hit so "unexpectedly" by the need for digital teaching certainly has a variety of causes. This may be analyzed later by experts. However, in the third year of Corona, the Free State of Thuringia has still not provided any funding for digital teaching projects, and Technische Universität Ilmenau had to pull itself in front of the cart by acquiring foundation funds.

8. Next steps

In order not to sleep away the future in inactivity, we are working as a member of the Ilmenau team "examING" (as one of 139 projects funded by the Foundation Innovation in Higher Education in the federal-state program "Strengthening Higher Education through Digitization), in the project "DIGexam" a topic on the integration of digital teaching and exami-

nation materials. On the one hand, the aim is to examine how digital teaching aids can be integrated into the final examinations of modules, but on the other hand, students can also be introduced to the examination formats of the final examinations during the courses.

In DIGexam project, the possibilities for competence-oriented digital testing by means of EvaExam are to be used, evaluated, and substantiated by systematically collected data, and the existing possibilities are to be expanded by the use and integration of additional online learning software. Through this combination, new learning, exercise, and examination formats can be offered, the use of which should lead to an increase in competence among students. At the same time, the integration and use of the additional learning software should lead to an increase in user acceptance by both examiners and students.

The achievement of these two goals will be continuously evaluated through a systematic survey. The results will be used to revise and adapt the examination formats offered (Fig. 9).

After the revision, these newly created possibilities will be made available to all faculties and structural units. With selected subject areas from all faculties (target: one group per faculty), a final evaluation will be carried out as part of the regular examinations using the respective subject-specific online tools (e.g. simulation or CAD tools).

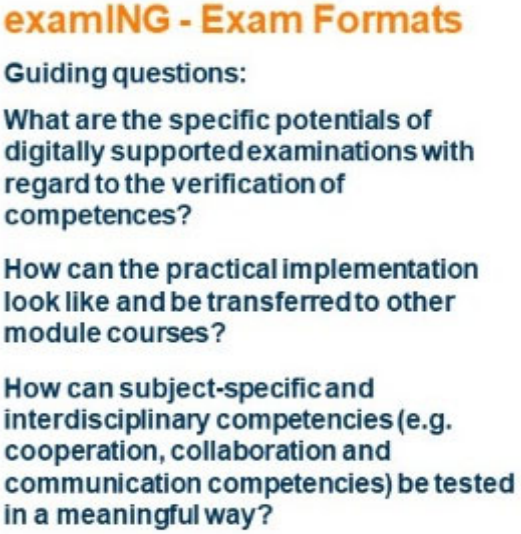

Fig. 9: Guiding questions in the examING project [2].

By using EvaExam online exams, new exam formats can be generated effectively, since existing and proven question catalogs can be accessed for further use. At the same time, there is the possibility of direct comparison of achieved examination performances (both semester-accompanying and final examinations), since a long-term continuous result tracking is available for the paper examinations conducted with EvaExam.

In a direct comparison between Moodle and EvaExam, the task-specific tool EvaExam proved to be both much more effective and efficient.

The extent to which the evaluation results at the end of the project will be influenced by the internal pressure built up over several years to use a solution favored by the infrastructure service provider (Computer Center) remains to be assessed separately.

The transfer of students to the newly created modules results in a necessary overlap period of one year, during which some of the courses are to be read in both the winter and summer semesters. For this purpose, a part of the relevant course will be delivered as blended learning via video-based online lectures accompanied by advising and commentary sessions. For this part, an evaluation is planned to determine to what extent the results of the comparison groups generally differ and in which areas possible differences become visible. In addition, it will be determined whether and to what extent the newly developed examination set is (better) suited for the student group with blended learning than for the comparison group.

The planned solution of combining EvaExam online exams with 3D Complete Anatomy (Elsevier) for teaching in the bachelor module "Anatomy/Physiology" (biomedical engineering course, currently 76 students) offers the possibility to raise the students' level of competence achieved so far after completion of the course series from pure understanding and first approaches of application to the level of analysis. By means of continuous practice examinations, students are made to independently check and learn to assess their level of knowledge. The one- and two-dimensional

teaching contents of the previous teaching and examination form are extended using 3D Complete Anatomy as a learning platform and examination tool to a (pseudo-)three-dimensional knowledge transfer and examination. Students recognize spatial positional relationships and apply them in independent digital "dissection exercises". This corresponds to an increase of the achievable competence from level K2 (taxonomy according to Bloom [3]) to K3 and partly as well K4. By means of the self-assessments carried out within EvaExam, this achieved level of competence is also made visible to the students.

After successful completion of the tests, analysis, and evaluation of the results as well as user surveys, subject areas from all faculties with similar requirements for the use of digital tools will be integrated into online examination scenarios and exemplary forms of examination will be jointly developed. Finally, these scenarios will be tested, and the results will be jointly analyzed. The experiences of the Biomechatronics group for the realization of user tests etc. from the own work of many years in the usability research are applied here.

Fig. 10 depicts the planned "weaving" of the digital tools via the envisioned interrelationships.

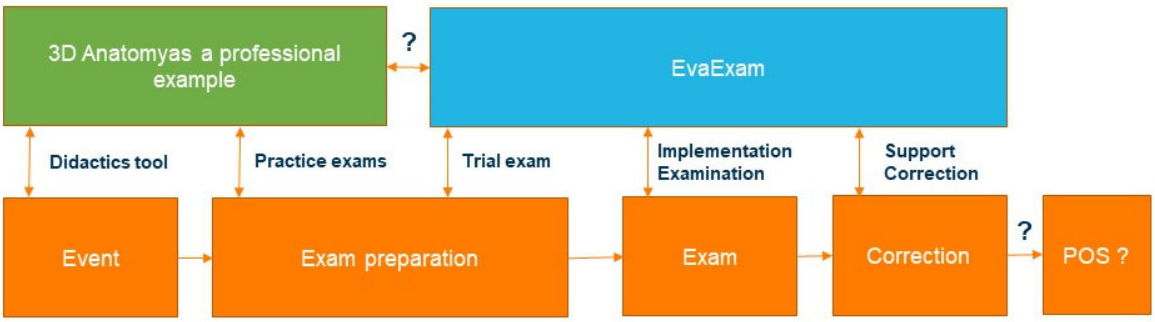

Fig. 10*:* Coordinated *use of software solutions for semester-accompanying teaching and testing. (POS: "Examination Online Server").*

Literature

[1] Grid of Online Lab Devices Ilmenau: http://goldi-labs.net/info.pdf

[2] Geigenmüller, A. (Vice President for Studies and Teaching at the Ilmenau University of Technology): Info-event on examING on 10.11.2021

[3] Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H. & Krathwohl, D. R. (Eds.). (1956). Taxonomy of Educational Objectives. The Classification of Educational Goals, Handbook I: Cognitive Domain. New York: David Mc Kay Company, Inc.

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Implementation of a synchronous exercise format in the digital teaching of two courses

D. Bernstein*, J. Bieber, M. Beitelschmidt

Chair of Dynamics and Mechanism Technology, Institute of Solid Mechanics, Faculty of Mechanical Engineering, TU Dresden

Abstract

Die Corona-Pandemie hat in den Jahren 2020/21 einen weitreichenden Einfluss auf die universitäre Lehre gehabt. Während es bei der Digitalisierung von Vorlesungen sogar mitunter möglich ist, eine verbesserte Wissensvermittlung im Vergleich zur Lehre in Präsenz zu erreichen, resultieren aus vielen Formaten des digitalen Übungsbetriebes deutlich Nachteile für die Studierenden [1,2]. In Ingenieurstudien-gängen sind aber gerade Übungen ein wichtiger Bestandteil der Stoffvermittlung, da hier auf individuelle Missverständnisse im Stoffverständnis eingegangen werden kann. Zudem gehören auch haptische Erfahrungen zu den wichtigen Lehrinhalten in der Ingenieurausbildung.
Dieser Beitrag behandelt die Umsetzung eines synchronen Übungsformats in zwei Lehrveranstaltungen.

The Corona pandemic had a big impact on university teaching in 2020/21. While improvements in teaching are possible by digitizing lectures compared to face-to-face teaching, many formats of digital exercises result in significant disadvantages for students [1,2]. In engineering courses, however, exercises are an important part of teaching, as they can address individual misunderstandings. In addition, haptic experiences are an important teaching content in engineering study programs.
This paper discusses a synchronous digital exercise format in two courses.

*Corresponding author: david.bernstein@tu-dresden.de

1. Concept of the courses

The Mechatronics Startup Project (MSP) is a one-week project in the first semester of the Mechatronics degree program. Teams of 3-4 students each develop mobile Lego robots that solve a task using the sensor and actuator technology of LEGO® MINDSTORMS® EV3. Programming is done in the LabVIEW environment of National Instruments. Every year, 60-80 students, all first-year students in the mechatronics program, take part in the event.

The English-language course Kinematics and Kinetics of Multibody Systems (MBS) is attended by students of degree programmes Mechanical Engineering, Mechatronics and Computational Modeling and Simulation. It consists of 2 semester hours each of lecture and tutorial. The course concludes with a written examination. According to the course registration, 175 students took part in the course in the summer semester of 2021, with 73 students completing the course by attending the written examination.

2. The MSP on-site

In non-pandemic years the Mechatronics Startup Project (MSP) takes place in the large ballroom of the TU Dresden. All student teams work together in the room at large tables as shown in Figure 1.

Fig. 1: Class room version of the Mechatronics Startup Project in the large ballroom of the TU Dresden.

Each team solves one of four possible tasks. Two tasks require just an A0 sheet on the floor while the two other tasks need a material-intensive course to be set up. At course registration, students select their task based on a brief description. Four teams form a relay team in which each task is represented. Teams are divided and assigned to relays randomly. When the EV3 accessory boxes are handed out and returned, all individual parts are laid out by the students on prepared posters in order to check the completeness of the boxes.

The free working time for task processing takes up the very largest part of the project week. The officially scheduled working time with intensive supervision by research assistants and student tutors is from 9 a.m. to 6 p.m. each day. However, some tutors are available until 10 p.m., which is especially popular on the day before the final competition. After the box is handed over to the students and after an initial familiarization with the basics of the EV3 system on Monday morning, laboratory tours of the participating institutes take place. This provides a practical reference to the tasks.

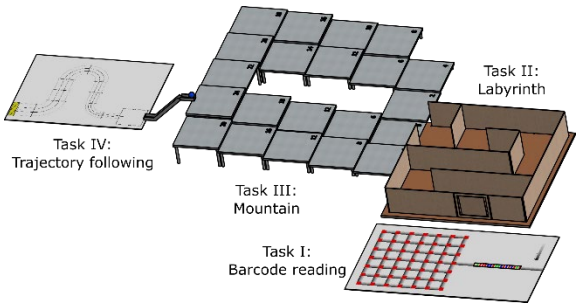

Fig. 2: Parcours of the MSP in the classroom semester containing 4 tasks

As a prelude to the actual work on the tasks, the presentation of the rules then takes place. During the project week, the teams present their progress within their relay under the guidance of a research assistant. The final event is the relay competition, in which the four robots of a relay team complete their respective tasks one after the other. A possible task course is shown in Figure 2. One robot triggers the start of the next robot in the relay. Two parcours examples are available to the students for testing purposes throughout the week.

In Task I, the robot is to be developed that can read a colored barcode. The bars in the barcode represent a sequence of movement commands that must then be executed within a grid. If the motions are executed correctly, the

robot reaches a trigger flap at the start of Task II. The task takes place entirely on an A0 sheet with a printed barcode and motion grid.

Task II takes place in a labyrinth. The robot has to find the exit of the labyrinth autonomously after being activated by the trigger flap. The labyrinth consists of fields with an approximately square base and wooden walls. The arrangement of the wooden walls in the final competition version of the labyrinth is not known to the participants beforehand. When the robot reaches the exit of the labyrinth, the following robot is to be triggered in a self-selected manner.

In task III, the robot has to climb steps to reach the highest level of the task course. Three paths of varying difficulty can be used, each with the same step height (2cm, 4cm or 6cm) to reach the top step. Once on the top step, a ball is to be pushed, which then rolls down a slide. To work on this task, the teams receive an expansion kit with additional building blocks and traction elements to enable them to climb the steps and also allow for more elaborate constructions.

In Task IV, a ball is to be balanced on a Lego brick with a square base while following a given trajectory on an A0 sheet. The path followed is to be marked with a pencil. In the course of the trajectory, the allowed tolerance band within which the marking line should be located becomes wider and wider. At the end of the path, the robot is to be stopped within a specified target area.

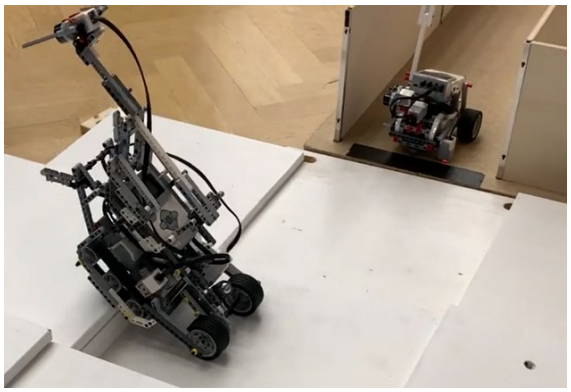

Fig. 3: A robot of task III (mountains) climbing a step, while a robot of task II (labyrinth) is stopped in its final position.

The robots are programmed in the software LabVIEW. Video tutorials produced for the course are available for learning the necessary programming skills.

Arrangements within the supervision team consisting of scientific staff of several professorships of the Faculty of Mechanical Engineering and student tutors are made verbally and informally. The work status of the individual groups is not documented separately throughout the week.

The MSP is a compulsory undergraduate course with 2 credit points. The prerequisite for passing the course is the completion of a technical solution that is suitable for the task in principle. Furthermore, continuous participation in the project is required, which is determined in the interim presentations.

3. The MSP in the digital semester

Holding the EPMT in a face-to-face format was not possible with the large number of participants due to the contact restrictions during the Corona pandemic in the winter semester 2020/21. Instead, a digital format was developed to provide the closest possible equivalent to the face-to-face project. In accordance with the applicable contact restrictions, the project was carried out in teams of two (in exceptional cases one or three) students each in their home environment. In contrast to the face-to-face project, students were asked to find a team partner on their own. The usual relay teams of four tasks were not formed. Instead, the two tasks I and IV were selected from the relay parcours which take place on an A0 course plan. Task II (labyrinth) would have entailed too much logistical effort to transport labyrinth setups to students' homes. Task III (Mountains) would also have involved handing out the extension boxes, which would have increased the effort a lot in handing out the boxes. Each team received a corresponding course plan of Task I or IV together with the brick box. An OPAL forum was set up to facilitate the team formation.

The box distribution and return with laying out the Lego components on posters was carried out in an institute building of the TU Dresden. The hand-out and return times were staggered and the participants were distributed among different rooms in such a way that the applicable distance and contact restrictions could be observed.

During the project week itself, a Zoom service conference was held over each of the project days. With the participation of all students, the general introduction on the first day, a start meeting on each project day and the final competition took place in the main room of the Zoom service conference. As part of the kickoff meeting, an online lab tour was conducted at one of the participating institutes. Further, a breakout room for each team was set up to spend time in during free working hours with at least one video-enabled device. In addition, there was a breakout room for supervisors and “ask for help” breakout rooms to signal to all supervisors that help was needed. The Zoom conference was configured so that each participant and supervisor was able to to move freely between the breakout rooms.

The video tutorials that were produced for the project in presence could be reused for the familiarization with LabVIEW. As in presence, the teams were supervised during free working hours by scientific staff and student tutors. The breakout room for supervisors was used for consultations among the supervisors. If students needed help, they could switch to a “ask for help” room or use a help button to send a signal to the conference organizer. The platform Matrix, which is provided by the TU Dresden, was used for the support organization. Here, short agreements on student help requests were made via the Matrix chat. In addition, a collaborative document (Etherpad) was used to maintain a supervision and progress history for each team. With the help of the chosen setup, it was possible for the supervisors to go from team to team in order to get an idea of the respective processing status. In addition to questions from the students, it was ensured that each team was visited by a supervisor at least twice a day in a organized round of visits. This allowed to identify fundamental problems in the students' solution approaches at an early stage. The progress documentation of the breakout room visits of the single teams also implied that no team was visited an unreasonable number of times and thus disturbed in its free processing. Beginning in the middle of the project week, the progress documentation was used to determine which teams needed close supervision in order to complete their task. The progress documentation of teams with sufficiently functional solutions was reduced accordingly.

In the final competition, each team demonstrated in front of all project participants and supervisors how the constructed and programmed robot completed the task course in the main room of the conference.

A supervisor measured the course time in order to determine a winner team for the respective task. In some cases, the students used several devices in the video conference to show the robot from different perspectives in parallel. The option in Zoom to focus on the video stream of multiple conference participants made this presentation format possible.

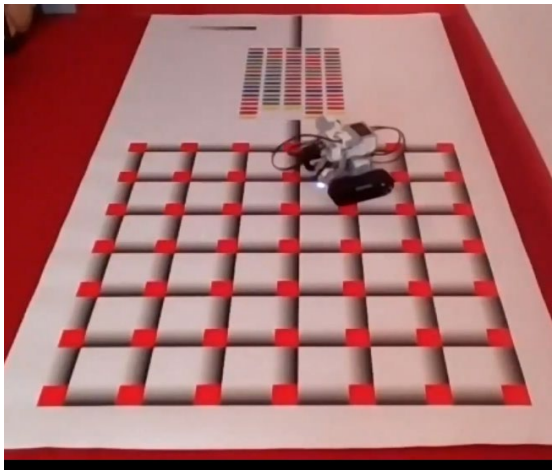

Fig. 4: Robot of the "barcode reader" task completing the course in the final competition of the MSP.

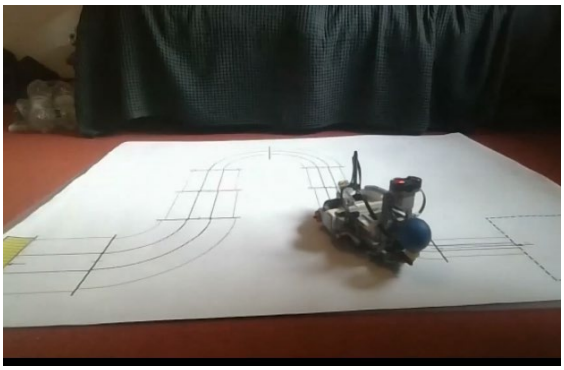

Fig. 5: Robot of the "trajectory following" task completing the course in the final competition of the MSP.

Figures 4 and 5 each show a robot completing one of the two tasks. Due to the larger number of teams, the final competition took longer than in the classroom. This also resulted from the fact that only one team at a time prepared

for the upcoming presentation. In contrast, in the class room relay competition several teams prepare for the upcoming presentation and complete the parcours directly one after the other.

The presence of each team member during normal project processing times was explicitly added to the requirements for passing the project and communicated accordingly. The justified absencefrom this processing times was possible. Although the explicit presence of each team member was still only checked during the interim presentations, this regulation created a high commitment, which is otherwise rather unusual in engineering courses. Accordingly, even small justified absences of the students from the compulsory processing times were reported to the supervisors.

4. Evaluation of the digital implementation of the MSP

Even during the implementation of the MSP, it was noticeable that the vast majority of students worked on the task with high motivation throughout the project week. The number of robots that successfully completed the task in the final competition was comparable to the class room project. Afterwards, the project was evaluated with the help of a voluntary survey in which 23 of the 60 participants took part. The statement whether they liked the project very much was rated by 96% of the respondents as "completely agree" or "agree". The same rating was given to the statement whether the students received competent help from the supervisors at all times. The question of how often students were visited by supervisors in their breakout rooms received an 87% response of "exactly right number of visits". The statement whether the students really missed being able to look at the robots of the other teams during the project week was mainly rated as "Partly/partly" and "agree".

A similar picture emerged from the subsequent evaluation among the supervisors who were also familiar with the class room project. The supervisors were positively surprised that the digital alternative to the class room project largely worked smoothly and adequately. Only two students experienced major problems after deciding to solve a reduced task on their own without a team partner.

5. The exercise MBD on-site

The exercise MBS takes place weekly in attendance semesters. Due to the large number of students, two tutorials are scheduled, one in German and one in English. For the introduction into the exercise topic, ten-minute introductory videos are available, which should be viewed in advance of the exercise date. The exercise time is used for the students to work on the exercise tasks. There is the possibility to discuss solution approaches with the supervisors and to ask questions. In some cases, solutions are discussed with the entire group on the blackboard. Many students work on the exercise tasks individually and exchange ideas with other students during the exercise times. Participation in the exercise dates is not compulsory. Roughly speaking, more than half of the students who take the exams also participate in the exercises.

6. The exercise MBD in the digital semester

Following the positive experience of conducting the MSP digitally in the winter semester 2020/21, a similar format was tested in the MBD exercise in the summer semester 2021. Accordingly, a Zoom service conference with breakout rooms was used, between which the students could switch freely. The exercise started in each case with a short introduction on the general approach to the respective exercise task. Afterwards, the free working time began. The number of the available breakout rooms was sufficient students could decide whether to work alone or in a group. Another separate breakout room was set up for supervisors. There were also several “ask for help” rooms. Going to these “ask for help” rooms signaled to the supervisors that there was a need for discussion while solving the tasks. Furthermore, there was the possibility to request a supervisor for discussion through the help but-

ton of the Zoom service conference. In addition to a research assistant, the exercise was supervised by two student tutors.

7. Evaluation of the digital implementation

At the beginning of the semester, the exercise was attended by many students. Almost 100 students were present in the first exercise. In the following weeks of the exercise, the number of participants decreased substantially and stabilized at less than 30 participants. Since few questions were actively asked by the students, the supervisors systematically visited the breakout rooms in order to talk to the students about the tasks. One particularly well-prepared student caught attention by asking many questions in one breakout room, with more than 10 students at a time following the discussion without contributing. Frequently, students followed supervisors through the breakout rooms to hear all of the discussions being held, but without ever actively participating themselves. Thus, an active conversation about the respective exercise tasks took place with a maximum of 10 students per exercise.

There has been no evaluation of why so few students have taken advantage of the opportunity for discussion in the exercise for better understanding of the task.

8. Summary

In the MSP, a digital teaching format was realized that has represented an adequate alternative to the class room project. The transfer of the concept to the MBD exercise did not meet with the desired approval and accordingly did not represent an equivalent to the class room exercise. It is possible that the obligation to participate in the processing times of the MSP played a greater role here.

Literature

[1] Bernstein, D.; Schuster, M., Beitelschmidt M: Vorstellung und studentische Evaluation digitaler Lernformate in zwei methodischen Grundlagenfächern der Mechanik, Journal Lessons Learned, TU Dresden, 2021, URL: https://journals.qucosa.de/ll/article/view/31/5

[2] Beitelschmidt, M.; Wang, Z.: Ingenieurkoffer für Experimentalpraktika@home, Journal Lessons Learned, TU Dresden, 2021, URL: https://journals.qucosa.de/ll/article/view/16/59

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Gamification of production automation

M. Erler*, A. Brosius

Professorship of Shaping Manufacturing Processes, Institute of Production Engineering, Faculty of Mechanical Engineering, TU Dresden

Abstract

Die Vermittlung technisch anspruchsvoller Lehrinhalte in Übungen ist oft an die Verwendung von Software geknüpft, die zur Bearbeitung benötigt wird. Gleichzeitig ist eine Vielzahl von Anforderungen und technischen Gegebenheiten zu beachten. Klassische Lehrveranstaltungen folgen dem Frontalunterrichtsprinzip. Der Lehrende zeigt an einem Beispiel alle zu erfüllenden Arbeitsschritte. Die Studierenden lernten auf diese Weise die Bedienung der Software und der benötigten Funktionen vorwiegend nach dem Prinzip „Vormachen und Nachmachen“. Leichte Variationen zum Beispiel erfordern dann noch eine gewisse Adaptionsleistung des Studierenden des Gesehene an die eigene Aufgabenvariante. Die Ergebnisse werden anhand festgelegter Kriterien und Fehlerkataloge bewertet.
Diese Vorgehensweise ist zum einen wenig motivierend und zum anderen weit von den späteren Anforderungen der realen Arbeitswelt entfernt. Der Zwang zur Online-Lehre infolge der Covid-19-Pandemie wurde als Chance genutzt, bei der Lehrveranstaltung Produktionsautomatisierung dieses nicht mehr zeitgemäße Lehrkonzept durch ein neues zu ersetzen. Es basiert auf den Prinzipien der Gamification und erweitert den Handlungsraum des Lernenden erheblich. Durch den Einsatz real wirkender Belohnungen und der Möglichkeit die eigenen Ergebnisse selbst kontrollieren zu können, wird eine intrinsisch motivierende Arbeitsumgebung geschaffen. Die Integration einer wettbewerblichen Komponente steigert die Motivation zusätzlich.

The teaching of technically demanding content in exercises is often linked to the use of software that is required for processing. At the same time, a large number of requirements and technical conditions must be taken into account. Classical lectures follow the principle of frontal teaching. The teacher uses an example to show all the steps to be taken. In this way, the students learn how to operate the software and the required functions primarily according to the principle of "show and tell". Slight variations, for example, still require a certain adaptation performance of the student of the seen to the own task variant. The results are evaluated on the basis of fixed criteria and error catalogs.
On the one hand, this approach is not very motivating and, on the other hand, it is far away from the later requirements of the real working world. The compulsion to teach online as a result of the Covid 19 pandemic was used as an opportunity to replace this outdated teaching concept with a new one in the Product Automation course. It is based on the principles of gamification and considerably expands the learner's scope of action. An intrinsically motivating work environment is created through the use of real rewards and the possibility to control one's own results. The integration of a competitive component further increases motivation.

*Corresponding author: martin.erler@tu-dresden.de

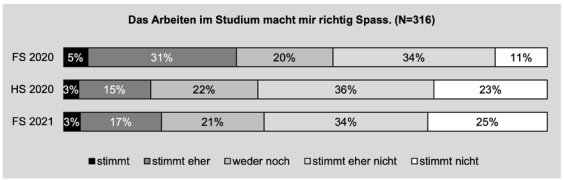
1. Initial situation

The course Production Automation is primarily aimed at students of mechanical engineering specializing in production technology. However, industrial engineers and computer scientists also take this course. The aim of the course is to teach automation technologies, production planning knowledge, common tools and workflows along the product engineering process (PEP). The focus is on manufacturing and its planning. Work preparation takes a special position in this context. The core content in the classic offline format was the planning of a milling operation with upstream design of the component to be planned using the CAD/CAM software PTC Creo. The process was strictly linear. Based on a given drawing, the component was designed and then its machining was planned. This was done successively in several practice hours, accompanied by the instructor. In this way, the students learned how to use the software and the required functions, mainly on the principle of "show and tell". Slight variations in the component geometry required a certain amount of adaptation by the student of what they had seen to their own variant of the task. The results were evaluated on the basis of defined criteria and error catalogs.

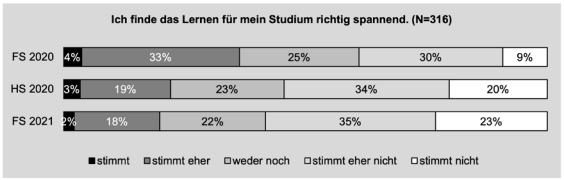
2. Something had to be changed

With the shift of teaching to the digital space, there was a unique opportunity to adapt both the content and the delivery methods of the course. The main improvement variable addressed should be student motivation. For years, this has been regarded across all fields of study and courses as in need of improvement and, at the same time, as a critical component for academic success. Problematic is the activation of students to avoid procrastination [1]. Self-efficacy, in particular, takes on a central role here, as it is "related to a higher interest in studying and a higher motivation to perform. As a result, students more strongly pursue the goal of being successful in their studies and achieve higher academic performance" [2]. In any case, lack of access to information and knowledge can no longer serve as a reason for high dropout rates in the age of the Internet.

The pure transfer of specialized knowledge can therefore no longer be the sole main component of teaching. Students (rightly) expect an evolution of teaching. Basic motivational mechanisms that appeal to as broad a front of different characters as possible should be part of as many courses as possible. After all, people like to do what is fun, and they strive to get better at it. But it is precisely this enjoyment of learning that has suffered to a particular extent in the last two semesters, as a survey at the St. Gallen campus shows (Figure 1).



Einstellung 1



Einstellung 2

Figure 1: decreased learning fun during covid-19 [3]

Furthermore, the previous teaching concept was very much focused on practicing a specific solution. The solution was already partially available in the form of the finished design. It was only necessary to create a correct production plan for it. What had to be done for such a plan was demonstrated with a very similar example. In this way, the learner was already relieved of many action and decision-making steps. For example, he was shown functioning machining strategies, tool selection and setups that differed only slightly from those of the planning to be created. As a result, quite a few of the solutions created by the students were pure imitations of the procedure shown. On the one hand, this was not very motivating, since the solution space was basically limited by the given design. On the other hand, the learner was deprived of the actually interesting and challenging part of the task: finding a solution and procedure that works at all. For this, significantly more complex thought processes are necessary than for pure copying. For exam-

ple, the processing sequence requires numerous technical and technological conditions to be taken into account, all of which must be considered and thought through. In order to be able to take these into account, it is necessary to take a deeper look at the requirements and consequences behind them. Since these are often not monocausal, but result from a combination of design and selected procedure, the learner must also repeatedly reconsider his fundamentally selected processing sequence. The iterative procedure resulting from this in the actual workflow was largely prevented by the solution shown on the example part and the possible learning effect was prevented.

The fact that this assumption is correct was shown by mistakes made time and again, which can be classified as typical imitation errors. For example

- the use of the tools from the example, although they were rather inappropriate,
- Tool paths that do not produce stock removal (air cuts),
- unnecessarily many loop lashings (as in the example) or
- technologically incorrect machining sequences

could be observed.

Another obstacle was the way the consultations were organized. They took place physically in the computer pool. Although this meant that there was personal contact with the teacher, the interaction between teacher and learner was limited to direct conversation. The other learners were able to listen to this conversation. However, especially with technically demanding questions, the visualization of the problem situation and solution is more than useful from a didactic point of view. For example, it is very difficult to describe in words the selection of a suitable tool if it depends primarily on the geometry of the feature. In such cases the teacher went to the learner's place and both looked at his screen. Thus, the knowledge gain of this problem was limited to one learner. It was absolutely the rule that the teacher had to answer the same questions over and over again during a consultation or help solve very similar problems.

If all factors were taken together, the picture of a teaching event emerged, which was oriented towards the adoption and adaptation of demonstrated action steps to a very similar task. The transmission of the teacher's knowledge was close to the concept of frontal teaching. The possibility of recognizing and understanding one's own mistakes was hardly provided for. In connection with the limited scope for design, the motivation of the learners to deal with the actually interesting aspects of production planning was rather limited.

3. Gamification

To change this, the gamification approach has been adopted [4]. It is well known that "gamification can help support motivation to use these systems in a work-related way or to learn how to use software" [5]. To this end, gamified elements such as high scores, awards, virtual rewards, or different game levels are added to the underlying task.

But the task itself must also be adapted to this concept or be suitable for it. To get the learner to care about the reward elements offered, both the achievable goals must be attractive and the steps necessary to achieve them must be sufficiently clear and achievable. However, what appears attainable to a learner depends heavily on that learner's individual skills and knowledge. With the ever-growing number of students, this spread has increased. The modularization of teaching has also ensured a very broad field of study. Thus, in addition to production engineers, students of economics, teaching and also computer science are regularly represented in this course. The technical fundamentals that these groups bring with them differ greatly. In some cases, they do not even have a basic knowledge of process engineering. In order to nevertheless enable these extremely heterogeneous levels of competence to engage in self-directed learning, several approaches are required. This increases the chance that even with only limited prior knowledge, an approach to the problem can be found.

Complicating matters further was the fact that Covid 19 restrictions meant that elements or tools requiring physical presence had to be dis-

pensed with. A shift of the entire course to virtual space was thus required. However, this also comes with some disadvantages. For example, it is known that some people need personal contact with the instructor or fellow students in order to develop a positive motivation to work. Still other people learn primarily through conversation and the accompanying exchange with another person. Gamification can help here to get into conversation with others.

The core of this is the task. This is designed so openly with regard to possible solutions that it can be considered impossible for two students to find the same solution independently of each other. This allows the students to exchange ideas without being inhibited in their motivation. Also, you cannot simply adopt the solutions of others. This promotes professional exchange, since the question of "why did you do it that way?" always resonates.

However, in order for the learner to get to this point where he is already fully engaged with the task, the initial entry threshold must first be overcome. This is often perceived as a "mountain" that one does not know exactly how to approach at first. This often leads to the fact that processing is not even begun

To solve this problem and increase the learner's motivation to enter the task, several measures were resorted to:

- a task that offers a projection surface and thus increases identification,
- a design task that can be understood by anyone without prior technical knowledge,
- a target that is immediately comprehensible and verifiable for everyone
- as well as a working and learning mode that invites discussion and exchange.

4. Implementation

The task introduces the learner to the situation as a newcomer at a fictitious innovative toy manufacturer. There he is responsible for the special order "Design and production of a marble run in small series". Concrete requirements are placed on the design (e.g. minimum length or minimum slope). However, there are no specifications as to how these are to be met. Only a maximum unit price is given in order to ensure a certain minimum level for learners who are running this course with the minimum effort. Beyond that it is bound alone to the given manufacturing environment (tool catalog and machine tool). This gives the learner many degrees of freedom, which allows an almost infinite number of approaches and solutions. It is deliberately refrained from showing an example solution in order not to limit the solution and thinking space.

Fusion360 from Autodesk was chosen as the technical software basis. In addition to the mandatory features (executable on all relevant operating systems, available online, free of charge for teachers and learners) and functions (integrated CAD- CAM, CAM verification module), it offers a very intuitive operating concept. In addition, there are many learning resources available free of charge. This enables the learner to go through all steps in one software. Annoying interface work (e.g. exporting files, memorizing data) is no longer necessary. This promotes in particular the mutual play between design and manufacturing and thus opens up a very large scope of action, since the learner can concentrate on finding a solution and is not interrupted again and again by annoying cumbersome work. This also promotes the emergence of the so-called flow. This occurs when one is completely immersed in the task and is perceived as pleasant and desirable by the vast majority of people.

In order to counteract the sometimes arising overload due to the sheer number of options for action, the strong dependencies of both parts on each other, which are close to those of a real PEP, are used. At first glance, countless solutions are conceivable. However, when trying them out, it quickly becomes clear that many of them do not lead to the desired results for a wide variety of reasons.

In order to facilitate the start for as many users as possible with different levels of practice and behavior, videos were made available on OPAL with further links before the start of the exercise. This provided the opportunity to acquire and practice the necessary knowledge in advance. For other types of learners, a digital introductory event (goto meeting) was held with a hybrid structure (question part and subse-

quent provision as a video on OPAL). In addition, the forum was used and a weekly consultation (GoToMeeting) was held.

In addition to the technical specifications, the marble run must also meet economic requirements. This is where the strongest game element is implemented: a competitive situation for the lowest manufacturing costs. The best 25% of all final solutions submitted receive a staggered bonus on the overall score (Table 1).

Table 1: Distribution cost bonus

Percentile (bigger is better)	Bonus
100 - 96	0,5
95 - 91	0,4
90 - 86	0,3
85 - 81	0,2
80 - 76	0,1

For example, the learner can exchange time for quality - as in real life - and additionally receives information about the ranking of his performance in comparison to others. The calculation of the production costs is done via a standardized Excel file, which has to be filled in by the learner and handed in next to the project file (Figure 2). In addition, there is also a technical evaluation of the solution according to the classic point deduction principle in case of errors.

material costs	3,70	€
machining time	65	minutes
machine hour rate	100	€ / h
machine setup	10	minutes
number of setup changes	2	pcs
duration setup change	5	minutes
hourly rate machining technician	60	€ / h
manufacturing costs	161,67	€
overhead	50	%
production costs	242,5	€

Figure 2: Screenshot of the calculation sheet for the production costs.

In order to reflect the iterative improvement process typical in real working life, the learners can submit interim results and have them evaluated. For this purpose, 4 stages of 14 days each are planned.

The intermediate results are made available on a web page[1] (Figure 3).

This allows learners to track their progress self-directed and online. At the same time, the competitive situation for receiving the bonus points is visualized.

rank	percentile	cost bonus	matriculation number	cost of sales	data valid
1	100 - 96	0.5	4895635	50.32	✓
2	80 - 76	0.1	4549230	67.17	✓
3	-	0	4536143	76.95	✓
4	-	0	4894632	91.57	✓
5	-	0	4989512	290	✓
6	-	-	4905466	-	✗
7	-	-	4904285	-	✗
8	-	-	4886528	-	✗
9	-	-	4834684	-	✗
10	-	-	4905358	-	✗
11	-	-	4839781	-	✗

Figure 3: Highscore of the current intermediate results

The creation of the homepage as well as the maintenance and evaluation of the data are automated. The students upload their intermediate and final results as a ZIP file via OPAL into the corresponding submission module. Thus, all results can be downloaded by the instructor with a few clicks, regardless of the number of participants. A python script unpacks the files, parses the contents, extracts the data from the individual files and makes them available as assets. Missing or erroneous data is displayed so that the instructor is informed about this. Then, using the Angular framework, a homepage is automatically created from the assets provided. This then only needs to be delivered. This almost automatic build pipeline reduces the effort for the teacher to a few minutes. What remains, however, is the manual control of the production planning itself. Since the students have to hand in the entire project file, the results achieved can be compared very well with the underlying planning. Here Fusion360 supports with a comfortable NC verification (Figure 4). Thanks to the digital implementation of the exercise throughout, consultations can also be realized correspondingly easily, for example via screen sharing.

The weekly consultations serve as a learning and exchange space. These take place online

[1] https://paevatool.webspace.tu-dresden.de

in the meeting environment. The resulting opportunities for interaction not only largely compensate for the lack of physical contact, but even create new possibilities. For example, learners can share the screen, which makes it possible to discuss and visualize a problem in the group. The assistance then offered by the instructor can be comprehended by everyone and, if necessary, used to solve a problem of their own. The consultations are recorded. In this way, individual topics can be viewed again afterwards.

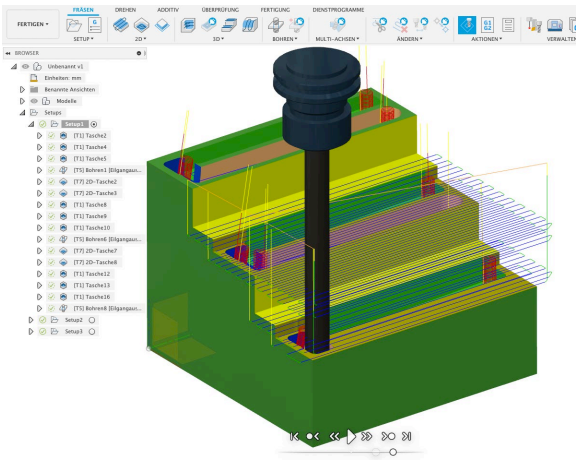


Figure 4: NC verification in Fusion360

Not a single sheet of paper is needed for the entire exercise.

5. Concept & Effect

In the way described, the students can experience a holistic planning process with all the relevant elements that make something like this really interesting in real life. At the same time, they are positively extrinsically motivated by the competitive situation for the bonus points. The task, which is comprehensible to everyone, promotes intrinsic motivation, which is also maintained during the course of the project due to the transparency of the underlying evaluation. The deliberately open solution space reduces the numerous specifications of the old exercise, which are often perceived as restrictive, and causes a paradigm shift in the unconscious perception of the task. Where previously a "find the solution desired by the teacher" dominated, space has now been created for creative and at the same time innovative solutions. By complying with the simulated customer requirements explained in the assignment, students learn to translate external specifications into technical processes. The fact that they can check their results on a small scale and independently using the tools provided enables a self-directed learning process. This is supported by the avoidance of hard limits as far as possible. This gives students the opportunity to compensate for disadvantages at one point with advantages at another. Frustrating "I can't get any further" moments are thus largely absent.

All elements together create a positive motivation to learn.

6. Findings

The possibilities of virtual learning spaces were very useful. The frequency of duplicate questions decreased significantly compared to previous years. It was also possible to get many learners out of the anonymity and passivity of virtual lectures after an initial hesitant phase. From the third consultation at the latest, there was a lively exchange of ideas and approaches to solutions among the students as well.

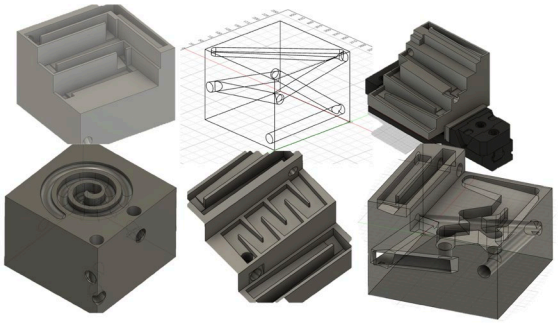


Figure 5: Different marble run designs by students.

The solutions devised by the students suggest that this exchange was also successful. Thus, numerous very different and creative marble run designs were created (Figure 5). Not only did these meet the requirements, but also the frequency and severity of errors of the associated production planning were at most as high as in the old exercise. This is all the more remarkable because the milling operations applied and geometries machined were in some cases significantly more complicated than in the old exercise.

Success can also be seen in the cost of sales (Figure 6). These are close together in the upper - i.e. points-effective - range. On the one hand, this indicates functioning competition and, on the other, that the framework conditions are working successfully.

rank	percentile	cost bonus	matriculation number	cost of sales
1	100 - 96	0.5	12345679	47.88
2	95 - 91	0.4	12345677	47.97
3	90 - 86	0.3	12345673	48.07
4	85 - 81	0.2	12345678	49.75

Figure 6: Top4 of the cost of sales

The example presented shows that the transformation of classic exercises into digital and motivating formats can succeed. Modern technologies and learning approaches can be used very well here. The effort required of the teacher can even be reduced, as repetitive activities can be automated.

OPAL can be used well for this purpose, although the interface is not very intuitive. Also the function to download all submitted solutions requires a certain detective intuition.

However, setting up the web space where the homepage is hosted was much more time-consuming. Numerous rules and regulations required several hours of training. The TU's internal checklist for web applications alone included well over 100 - in some cases very specific - questions on technical implementation. For the average computer user, the vast majority of these are likely to be difficult or impossible to understand. A reduced or pre-filled list for different types of applications as well as a wizard would help enormously. The obligatory imprint, but especially the accessibility statement, is also a challenge for the typical teacher due to the legal requirements for it. It is true that the TU-internal web support assists here to the best of its ability. But these are not sufficient to reduce the effort to an acceptable level. This issue is very important for a university that wants to take the step into the digital age. There is an urgent need for a central and appropriately equipped office to support teachers in the barrier-free design of homepages, both technically and legally. Otherwise, many such projects are in danger of failing because of the effort involved - or they are not even started.

8. Literature

[1] M. Neugebauer, H.-D. Daniel, and A. Wolter, Eds., *Studienerfolg und Studienabbruch*. Wiesbaden: Springer Fachmedien Wiesbaden, 2021.

[2] D. Depping, T. Ehmke, and M. Besser, 'One learns by experience—and becomes self-efficacious as well as motivated. How do different components of student teachers' professional competence relate to the use of learning opportunities?', *Zeitschrift fur Erziehungswiss.*, vol. 24, no. 1, pp. 185–211, 2021, doi: 10.1007/s11618-021-00994-w.

[3] T. Kindler, S. Koengeter, and T. Schmid, 'Drei Semester studieren unter Covid-19-Bedingungen. Eine Längsschnittuntersuchung zu Veränderungen der Studienbedingungen während der Covid-19 Pandemie', no. July, 2021, doi: 10.13140/RG.2.2.31152.07683/1.

[4] K. Seaborn and D. I. Fels, 'Gamification in theory and action: A survey', *Int. J. Hum. Comput. Stud.*, vol. 74, pp. 14–31, 2015, doi: 10.1016/j.ijhcs.2014.09.006.

[5] S. Strahringer and C. Leyh, Eds., *Gamification und Serious Games*. Wiesbaden: Springer Fachmedien Wiesbaden, 2017.

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Digital skills for humanities and social science students. Benefits of a Blended Learning format for teaching programming skills

Y. Frommherz*, J. Langenhorst

Chair of Applied Linguistics, Institute of German Studies, Dresden University of Technology

Abstract

Die Geistes- und Sozialwissenschaften (GSW) werden zunehmend digital. Wissenschaftler:innen stehen mittlerweile relevante Daten in großer Quantität zur Verfügung – aus dem Internet und durch die Digitalisierung analoger Bestände. Die neue Masse an Daten ermöglicht und erfordert den Einsatz quantitativer Analysemethoden. Zwar existieren niedrigschwellige Tools für einzelne Arbeitsschritte bei der Erschließung und Auswertung von Daten innerhalb der digitalen GSW, doch bieten diese lediglich vordefinierte Schnittstellen und schränken Wissenschaftler:innen somit ein. Grundlegende Programmierkenntnisse können hier Abhilfe schaffen, indem sie Forschenden ermöglichen, ihre Fragestellungen wesentlich flexibler zu verfolgen. Die Professur für Angewandte Linguistik bietet daher seit Langem einen Programmierkurs an, der sich spezifisch an den Bedarfen Linguistikstudierender ausrichtet und diesbezüglich stetig verbessert wird. Die Umstellung auf ein Blended Learning-Format im Video-Tutorial-Stil erwies sich als sehr geeignetes Setting: Studierende können die Inhalte räumlich-zeitlich flexibel konsumieren und so ihren Fortschritt individuell gestalten. Dieser Beitrag liefert einen ausführlichen Bericht über die Vermittlung von Programmierkenntnissen an Linguistikstudierende, diskutiert Vor- und Nachteile des umgesetzten Blended Learning-Formats und bietet einen Ausblick auf ein laufendes Projekt, in dem der bestehende Kurs optimiert und auf Studierende anderer GSWs ausgeweitet wird.

The humanities and social sciences (HSS) are subject to a digital turn. Scientists can now access relevant data in great quantities from the internet and by digitizing analog data sources. This new bulk of data both enables and requires the use of quantitative methods. While low-threshold software does exist for specific steps within digital HSS research, these tools are of limited use in that they predefine how researchers can interact with their data. With basic programming skills, researchers can overcome this constraint and pursue their research goals much more flexibly. Therefore, the Chair of Applied Linguistics has long been offering a programming course. This course targets the specific needs of students of linguistics and has continuously been improved in this regard. Especially switching to a Blended Learning format, primarily using video tutorials, has proven to be an adequate setting: Students can study materials at their own pace wherever and whenever they wish. This article provides a detailed account of how programming skills can be taught to students of linguistics, discussing the (dis)advantages of the implemented Blended Learning format and giving an outlook on an ongoing project which aims at optimizing the course and extending it to students of other HSS.

*Corresponding author: yannick.frommherz@tu-dresden.de

1. Introduction

The humanities and social sciences (hereafter: *HSS*) are undergoing a *digital turn* [1-3] It has never been easier to access large amounts of data relevant to the HSS – whether from the Internet or via the digitization of analog data sets. This development makes the use of quantitative methods possible and at the same time necessary [4, p. 297]. However, the focus in HSS has traditionally been on qualitative research. In addition to data access techniques, these newly relevant quantitative methods go beyond the skills typically taught in HSS curricula. At the same time, however, low-threshold tools have emerged that can be used to accomplish many new tasks within ever more digital HSS research. For example, there is easy-to-use software for examining texts with regard to patterns occurring in them (such as keywords). However, the analytical categories that a user can choose between are always predefined and thus limited. As soon as research questions are pursued for which these tools were not designed, at least basic programming skills are required. Thus, if students and researchers rely solely on such software, they will hardly be able to exploit the full potential which arises from the digital turn.

The Chair of Applied Linguistics at TU Dresden therefore believes that teaching digital skills in general and programming skills in particular is a necessary part of a linguistics program. In order to sustainably prepare students for the increasingly digital research and professional world, the Chair has been offering a programming course for many years.

One challenge in teaching linguistics students programming is that the students generally have no prior knowledge of programming and little technical knowledge in general. Therefore, from the beginning, the design of the programming course has focused on how these skills can best be taught to the given target audience. With this question in mind, the course has been and continues to be developed. Among other things, it was converted from a traditional face-to-face seminar to a Blended Learning format. In such a setting, elements of traditional, temporally synchronous and spatially co-present teaching are combined with online learning content of different media types that students can consume temporally asynchronously and spatially flexibly [5-7]. This allows students to largely control their own learning progress, which has advantages when learning programming (see below).

This paper provides a detailed report on how programming skills can be taught to students of German Philology, and specifically Applied Linguistics. Building on a detailed argument of how HSS researchers benefit from programming skills as a fundamental digital competence (Ch. 2), the initial situation leading to the switch to a Blended Learning format is described (Ch. 3). Chapter 4 delineates the current programming course and, finally, Chapter 5 concludes with an outlook on an ongoing research project that will further optimize the existing course and extend it to students of other HSS. The article is not least addressed to interested lecturers within the HSS who also want to prepare their students for the possibilities and requirements arising from the digital turn.

2. Why do humanities and social science students need programming skills?

In the following, concrete steps of an exemplary study will be used to demonstrate why HSS researchers benefit from programming skills. Where appropriate, reference is made to related techniques that also require basic programming skills, but in return provide researchers with methodological flexibility. The exemplary study will use a quantitative approach to investigate how so-called success coaches on YouTube engage their audience linguistically. This is a topic that could be investigated as part of a student paper in a linguistics program. Typically, this would be done in a qualitative way, i.e., the focus would be on individual pieces of evidence (individual instances of *audience engagement*) that would be subjected to in-depth analysis.

In the quantitative approach pursued here, however, a large amount of data is to be analyzed automatically in order to be able to recognize patterns that go beyond individual pieces of evidence. Ideally, this will reveal regularities that would remain undiscovered using a qualitative approach. In any case, however, the patterns in the data can be *quantified,* allowing clear statements about the relevance

of a certain phenomenon in the given context. In the first step, the data, i.e., the language occurring in the videos, needs to be accessed. With the help of existing modules (roughly speaking, ready-made code blocks for a specific purpose) for the programming language Python used here, as well as a few additional lines of code, subtitles of a given YouTube video can be accessed using its ID (each YouTube video has such an ID). The subtitles can then be saved in a suitable format including relevant metadata (Fig. 1 and Fig. 2).

```
for id in video_ids:
        result = {}
        transcript = YouTubeTranscriptApi.get_transcript(id, languages=['de'])
        text = ""
        lines = []

        for line in transcript:
                lines.append(line['text'])

        result['title'] = title.replace(" - YouTube", "")
        result['video_id'] = id
        result['transcript'] = lines
```

Fig. 1: Part of the code for downloading YouTube transcripts.


```
{
    "title": "ERFOLG BASICS: Durch diese Regeln wurde ich Milliardär",
    "video_id": "waavw4CRtoo",
    "transcript": [
        "liebe youtube freunde es geht heute um",
        "erfolg weltlichen erfolg und es gibt nur",
        "einen glasklaren grund warum ich",
        "überhaupt befugt bin und fähig bin",
        "darüber zu reden",
```


Fig. 2: Saved YouTube transcripts.

Similar modules that allow researchers to download specific content from social media with just a few lines of code are available for various platforms. Apart from this, researchers can also *scrape* themselves, i.e., download specific content from almost any website (so called *web scraping*). Another data mining method available to researchers with programming skills is *Optical Character Recognition* (*OCR*). This makes it possible to read characters from images, making the extracted text machine-readable, which is interesting both for historical sources, but also for so-called *sharepics* (images with text for sharing, such as on Instagram).

The second step is to preprocess the collected data. Using suitable modules, the data can be managed, filtered and prepared for analyses in a flexible and efficient way. For the analysis in the context of the exemplary study, the collected data should be available word for word, which is done in a step called tokenization (Fig. 3).

```
In
Ihren
Videos
greifen
Sie
doch
mehrere
Themen
an
,
denken
Sie
nicht
,
dass
Sie
damit
jemanden
beleidigen
könnten
?
```

Fig. 3: Tokenized text.

In the third step, the data is analyzed. For this purpose, *audience address* is operationalized as collocations of the personal pronouns *Du* (informal 'you' in German) and *Sie* (formal 'you'). Collocations are words that frequently occur together, such as *heavy* and *rain* in common speech. Here, we will analyze which words occur more frequently in the vicinity of the addressing pronouns *Du/Sie* than can be expected from their frequency in the rest of the text (Fig. 4. shows this for *Du*, *N* = 4 videos).

collocate	log Dice
kannst	12.23
hast	12.07
liebst	11.78
bist	11.76
wenn	11.46
etwas	11.4
lernen	11.14
tust	11.07
musst	10.84
was	10.82
findest	10.62
wirst	10.58

Fig. 4: Collocations of ‚Du'.

For *Du,* Fig. 4 shows, among other things, that the modal verb *können* ('can') occurs most frequently (compared to the expected frequency) in the analyzed YouTube videos of success

coaches. It seems that the proverbial key to success advertised by the examined coaches lies in the intrinsic ability of the target audience. This hypothesis could now be a starting point for further quantitative and qualitative investigation.

In summary, as demonstrated by this use case, only with programming skills researchers can efficiently access relevant data, preprocess and analyze it in a methodologically flexible manner tailored to the research question at hand. Furthermore, programming skills are immensely useful for visualizing data. Although no-code software for this purpose exists as well (e.g., SPSS or Microsoft Office software), programming skills enable a much more flexible visualization, which is especially advantageous for the purpose of scientific publication.

In addition to these concrete methodological benefits of programming skills, digital work also enables researchers to acquire or consolidate *algorithmic thinking* [4, p. 95]. Algorithmic thinking is the ability to 1) analyze a given problem with precision, 2) define simple steps to solve the problem, 3) create a solution from these steps, i.e., construct a complete and correct algorithm, 4) test this algorithm for all typical as well as atypical cases, and 5) improve its efficiency. Algorithmic thinking is not only a prerequisite for successful programming, but it equally grows out of exposure to code. Researchers also benefit from practicing algorithmic thinking outside of programming, for example in their scientific work, as a thorough, sophisticated approach to a problem (1-3 above) as well as the constant effort to test a potential solution (4) are elementary aspects in both cases.

3. Initial situation

Being able to program is thus an increasingly relevant digital skill for students. Therefore, the Chair of Applied Linguistics has long offered a course called *Programming for Linguists*. As mentioned, before the switch to Blended Learning, the course was conducted as a traditional face-to-face seminar teaching the scripting language Perl. From week to week, new content was taught in the seminar and weekly assignments had to be solved by the students. In addition, a tutorial was offered, which is unusual for seminars in linguistics, but proved to be necessary due to the density of the content. Individual seminar sessions were used to collaboratively work on assignments, while others served as an introduction to programming concepts or, later in the semester, to specific linguistic techniques such as *web scraping* and, in particular, corpus analysis methods.

Over the course of the semesters, many students were inspired to go about solving their research questions using programming skills. However, at the same time, many participants did not complete the seminar – the dropout rate was significantly higher compared to other seminars at the Chair. Teaching a variety of programming techniques in a single semester to students most of whom had never programmed before and often had little prior technical knowledge turned out to be challenging in this mode.

4. Switch to Blended Learning

Starting with the winter semester 2020/21, the course was first conducted in a Blended Learning format as part of the Covid-19-related conversion to digital teaching. On the one hand, asynchronous video content was offered. On the other hand, the tutorial continued to be held synchronously and – as far as the pandemic allowed – also spatially co-present. Teaching materials of various media types, first and foremost the aforementioned videos, but also code snippets, illustrative diagrams, supplementary documents, and links to further resources were bundled (Fig. 5 and Fig. 6). Communication in the seminar took place via a chat room. Further advice on problems was primarily given via e-mail. Later in the semester, so-called *real-time coding* was made available in video format, i.e., recordings in which complete programming tasks were solved in real time, such as scraping a web page. Here, the individual steps – analyzing the page, finding links, downloading pages, extracting and annotating text and metadata, assembling a corpus file – were demonstrated step by step, rather than merely explained (Fig. 7). These real-time coding sessions were inspired by coding streams on the streaming platform

Twitch and on YouTube, where developers can be watched programming live – or afterwards in case the stream is recorded. Such streams enjoy great popularity and now represent a kind of teaching format in its own right [9][10].

One difference between the real-time coding used in the seminar and the Twitch streams is, of course, that there is never any live interaction with the viewers.

Fig. 5: Overview page of the course (winter semester 2020/21).

Apart from the new format, another innovation was that Python was taught instead of Perl, since by the time the seminar was revised, Python had advanced to be *the* programming language in science. Python offers numerous libraries for analyzing structured data (including Pandas), data visualization (including Matplotlib), annotation (including the NLP libraries Stanza, SpaCy, NLTK, TextBlob, etc.), and scraping (including BeautifulSoup, Selenium). Additionally, Python is potentially easier to learn for beginners than previously-taught Perl due to its somewhat simpler syntax and semantics (for a comparison of Python/Java: [11]).

Even though existing libraries are one reason to teach a specific language, the focus of the seminar – as a *programming seminar* – was to have students develop as much code as possible themselves. Students should not simply assemble existing code using Python modules like in a construction kit, but rather work out as many steps as possible themselves. Pure introductions to libraries would hardly have added any value compared to the existing low-threshold tools mentioned at the beginning, which also exist for the analysis of (corpus) linguistic data (e.g., Corpus Workbench, Sketch Engine). It would be possible, for example, to have a Python package output frequent co-occurences with just a few lines of code. With little effort, however, one can reproduce this process, making transparent how the data is handled. Thus, one is not confronted with a black box in the form of a tool, but, having devised the individual steps, one understands the process better.

After the setup of Python was mastered and the students had familiarized themselves with the shell, the course introduced the basics of programming such as control structures and data types as well as related simple exercises. Midway through the semester, more and more specific corpus linguistic applications were worked on.

Fig. 6: Course content.

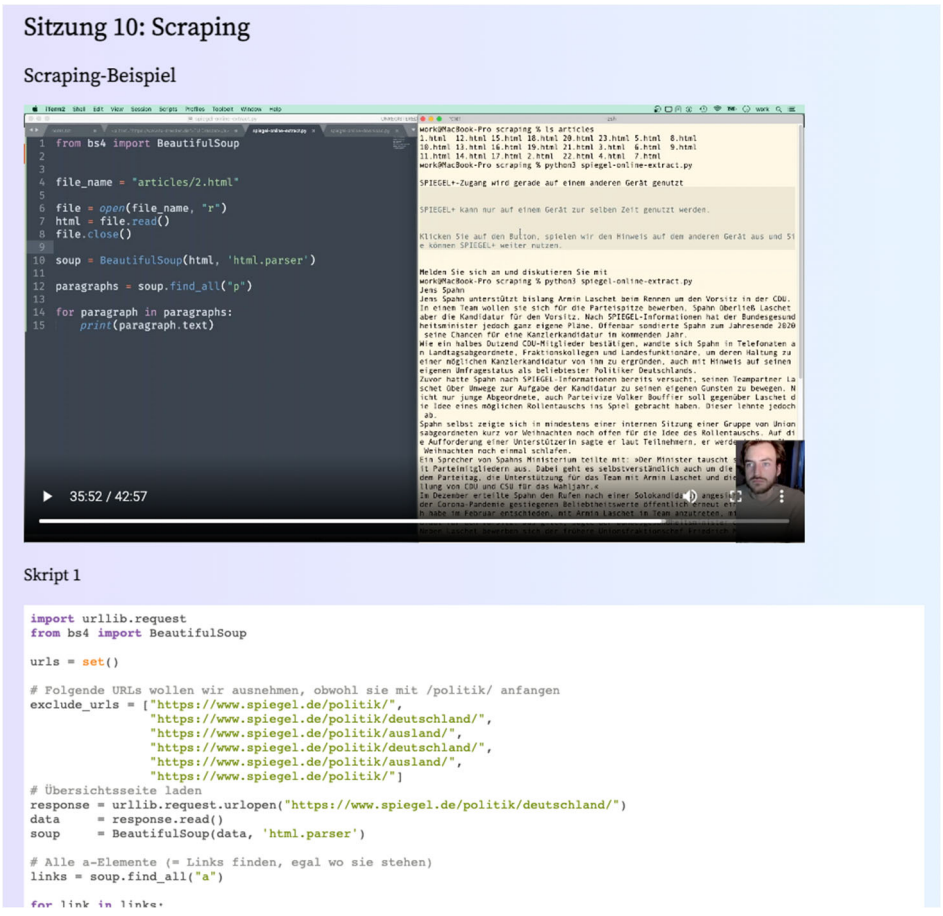

Fig. 7: Real-time coding video with associated code snippet.

Corpus linguistics studies linguistic phenomena on the basis of large collections of texts (*corpora*), which are annotated linguistically (e.g., with parts of speech) and with metadata (e.g., author, year, genre). Students were first provided with differently structured corpora to be analyzed for frequent words, n-grams (*n* consecutive words), etc. Then, the focus shifted to creating and annotating own corpora from web sources. Overall, students

learned to write scripts to examine self-created corpora for various linguistic patterns as well as the factors that condition their occurrence. Many other types of analyses can be derived from the techniques learned, providing students with methodological flexibility.

5. Results

The implementation of the seminar in the Blended Learning format can be considered a success. The dropout rate was lower than in previous semesters and the submitted assignments were mostly of high quality. In the winter semester 2021/22, the seminar was offered in the same form for the second time, with results comparable to the first semester.

This pleasing result seems to be due in large part to the Blended Learning format itself. In addition to spatial and temporal flexibility when learning new content, the greatest advantage seems to be that the video content can be watched as often as desired and sections that are not understood well can be repeated resulting in learners being less likely to feel disengaged. In addition, the real-time coding described above (which can also be consumed flexibly) conveys a more realistic image of programming in two respects: First, it becomes clear that accomplishing real tasks – as opposed to prefabricated, small-scale exercises – requires a certain amount of time, and that code grows incrementally in a way where not every single line of code can be planned in advance. Second, it becomes clear that it is not possible to write more than a few lines of code without adjustments becoming necessary or errors creeping in. In contrast, in static representations like textbooks only finished code is shown. The code may be extended from example to example, but the process behind it never becomes visible in a dynamic way. The incremental and iterative reality experienceable in real-time coding could result in learners being less likely to feel discouraged when they encounter problems in their own work. At the same time, the videos present an all-round vivid picture of programming, which can also stimulate learners' motivation. Overall, the Blended Learning format seems to be suitable for teaching programming to beginners from linguistics.

A disadvantage is the omission of physically copresent sessions in which participants work out solutions together. Certainly, such sessions bear the risk that individual participants no longer keep up with the material, but at the same time, working together in the same room is also a motivating factor for students [8][9]. The Blended Learning implementation of the seminar has so far been conducted completely without collaborative elements – apart from exercises in the tutorial. In addition, a certain tension arose between the very flexibly consumable course content on the one hand and the strictly scheduled submission and subsequent evaluation of the homework – the evaluation by the lecturer took place in a fixed rhythm. Although the real-time coding videos gave the course a certain dynamic, all content was static in that the students could not interact with it. This certainly left some potential unused.

6. Outlook: Programming for humanities and social sciences

Building on the positive experience with the Blended Learning format for teaching programming skills to linguists, a course offering is currently being designed and developed that aims not only at linguists but also students from other HSS. This work is conducted as part of the *Experimentierraum Digitale Medienkompetenz* (*ExDiMed*) project. The aim of the project is to provide students from HSS with digital skills in dealing with media and data by means of Blended Learning formats. As stated at the beginning, programming is a fundamental skill in the increasingly digital HSS. ExDiMed, in turn, is institutionally anchored in the virTUos network and thus linked with other projects on the topic of **vir**tual teaching and learning at **TU** Dresden in an **o**pen-**s**ource context.

The motivation for introducing a programming course in linguistics also applies to other HSS, as could be ascertained conducting interviews with representatives of various HSS (specifically: communication, visual, historical, and social sciences): Students in these HSS generally also have little to no prior programming knowledge. In addition to the dominant qualitative evaluation, existing data sets from these fields could also be analyzed quantitatively.

Furthermore, there is great potential in tapping new data sources (e.g., via web scraping, API retrievals, or OCR). Moreover, text is an important, if not the most important, data type not only in linguistics, but also in other HSS (e.g., digitized historical writings, newspaper corpora, or social media posts in history, communication, and social sciences, respectively). The focus of the offering will thus remain on textual data, with possible excursions into, for example, two-dimensional data (such as images in the visual sciences).

The programming language Python is retained, but it will now be taught in the web-based IDE *JupyterLab.* In so-called *Jupyter Notebooks,* code cells can be elegantly interwoven with markdown cells (Fig. 8 and 9). The latter can be used for explanatory texts or the formulation of exercises and can be set as non-editable for students. Code cells can either be empty (e.g. for exercise tasks) or already contain code that can be expanded by students ("Finish the code"), modified ("Set relevant parameters" or "Find the error") and, in any case, executed.

Hence, an interactive notebook can be designed in which students can acquire knowledge in a self-directed manner and apply it at the same time. Students receive their personal copy of a notebook and can therefore not only add code to an exercise where explicitly expected, but also add as many additional code and markdown cells as they wish (e.g., to pursue their own ideas or to make notes at relevant points).

The division of code into cells (possibly with markdown cells in between) conveys and underlines the incremental character of programming already emphasized as important: Cell by cell (step by step) a problem is solved, and in each cell it is checked whether the code delivers the desired (intermediate) result. In this way, the step-by-step approach which is so central to algorithmic thinking is also practiced (see Ch. 1). The notebooks will largely replace the videos from the current format. However, individual notebooks, for example for the introduction to the IDE, will be accompanied by videos. The well-received real-time coding videos will also be retained. Videos can be embedded elegantly in the notebooks.

The advantages of the Blended Learning format mentioned above (individual learning pace and addressing different levels of competence, flexible learning in terms of time and location, conveying a realistic picture of programming) also apply after shifting from a video-based approach to interactive notebooks which are partly accompanied by videos. At the same time, the content is prepared much more dynamically, and students can interact with it directly, which makes the course less static compared to the current one.

In order to achieve additional interaction *between the* students, *hackathons* are planned, in which participants work collaboratively on a certain problem within a few hours. Exercises in group work are also planned, for which the collaboration option inside JupyterLab may be used (the prerequisite is that the students access the same server, which also enables collaborative, synchronous work from separate locations). Collaborative learning settings have been shown by various studies to be beneficial in teaching programming skills [11-13]. In such an environment, students can co-construct ideas and solutions that they may not develop in isolation [12].

In terms of content, a distinction is made between a basic module and several advanced modules. In the notebooks of the basic module, the theoretical foundation for programming with Python will be laid. Topics such as variables, operators, data types, control structures (conditional statements and loops), functions and methods, import of modules and packages as well as input/output are explained, again putting emphasis on hands-on application and realistic exercises. The basic module will be preceded by a concise, applied introduction to algorithmic thinking (see Ch. 2). Internalizing this basic way of approaching a (programming) problem may be even more important than the concrete syntax and semantics of a given programming language [4, p. 90]. Results from an iteratively designed programming course [11] in which only one parameter was changed from condition to condition suggest that offering even a short unit on algorithmic thinking prior to teaching actual coding leads to better programming skills.

Bedingte Anweisungen

Wir widmen uns als Erstes den bedingten Anweisungen und definieren dafür einen simplen string. Führe 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.")
```

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

Übrigens haben wir gerade eine sog. string-Methode kennengelernt, nämlich `startswith`, die überprüft, ob ein string (hier: `sentence`) mit der in der Klammer definierten Zeichenkette beginnt. Diese und andere Methoden besprechen wir im Detail im nächsten Notebook.

Wie gesagt, bei bedingten Anweisungen geht es immer um `True` oder `False`. Die obige Bedingung ist eigentlich abgekürzt formuliert. Ausformuliert lautet sie:

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

Nur wenn die angegebene Bedingung zutrifft (also den Wert `True` annimmt), wird der im Anweisungskörper geschriebene Code ausgeführt. In der Praxis verwendet man stets die Abkürzung, die, wie oben gezeigt, auch natürlichsprachlich intuitiv Sinn ergibt.

Nun ändern wir den Satz (genauer gesagt: wir referenzieren mit der Variablen `sentence` ein neues Objekt, das alte Objekt verliert seine Referenz):

```
sentence = "Die morgige Nacht wird schön."
```

Verwenden wir nun die gleiche bedingte Anweisung, so geschieht nichts, denn sie ergibt `False` und folglich wird die Anweisung im Körper nicht ausgeführt. Wir brauchen also eine zweite Bedingung, zusätzlich zur ersten, die wir beibehalten möchten:

Fig. 8: Introduction to conditional statements as an example of the combination of markdown cells (explanatory texts) and code cells (not executed here) in JupyterLab.

Following the basic module, advanced modules will be dedicated to different use cases. These include applied contents from the current course (such as web scraping), which will be modified in such a way that they are also of interest to students from other HSS. In addition, subject-specific modules are planned that specifically address the requirements of the respective HSS (as an example: automated *news factor analysis* for communication science). Further advanced modules will deal with statistical analysis and visualization. All advanced modules will be independent of each other, so that students from different HSS can compile a programming course relevant to them on a modular basis, presupposing they have completed the basic module. Regardless of the adapted and expanded format, the goal remains that this course should enable students with little to no prior knowledge to work on HSS research questions in a digitally competent manner – from accessing their own data to data preprocessing, analysis, and visualization.

✏️ **Übung:** Bei Variablennamen haben wir ja schon gelernt, dass diese case-sensitive sind. Finde nun heraus, ob dies auch bei Zeichenketten der Fall ist, indem Du zwei Variablen mit zwei Zeichenketten definierst, die sich nur in punkto Groß-/Kleinschreibung unterscheiden. Lass Dir anschließend ausgeben, ob die Werte der beiden Variablen für Python gleich sind oder nicht.

```
# In diese Zelle kannst Du den Code zur Übung schreiben.
str1 = "hallo"
str2 = "HALLO"
print(str1 == str2)
```

```
False
```

Fig. 9: Combination of markdown cell (exercise description) and (executed) code cell in JupyterLab.

In the medium term, the developed course is to be anchored in the new master's program Digital Humanities at TU Dresden (starting in winter semester 2022/23). In addition, it will be made available as an open educational resource and indexed in relevant directories.

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Literature

[1] Baum, C. & Stäcker, Th, Die Digital Humanities im deutschsprachigen Raum. Methoden. Theorien. Projekte, in: Dies. (Hg.): Grenzen und Möglichkeiten der Digital Humanities (= Sonderband der Zeitschrift für digitale Geisteswissenschaften 1), 2016. https://doi.org/10.17175/sb001_023

[2] Snee, H., Hine, C., Morey, Y., Roberts, S., & Watson, H. Digital Methods as Mainstream Methodology. An Introduction. In: H. Snee, C. Hine, Y. Morey, S. Roberts, & H. Watson (Hrsg.), Digital Methods for Social Science. An Interdisciplinary Guide to Research Innovation; S. 1–11. Palgrave Macmillan UK, 2016. https://doi.org/10.1057/9781137453662_1

[3] Deutsche Forschungsgemeinschaft. Digitaler Wandel in den Wissenschaften. Impulspapier, 2020. https://doi.org/10.5281/zenodo.4191345

[4] Jannidis, F.: Grundbegriffe des Programmierens In: Ders., Kohle, H., & Rehbein, M. (Hrsg.). Digital Humanities. Eine Einführung. Metzler, 2017, 68-95.

[5] Seufert, S., Mayr, P. Blended Learning. In: Fachlexikon e-learning. Wegweiser durch das e-Vokabular. Bonn, 2002.

[6] Schoop, E., Bukvova, H., Lieske, C. 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, 2010. https://nbn-resolving.org/urn:nbn:de:bsz:14-qucosa-26183

[7] Kerres, M. Mediendidaktik Konzeption und Entwicklung mediengestützter Lernangebote. München: Oldenbourg Wissenschaftsverlag, 2013. https://doi.org/10.1524/9783486736038

[8] Loes, Chad N. The Effect of Collaborative Learning on Academic Motivation. In: Teaching & Learning Inquiry 10(1), 2022. https://doi.org/10.20343/teachlearninqu.10.4

[9] Haaranen, L. Programming as a Performance. Live-streaming and Its Implications for Computer Science Education. In: ITiCSE '17: Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education. June 2017, S. 353-358. https://doi.org/10.1145/3059009.3059035

[10] Pirker, J., Steinmaurer, A & Karakas, A. Beyond Gaming. The Potential of Twitch for Online Learning and Teaching, In: 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1 (ITiCSE 2021), 2021, S. 74-80. https://doi.org/10.1145/3430665.3456324

[11] Koulouri, T., Lauria, S., & Macredie, R. D. Teaching Introductory Programming. A Quantitative Evaluation of Different Approaches, ACM Transactions on Computing Education, 2015, 14 (4), S. 1-28. https://doi.org/10.1145/2662412

[12] Beck, L., & Chizhik, A. Cooperative learning instructional methods for CS1. Design, implementation, and evaluation, ACM Transactions on Computing Education, 13(3), 2013, 10:1-10:21. https://doi.org/10.1145/2492686

[13] Braught, G., Wahls, T., & Eby, L. M. The Case for Pair Programming in the Computer Science Classroom. ACM Transactions on Computing Education, 11(1), 2011, 2:1-2:21. https://doi.org/10.1145/1921607.1921609

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Pecha Kucha: A format for (digital) final presentations

S. Meier-Vieracker*

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

Abstract

Pecha Kucha ist ein aus Japan stammendes Vortragsformat, bei dem 20 Slides für jeweils 20 Sekunden gezeigt werden, so dass die Redezeit exakt 6:40 beträgt. Es wird zunehmend auch in akademischen Lehrkontexten eingesetzt. Empirische Forschungen legen nahe, dass dieses Format klassischen PowerPoint-Präsentationen in einigen Aspekten überlegen ist und positive Lerneffekte mit sich bringt. Der Beitrag diskutiert auf der Grundlage eines Erfahrungsberichts zu einem linguistischen Projektseminar, in dem die digitalen Abschlusspräsentationen als Pecha Kucha gestaltet wurden, die Vor- und Nachteile dieses Formats. Weiterhin werden Möglichkeiten der Übertragung in analoge Settings diskutiert.

Pecha Kucha is a presentation format originating in Japan in which 20 slides are shown for 20 seconds each, making the speaking time exactly 6:40. It is increasingly being used in academic teaching contexts. Empirical research suggests that this format is superior to classic PowerPoint presentations in some aspects and can bring positive learning effects. The present article discusses the advantages and disadvantages of this format on the basis of a field report on a linguistics project seminar in which the digital final presentations were designed as Pecha Kucha. Furthermore, possibilities of transfer to analog settings are discussed.

*Corresponding author: simon.meier-vieracker@tu-dresden.de

1. Introduction

Presentations by students in courses are often frustrating for everyone involved. Frustrating for the presenters who, after an often tedious preparation phase with many frictional losses in the group work, have to expose themselves to the insufficiently explicit expectations of the lecturers; frustrating for the other students who get the possibly poorly prepared and poorly weighted material taught in this way and not through the more experienced lecturers; frustrating for the lecturers who often already know the content and therefore recognize above all the deficiencies in the sometimes too verbose, sometimes too cursory presentations. Especially in humanities seminars, which are often nothing more than a series of one-hour student presentations, the usual presentation formats hold a high potential for frustration.

Assuming that the complete abandonment of student presentations is not an alternative either, the presentation formats themselves must be reconsidered. That there is a need for this can be seen from the countless guides and advice books that lecturers publish on their homepages [1]. Instead of adding still another one to these guides, this paper presents Pecha Kucha, a presentation format that is characterized above all by an extremely strict time regime. In the summer semester of 2022, it was used very successfully in a linguistic project seminar on the topic of "Fan Cultures and Fan Communication".

In the following, I will first introduce the format and provide a research overview. I will then describe the design and structure of the project seminar in which the Pecha Kucha presentations were embedded and reflect on the advantages and disadvantages of the format. I will conclude with some reflections on whether and to what extent the format is bound to digital teaching contexts or can also be transferred to analogue face-to-face teaching.

2. What is Pecha Kucha?

Pecha Kucha is a presentation format originating from Japan, in which 20 slides (PowerPoint or similar) are shown for 20 seconds each and underlaid by the presenting person with oral presentation text, so that the speaking time is exactly 6:40 min. This is a complete description of the rules and regulations. How the slides scheduled in this way and the oral presentation are designed is not further regulated, although there are recommendations such as the KISS strategy (keep it short and simple).

Pecha Kucha is not the only lecture format that relies on the traditional rhetorical style principle of brevity [2]. Impulse speeches, lightning talks, or elevator pitches are also characterized by tight time limits and are therefore also often used in teaching contexts to prevent lectures from being too lengthy. Compared to these formats, however, Pecha Kucha is even stricter, since the internal timing of the individual slides also follows a clear rule.

Pecha Kucha is used in business, but also in educational contexts. Typically, several Pecha Kuchas are presented one after the other, and the classic format is the PechaKucha Night [3], which is now institutionalized worldwide. Comparable to science slams [4, 5], Pecha Kucha is thus often used for popularizing science communication that purposefully crosses the boundaries into entertainment. Beyond these social events, Pecha Kucha is also a frequently used format in academic teaching [6].

The potentials of Pecha Kucha in educational contexts are also addressed in research. Numerous research papers are dedicated to the possible applications in the context of foreign language teaching. Pecha Kucha seems to be helpful in developing public speaking skills in general [7] and can improve fluency in language learners [8]. Moreover, the strict and therefore guiding set of rules can reduce the fear of public speaking [9].

While research on language learning contexts is mainly interested in language production aspects, other studies focus more on reception and ask, for example, about comprehension and retention performance in Pecha Kucha compared to conventional PowerPoint presentations [10] as well as about different quality judgments. Measured against classical criteria for successful presentations such as clear presentation structure or eye contact, which are also mentioned in most guidelines, Pecha Kucha presentations perform better [11]. Even if there is no clear evidence that Pecha Kucha

presentations are therefore generally better suited than other presentation formats for understanding and retaining professional content [10], students and lecturers perceive them as more pleasant and more entertaining. [12].

To sum up, the research situation makes us confident that the format can at least be integrated into university teaching as a supplement. I will now show how this can be done in concrete terms.

3. About the design of the project seminar

The subject of the seminar, which was held entirely digitally, was fan cultures and fan communication in their entire breadth. Based on the observation that fan-typical practices always include linguistic-communicative aspects and that fans are characterized by a high semiotic productivity [13], fans are an excellent object of study in media linguistics [14], which can also be used to address other linguistic questions, such as language and identity, language and emotion, or language in social groupings.

The seminar was divided into three phases. Six plenary sessions at the beginning served to convey the most important theoretical and methodological basics from sociological as well as linguistic fan research. In the following six sessions, the students worked in small groups on their own research projects, the results of which they finally presented as Pecha Kuchas in the last session. The selection and design of the topics for the research projects was entirely up to the students, whose knowledge of the sometimes very specialized fan cultures and fan practices was thus activated. Many students were fans themselves and thus had profound insider knowledge [15] and privileged access to the empirical field.

In the first phase of the seminar, input videos provided in advance (Fig. 1), seminar readings and their discussion in the seminar, and group work for exemplary analyses of empirical material served to teach the material. The students were already divided into the groups in which they would later work on the projects and were asked to develop ideas for a possible research topic at an early stage.

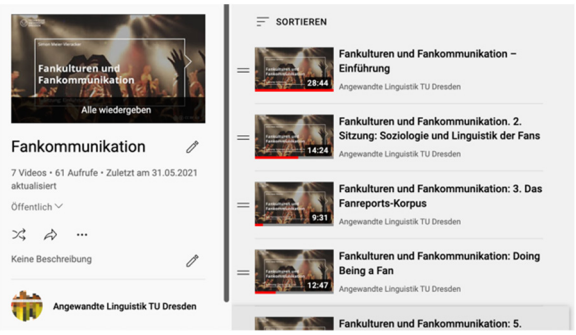

Fig. 1: YouTube playlist with input videos

In the second phase, the groups then worked independently on their projects. A collaborative Zotero library [16] was available as a bibliographic resource, in which extended research literature including full texts could be accessed. To structure the workflow in the project work, a Miro board was set up, i.e. a collaborative whiteboard platform on which a wide variety of media types (texts, images, videos, links) can be collected and visually structured. Milestones were defined on this board (such as formulation of the research question, evaluation of the research literature etc.), at which the groups were to file their interim results (Fig. 2).

Fig. 2: Miro board

In this way, the groups working on their own could nevertheless follow the procedure and progress of the other groups. This progress documentation also served as a basis for the consultation meetings. During the meetings, I

was present in a virtual meeting room (wonder.me) and was available for shorter or longer consultations. In addition, the groups worked independently and also with internally distributed tasks in order to carry out the time-intensive research work efficiently. Finding topics and choosing appropriate research methods took some time, but finally the following research was conducted:

- Fan reactions to the series ending of Game of Thrones
- Fan chants in soccer stadiums
- Fan protests in soccer stadiums
- Communication of fans in the fanfiction scene
- Glorification practices in @instagram biographies.
- Fan mourning

Research methods ranged from questionnaire surveys to Internet linguistic text analysis and multimodal analysis.

Then, in the final session, the results from the research projects were presented as Pecha Kuchas. All groups submitted their 20-slide presentations in advance. The display duration was automatically timed at 20 seconds. Thus, the slides ran through in a videoconference at the specified pace and were accompanied by spoken text by the students with distributed roles. Between each presentation, about ten minutes were used for feedback and discussion. Overall, the presentations were of surprisingly good quality and were a very successful conclusion to the seminar. Even from the perspective of the students, who had initially expressed clear reservations about this format, it was judged as successful.

4. Pecha Kucha: advantages and disadvantages

As the final evaluation interview and the anonymous written evaluations revealed, the very strict Pecha Kucha format offers a number of advantages:

- The strict time regime and automatic run-through of the slides effectively prevents speaking time overruns, so that the available time slots are equally distributed. The same rules and therefore the same restrictions apply for everyone.
- Such a strict format as Pecha Kucha makes meticulous preparation inevitable, so that the presentations, the slides as well as the spoken text including the speaker changes, are consistently on a high technical level [11]. Slides that are too text-heavy, which according to empirical research results have a negative effect on the comprehension and retention performance of the audience [17], are avoided in favor of text-reduced and attractively illustrated slides. Superfluous and extensive metatextual information and group-internal coordination during the presentation must be reduced to a minimum in favor of a concise presentation of the project results [18].
- The total length of 6:40 min is pretty much the time span for which the audience can listen without distractions - even in a digital setting. The rather fast change of the slides additionally binds the attention.
- The time limit requires a dynamic, sometimes even artistic style of presentation with a certain spontaneity, which has its own entertainment value [12]. To put it casually: It's just fun.

However, these advantages are also countered by some disadvantages:

- The most serious objection is that the tight time frame requires a reduction of the information richness, as is known from popular science genres [19], which, however, can conflict with scientific quality standards. For the qualification goal of presenting scientific facts methodically and cleanly with the required complexity and depth of detail, Pecha Kucha is therefore hardly the right format. However, accompanying materials that are prepared in addition to the Pecha Kucha presentation can help. In our case, these were digital materials such as padlets or frames in the shared Miro board, where more in-depth information or empirical evidence could be read or the project results were summarized once again in an overview (Fig. 3).
- The format tends to favor students with a preference and talent for performance.

This can and should be countered by the fact that the presentations themselves are not graded, especially since they are group performances that sometimes involve very different workloads. In the seminar described here, individually written project documentation and reflections were submitted instead.

- Currently, Pecha Kucha is largely unknown among students. They therefore search the Internet for templates and suggestions and may find special rules such as the requirement of completely text-free slides. This can be remedied by communicating the rules early and clearly, preferably in written form.

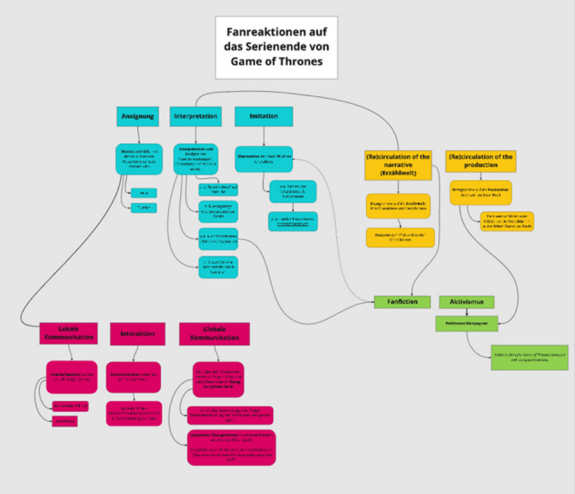

Fig. 3: Project result: A classification of fan reactions.

With the necessary supplementary workarounds and strategies, the advantages thus clearly outweigh the disadvantages and make the Pecha Kucha format appear superior to free formats, at least for the special setting of project presentations.

5. Open questions

The format was tested in a fully digital setting and was particularly convincing here. It should now be tested whether the format can also be used in analog settings in a similarly profitable way. In the digital setting, there is no loss of time due to the change of position at the lectern. The speaker changes can be precisely choreographed in advance and thus run particularly seamlessly. The focus of attention is therefore fully on the slides and the spoken text. Whether in a face-to-face event the physical presence of the speakers might introduce moments of distraction and jeopardize time management remains to be seen. It might also be possible to have the students pre-produce the presentations as videos, which are then watched together in the face-to-face event. However, this would mean that the live character, which is not insignificant for the overall experience, would be lost.

It also has to be be tested whether the format can be used in other, more knowledge transfer-oriented contexts. In the case of project presentations, the report character and the obvious structure (research question, methods, results, discussion) provide useful guidelines for the design of the presentations. If, on the other hand, theoretical concepts or detailed technical knowledge need to be conveyed, the selection and preparation of information is likely to be more challenging. Research also shows that Pecha Kucha presentations are not superior to other presentation formats for exam preparation purposes, i.e., they do not lead to better exam performance [18]. However, if one detaches oneself from such an outcome-oriented perspective, Pecha Kucha could at least be used as a supplement to other formats for knowledge transfer. The learning effects that go beyond pure technical knowledge, above all the acquisition of presentation skills, are also likely to come into play here.

6. Conclusion

The Pecha Kucha format proves to be a useful tool to be able to implement project presentations in classes in a concise, entertaining and at the same time demanding manner. The necessary reduction of the amount of information in the strict time frame is compensated in particular by the accurate preparation. The format is especially recommended for seminar contexts in which several projects have to be presented at once.

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Literature

[1] Lehrstuhl für Germanistische Linguistik, Universität Heidelberg. Anleitung zur Referatsvorbereitung, https://www.gs.uni-heidel-berg.de/sprache02/hin-weise/stud_ref.html (accessed 17 March 2022).

[2] Gardt A. Kürze in Rhetorik und Stilistik. In: Bär JA, Roelcke T, Steinhauer A (eds) Sprachliche Kürze. Belin, Boston: De Gruyter, pp. 70–88. https://doi.org/10.1515/9783110204346.70.

[3] PechaKucha Cities, https://www.pechakucha.com/cities (accessed 10 February 2022).

[4] Niemann P (ed). Science-Slam: multidisziplinäre Perspektiven auf eine populäre Form der Wissenschaftskommunikation. Wiesbaden: Springer VS, 2020.

[5] Niemann P, Schrögel P, Hauser C. Präsentationsformen der externen Wissenschaftskommunikation: Ein Vorschlag zur Typologisierung. Zeitschrift für Angewandte Linguistik 2017; 67: 81–113. https://doi.org/10.1515/zfal-2017-0019.

[6] Courtney Klentzin J, Bounds Paladino E, Johnston B, et al. Pecha Kucha: using "lightning talk" in university instruction. Reference Services Review 2010; 38: 158–167. https://doi.org/10.1108/00907321011020798.

[7] Mahendra AW. Breaking the silence. Utilizing Pecha Kucha to promote students' speaking skills. LLT Journal: A Journal on Language and Language Teach-ing 2018; 21: 55–64.

[8] Rokhaniyah H. Exploring PechaKucha in EFL learners' speaking fluency. Journal on English as a Foreign Language 2019; 9: 146–162. https://doi.org/10.23971/jefl.v9i2.1326.

[9] Coskun A. The Effect of Pecha Kucha Presentations on Students' English Public Speaking Anxiety. Profile: Issues Teach Prof Dev 2017; 19: 11–22. https://doi.org/10.15446/profile.v19n_sup1.68495.

[10] Oliver J, Kowalczyk C. Improving Student Group Marketing Presentations: A Modified Pecha Kucha Approach. Marketing Education Review 2013; 23: 55–58. https://doi.org/10.2753/MER1052-8008230109.

[11] Beyer AM. Improving Student Presentations: Pecha Kucha and Just Plain PowerPoint. Teaching of Psychology 2011; 38: 122–126. https://doi.org/10.1177/0098628311401588.

[12] Beyer AA, Gaze C, Lazicki J. Comparing students' evaluations and recall for Student Pecha Kucha and PowerPoint Presentations. Journal of Teaching and Learning with Technology 2012; 26–42. https://schol-arworks.iu.edu/journals/index.php/jotlt/arti-cle/view/3109

[13] Fiske J. The cultural economy of fandom. In: Lewis LA (ed) The adoring audience. Fan culture and popular media. London, New York: Routledge, 1992, pp. 30–49.

[14] Hauser S, Meier-Vieracker S. Fankulturen und Fankommunikation: Einleitende Anmerkungen. In: Hauser S, Meier-Vieracker S (eds) Fankulturen und Fankommunikation. Berlin: Lang, 2022, pp. 9–13.

[15] Winter R. Die Produktivität der Aneignung. Zur Soziologie medialer Fankulturen. In: Holly W, Püschel U (eds) Medienrezeption als Aneignung. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 67–79. https://doi.org/10.1007/978-3-322-87281-4.

[16] Winslow RR, Skripsky S, Kelly SL. Not just for citations: Assessing Zotero while reassessing research. Information literacy: Research and collaboration across disciplines 2016; 299–316.

[17] Tangen JM, Constable MD, Durrant E, et al. The role of interest and images in slideware presentations. Computers & Education 2011; 56: 865–872. https://doi.org/10.1016/j.compedu.2010.10.028.

[18] McDonald RE, Derby JM. Active Learning to Improve Presentation Skills: The Use of Pecha Kucha in Undergraduate Sales Management Classes. Marketing Education Review 2015; 25: 21–25. https://doi.org/10.1080/10528008.2015.999593.

[19] Niederhauser J. Das Schreiben populärwissenschaftlicher Texte als Transfer wissenschaftlicher Texte. In: Jakobs E-M, Knorr D (eds) Schreiben in den Wissenschaften. Frankfurt a.M. u.a.: Lang, 1997, pp. 107–122.

[20] Hermes J. Nicht verpassen: #acppk! TEXperimenTales, https://texperimentales.hypotheses.org/4567 (accessed 23 March 2022).

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Virtual excursion Kleinwelka

D. Hetjens[2], A. Lasch[1*], M. Rummel[2], R. C. Schuppe[2]

[1] *Professor of German Linguistics and History of Language, Institute of German Studies, Faculty SLK, TU Dresden (TUD)*
[2] *Research assistants at the Chair of German Linguistics and Language History*

Abstract

Im Artikel wird am Beispiel der "Virtuellen Exkursion Kleinwelka" das Potential von VR-Modellen als Ankerpunkten für interdisziplinäre und internationale Lehre und Forschung beleuchtet. Nach 1) einer knappen Einführung auch zum 2) sozialgeschichtlichen Hintergrund der Herrnhuter Brüder-gemeine zeigen wir 3) ausgehend vom virtuellen Modell** des "Hauses der ledigen Schwestern" Kleinwelka, wie 4) die technische Umsetzung eines solchen Modells realisiert wird, 5) wie und welche Ergebnisse aus Forschung und Lehre in einem solchen Modell präsentiert werden können und 6) wie sich am Beispiel eines solchen Modells die Relevanz der weltumspannenden Herrnhuter Brüdergemeine für die europäische Wissensgeschichte entfalten lässt.

In the article, the potential of VR models as anchor points for interdisciplinary and international teaching and research is demonstrated using the example of the "Virtual Excursion Kleinwelka". After 1) a brief introduction also on the 2) socio-historical background of the Moravian Church, we show 3) based on the virtual model** of the "Haus der ledigen Schwestern" Kleinwelka, how 4) the technical implementation of such a model is realized, 5) how some results from research and teaching can be presented in such a model and 6) how the relevance of the global Moravian Church for the European history of knowledge can be uncovered on the example of such a model.

*Corresponding author: alexander.lasch@tu-dresden.de ** Digitale Quellen sind im Text hinter "sprechenden Links" hinterlegt und nicht separat im Quellen- und Literaturverzeichnis ausgewiesen. Digital sources are placed behind "meaningful links" in the text and are not listed separately in the references.

1. Concern: virtual excursions

Kleinwelka is important as a local community from the mid-1750s (cf. [10] Mahling 2017, [11] Mahling 2019a: 40-50 and [12] 2019b) for the Moravian Church - a faith community founded in eastern Saxony at the beginning of the 18th century and spanning the globe in just a few decades (cf. inter alia [8] Lasch 2009/2021). The documents and traces of this community offer interdisciplinary research an incomparably rich archives of knowledge to trace and understand global effects of European mission culture (cf. exemplarily in the context of (post-)colonial linguistics [6] Lasch 2019). However, the paths into this knowledge archive in the context of the Digital Humanities (cf. in particular [3] Faull 2021) must first be laid out - a virtual excursion can be a first starting point for this.

Virtual excursions are used, especially in subject contexts in which exploration plays a central role, precisely when 1) access to certain places and spaces is (considerably) impeded by barriers of various kinds, or 2) learners are to be motivated in a special way through the use of modern and specific AR and VR technology: Geo- and historical sciences or their didactics (see for instance [18] Schmidt, Lindau & Finger 2013). The adaptation of the concept for historical-linguistic oriented teaching and research is obvious for these and two further reasons. For one, 3) sources may be inaccessible. Second, 4) project-oriented and collaborative teaching and learning may be limited by the fact that learners, e.g. in international collaborations, cannot work together on a project in one place.

Virtual excursions are therefore being developed in the context of the DigitalHerrnhut project in virTUos (Virtual Teaching and Learning at the TU Dresden in an Open Source Context, [7] Lasch 2021) as an innovative virtual teaching and learning environment incorporating culturally relevant sites of the Moravian Church in Eastern Saxony, starting from a pilot of the "Haus der ledigen Schwestern Kleinwelka". The aim of this pilot is to present digitized sources and smaller contributions from teaching and research in a 'walkable' 3D model of the house and relevant outdoor spaces in order to open up experiential and learning spaces for exploration and to map out initial paths into a part of the Moravian knowledge archive.

The content already embedded in the 3D model in this paper was developed in two summer workshops and the seminar Digital Herrnhut in the winter semester 2021/2022 and serves as thematic starting points for follow-up work as well as for communication between science and the public (e.g. for the opening of the Summer visits 2022 in Kleinwelka).

Fig. 1: Kleinwelka near Bautzen in the Stichsammlung Herrnhutischer Gemeinen und Schulen by Abraham Louis Brand (1782).

2. Moravian Church

The Moravian Church or Herrnhuter Brüdergemeine (cf. on the chapter [14] Meyer 2021 and [20] Vogt 2022 in detail and in the context of Pietism overarching [2] Breul 2021) is a pietistic community foundation that goes back to Nikolaus Ludwig von Zinzendorf (1700-1760) (cf. [1] Atwood 2021). Starting in 1722, he enabled persecuted members of the Unitas Fratrum to settle in Berthelsdorf in eastern Saxony on 'des Herren Hut'; by 1727, the community was constituted (cf. [21] Zimmerling 2022). In contrast to the conception of faith of the pietistic Halle, Zinzendorf declares faith to be a "religion of the heart": the attachment of the heart to Christ is central, faith and trust in God are matters of the heart. In principle, all believers can

be recognized and awakened by God, with faith and awakening as signs of God's electing grace (predestination). If one thinks of community in this radical way, it seems consistent that all (awakened) members of the community are equal to each other (equality), in principle independent of gender, origin and property. Since the experience of revival is a prerequisite for acceptance into the community (exclusivity), members are urged to always examine themselves and reflect on their attitude toward themselves and their life in the community (reflexivity) (cf. [5] Lasch 2005: 4-23). The Christocentric model of faith as well as its design brought Zinzendorf and the young community into conflict with Lutheran orthodoxy soon after its founding, which in the meantime led to Zinzendorf's expulsion several times and also to the ban of the community in (Electoral) Saxony. Zinzendorf himself understood the exile as a "pilgrimage" and his community as a "pilgrim community" (cf. [1] Atwood 2021: 189f.), which laid the foundation for the community's worldwide missionary activities from the 1730s onward (cf. [15] Vogt 2021: 570-572). August Gottlieb Spangenberg (1704-1792) ([13] May C 2011) was given the task of institutionally stabilizing the community after Zinzendorf's death in 1760. Until the end of the 18th century, this is the most important goal of the synods, in addition to clarifying how to deal with the financial challenges posed by the mission. Under Spangenberg's leadership, the Unity professed the Confessio Augustana and rejected its own confession. He smoothed out Zinzendorf's biography and, with *Von der Arbeit der evangelischen Brüder unter den* Heiden (1782) and *Unterricht für die Brüder und Schwestern, welche unter den Heiden am Evangelio dienen* (1784), laid a foundation for mission theology, the principles of which applied throughout the 19th century. In addition, the writing of one's own history was initiated: The *Historie von Grönland* by David Cranz (1723-1777), the *Geschichte der Mission der evangelischen Brüder auf den caraibischen Inseln* Christian Georg Andreas Oldendorps (1721-1787), the *Geschichte der Mission der evangelischen Brüder unter den *Indianern in Nordamerika* Georg Heinrich Loskiels (1740-1814) or the *Alte und neue Brüder-Historie* in three volumes, also by Cranz, are to be mentioned for example. In addition to these large-scale narratives, the *Nachrichten* contribute quite significantly to the portrayal of the community. These are printed from 1817 as *Beyträge zur Erbauung aus der Brüder=Gemeine* (BBG), from 1819 as *Nachrichten aus der Brüder=Gemeine* (NBG), and have handwritten predecessors from the middle of the 18th century. In England, however, the *Periodical Accounts Relating to the Missions of the Church of the United Brethren* established itself as one of the central organs for the English-speaking addressees (cf. [8] Lasch 2009/2021: 5-14).

These few examples are only a partial illustration of the important role played by the Moravian Church or Moravian Brüdergemeine in the 18th century as a mediator of knowledge from the worldwide mission fields (cf. [19] Vogt 2021): In just a few decades, the community spread throughout the world, cultivated its relations with international circles of scholars, published extensively and in several languages, thus helping to shape our European view of the world quite significantly.

3. Das “Haus der ledigen Schwestern” Kleinwelka as an anchor point for a virtual excursion

Kleinwelka (cf. on the whole chapter [10] Mahling 2017) as one of the local moravian congregations near Bautzen plays a special role for the rapidly expanding community in two ways. On the one hand, Kleinwelka is a "spiritual center" for the "work among the Sorbs" ([14] Meyer 2021: 236). On the other hand, Kleinwelka is one of the central places of education of the (missionary) community for more than 150 years. After the first settlements, the characteristic prayer hall is already built in 1757/58 at the central Zinzendorfplatz; choir houses and the graveyard (1756) as the community's cemetery identify the place as Herrnhutian. In 1764 the Brothers' House is occupied, in 1770 the Sisters' House is consecrated, in 1778 the first house of the Boys' Institution and the Diaspora House are opened and soon extended by the first house of the Girls' Institution (1781). In the following years, the schools in Kleinwelka become a hub of the worldwide mission: parents working in the mission send their children to Kleinwelka's schools for education before they attend (e.g.) the Pädagogium Niesky: Since "immer wieder die Eltern

ihre Kinder nach Kleinwelka schickten und die Kinder dann wieder ihre Kinder [...]", one has to ask, who "hier nicht zur Schule gegangen [ist.] Also fast alle Missionarsfamilien waren über Generationen hier", as Marleen Schindler, in an interview with Andreas Tasche elaborates as a study achievement. The interview is published on the project blog DigitalHerrnhut, as an episode of the student podcast lasch not least as well as in the Virtual Excursion Kleinwelka ([17] Schindler 2022). Representing the internationally networked "spiritual center" Kleinwelka, the multi-part building complex of the sisters' houses becomes the focus of our interest for the design of a virtual excursion.

Fig. 2: The Schwesternhauskomplex. Photo: CC BY-SA 4.0 Mike Salomon. Perspective based on the engraving by Abraham Louis Brand (1782), cf. fig. 1.

The “Schwesternhäuser” are located between the prayer hall and the churchyard and have been largely preserved in their historical state, so that the gradual expansion until 1896 can still be reconstructed today: The sisters' house from 1770 quickly became too small; a large annex, the sisters' choir house, has been in use since 1787. This section of the ensemble - the sisters' house and the sisters' choir house as well as the sisters' garden (in the center of Fig. 2) - form the core of a virtual excursion.

4. Technical aspects of modeling

The 3D model of the Sisters' House and the Sisters' Choir House (not yet publicly accessible) was created by agreement between Brüderunität, Schwesternhäuser Kleinwelka e.V. and TU Dresden using the commercial service Matterport. Matterport is a platform that, according to its own description, allows ‘real-world objects to be transformed into immersive, digital twins’. By this, it means creating 3D models of objects and especially interiors that can then be explored in AR and VR environments or simply in a browser app. For this purpose, Matterport provides a dedicated cloud environment that allows collaborative editing of the models and enables a browser-based 'visit' and exploration of the model from any network-enabled device. The accessibility, the simplicity of the technical implementation and the remarkable level of detail of the modeling speak in favor of the use of this offering, which was originally conceived for the real estate trade, but is gradually being used, also driven by pandemics, more and more by cultural institutions such as museums or for digital teaching and learning environments.
In addition to the model, so-called (paid) "Add Ons" can be used to directly obtain and further process the data of the model. According to the company's own description, the Matterpak, for example, is ‘intended for architects, engineers and people working in the construction industry who can import these assets into third-party programs (such as 3ds max, ReCap, Revit or AutoCAD), make additional changes’.
But it is of course also possible, and we plan to let students use this data creatively in the context of the digital humanities in the near future. For the time being, however, we are only using the 3D model to enrich it with various types of digital material and, as a first step, to expand it into a virtual excursion.

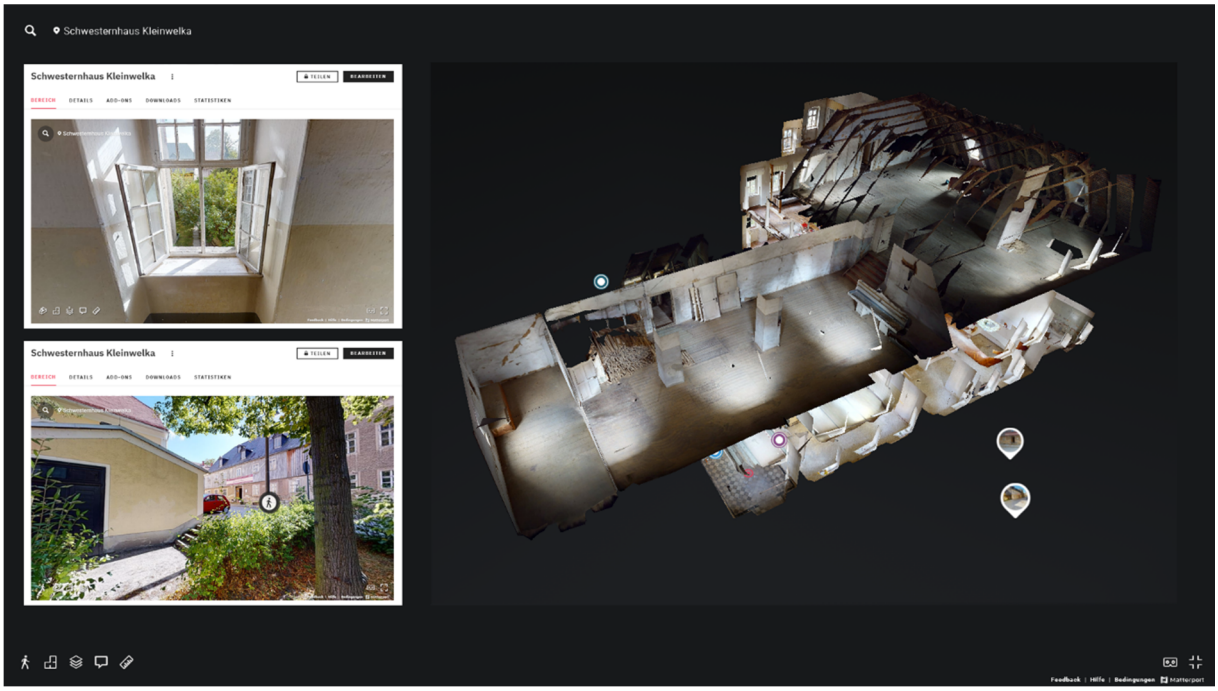

Fig. 3: 3D model of the "Schwesternhaus". "Doll's house" view, view of the sisters' house garden and panoramic view of the exterior.

5. Enrichment of the model with digitized data and results from research and teaching

Such models are of particular value if they can be enriched with digitized material and results from research and teaching, and thus enable students in teaching or citizen scientists and the interested public not only an exploration possibility of a culturally-historically relevant place in digital environments, but the enrichment of the 3D model can be controlled collaboratively in different teaching and learning contexts, whereby there are no restrictions regarding the complexity - textual single documents can be created just as well as multimedia tours lasting several hours. One example was the integration of an interview (see section 3), implementations of collaboratively created digital transcriptions and editions have also been done. In addition, interim work statuses can be documented, presentations can be posted, video tours can be created, and interviews and image digitizations of sources from a wide variety of sources can be exhibited. Since the Moravian knowledge archives are not only of interest for historical linguistics, but also for geo-informatics, cultural and regional history, landscape architecture history and botany - as will be briefly illustrated in the outlook (section 7) - as well as theology, to name but a few, 3D models also offer starting points for interdisciplinary and necessary cooperation, which can also be organized internationally due to the low-threshold accessibility of the models. Fig. 4 shows an example of the integration of heterogeneous (linguistically relevant) content into the 3D model of the nurses' home. From left to right, in this example, these are 1) an episode of the freely accessible podcast Old Writings, for which reader:s read in handwritten Herrnhutian sources for further processing (in the linked example, our student Marlene Wolf read). Then 2) reference is made to the project blog DigitalHerrnhut. 3) The excerpts of the printed biographies of Cornelius Adolf Römer (1805-1867) and Hermine Henriette Römer, née Weiß (1823-1868), are placed side by side; the digital copy is linked: Hermine Römer, it reads, moved into the sisters' home in 1837 and worked as a teacher first in Niesky and then in Berlin before marrying Cornelius Adolf Römer. In 1857 they moved to Kleinwelka to take over the inspection of the missionary institutions already mentioned above. The (printed) biographies in the *Nachrichten aus der Brüder=Gemeine* (NBG), cf. section 2,

Fig. 4: Floor plan of the first floor of the model of the sisters' house with embedded digital copies.

are, on the one hand, a central source for the development of personal networks in the Moravian Church. In addition, they are not an expression of individual biographies like today's curricula vitae. In these texts, the individual members position themselves within the community's horizon of values. Thus, on the other hand, biographies are a special resource for accessing the (linguistically constructed and processed) value system of the faith community (cf. [15] Roth 2021 and [5] Lasch 2005). Not only audio sources such as individual podcast episodes, but also 4) video content can be directly integrated into the model - in Fig. 4, this is both an introduction to the Kleinwelka Virtual Excursion for exploration and a tutorial for embedding media content to provide orientation in the Matterport editing interface. Hosting on video portals (e.g. Vimeo or as in the example on Youtube) is a prerequisite, but the content does not have to be made public, which is essential during the editing phases of the model in contexts of academic teaching. To conclude 5), the digital copy of a manuscript is embedded on the far right. This is an excerpt from the precursors of the printed *news* copied in the writing rooms of the community, which are currently being digitally indexed from the Herrnhut Archive in cooperation between the Herrnhut Archive and the Saxon State Library - Dresden State and University Library (SLUB) from the year 1765 ([4] Hermann 2022). Details about this indexing and evaluation are disclosed on the already mentioned project blog. Specifically, it concerns the report "Von Klein-Welcke, vom Nov. 1770" from the handwritten *Nachrichten* 1770, which is remarkable for its length of ten pages alone, which in the case of handwritten copied sources can always be an indication of special content, such as this: "Eine Materie des Lobens und dankens war die Beziehung und Einweyhung des neuen ledigen Schwestern=Hauses. Unsre lieben Geschwister Spangen=bergs kamen zu dem Ende am 8ten zu uns. Am 10ten geschahe Nach=mittags um 2 Uhr der Einzug der Schwestern aus dem alten Hause ins neue Chorhaus, wo sie sich zum Liebesmahl auf dem neuen Saal versammleten." (418) Addressed here is precisely Spangenberg ([13] May C 2011), who consolidated the community after Zinzendorf's death as bishop of the Moravian Church, which emphasizes the significance of the consecration of the sisters' house in Kleinwelka in a special way. The text was made accessible in the context of the Digital Herrnhut seminar and integrated into the Virtual Excursion Kleinwelka.

6. An example: Georg Heinrich Loskiel (1740-1814)

Just as in this example relationships between the central actors and places of the fraternity appear in miniature, which historically can be directly connected to the virtualized place of the sisters' houses, relationships can also be reconstructed that reach far into the world. One of these relationships can be built from the biography of Marie Magdalene Hasting, née Schneider (1770-1851). The text is freely available in digital edition by Lubina Mahling as one of more than 100 Herrnhut life descriptions in the Sorabicon, which presents 'scientifically based knowledge about the Sorbian language, history and culture.'

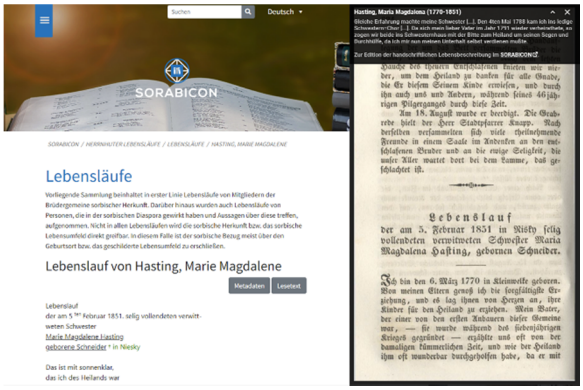

Fig. 5: Mary Magdalene Hastings (1770-1851) biography in the Sorabicon edition and in print for the NBG in the virtual sisterhood.

On the other hand, as can also be seen in Fig. 5, it is also printed in the *Nachrichten* (NBG) of the congregation, which, without being able to open the discussion too wide here, is on the one hand an indication of the extremely rich Herrnhut tradition and on the other hand of different circles of addressees as well as contexts of use of the biographies (in detail [15] Roth 2021). Both texts are exhibited side by side in the Virtual Excursion.

Maria Hasting was "geboren den 6ten März 1770. in Kleinwelke", the 'Sorbian Niesky', and remembers the "damalige[n] Gemeinhelfer und Prediger [...] Bruder Loskiel dem das Gedeihen der Kinder sehr am Herzen lag". Georg Heinrich Loskiel (1740-1814) passed through various educational and training institutions of the Brüdergemeinde, until in 1801 he was first "Präses der Direction der pennsylvanischen Gemeinden und Prediger der Gemeinde Bethlehem in Nordamerika" and in 1802 was ordained bishop of the Moravian church. Maria Hasting got to know him when, after theological training in Barby, he was not only active in "verschiedenen theologischen Aemtern in herrnhutischen Gemeinden thätig war" from 1765, but also founded the "Erziehungsanstalten in Kleinwelke und [im schlesischen] Gnadenfrei" which were central to the missionary community (ADB). The *Baltic Biographical Dictionary digital* (BBLD) fans out the places of his activity in much more detail, which gives a better impression of his mobility as a Moravian, especially his role in Eastern Europe and the importance with the appointment to the Unity Elders' Conference within the community: "Pastor d. Brüdergemeinde in Amsterdam, dann in Kl.-Welke b. Bautzen. 1782 in Livland. Gehilfe d. Vorsitz. d. Brüdergem. in Liv- u. Estland, lebte in Strikenhof b. Wenden. 1789 Gemeindehelfer u. 1. Prediger in Gnadenfrey (Schles.). 1794 Gemeindehelfer d. herrnhutschen Gem. in Niesky (OL), 1798 in Herrnhut. 1801 Präses d. Direktion d. pennsylvan. Gemeinden, Prediger u. Gemeindehelfer zu Bethlehem (USA). 1802 Bischof. Zum Mitgl. d. Unitäts-Ältesten-Konferenz berufen, † aber vor Beginn d. Reise nach Europa."

Fig. 6: Mention of Georg Heinrich Loskiel in the biography of Hastings (reading view and XML variant in Sorabicon).

In 1789 he published in Barby the influential and already mentioned History of the North American Mission. This history, along with others - which would go beyond the scope of this article - is one of the most important and comprehensive German-language sources on the

conditions on the American East Coast in the 18th century, which we open from Kleinwelka: "Nun meine lieben Brüder und Schwestern sehen wohl, warum ich diese Sache jezt aus unsrer Loosung angeführt habe. Wir haben jezt unsern lieben Bru[=]der Loskiel vor uns, der bis daher die Gemeine in Amsterdam bedient, u[nd] als ein Diaconus der Brüder Kirche, das Amt eines Predigers dort verwaltet hat. Jetzt soll er nach Kleinwelcke gehen, u[nd] dort das Lehramt abermal über sich neh[=]men. Da haben wir miteinander vor dem Heiland uns entschloßen, ihn zum Prediger des Brüder Volcks gegenwärtig zu ordinieren u[nd] einzusegnen," as we know from the development of sources in the seminaristic context and the speech at Loskiel's ordination on March 19, 1775 in Herrnhut.

7. Prospects

For teaching and research contexts, the Virtual Excursion Kleinwelka forms an important starting and gathering point. Not only does it provide an occasion to reflect on sources of different kinds and the networking of the members of the Moravian Church 'at the historical site' on the current technical state of the art of modeling AR and VR environments, but it also enables international collaboration, e.g. with students who will most likely never have the opportunity to visit the historical sites of the Moravian Church in Eastern Saxony during their studies. The same is true in reverse for students in Germany, who cannot easily take a field trip to Bethlehem, Pennsylvania, among other places, the place where Loskiel worked and where the Moravian Archives is now located - a corresponding expansion of the virtual field trips to include historical sites in the present-day United States is in preparation.

Furthermore, we demonstrate the relevance of Digital Humanities working practices when we bring together sources such as those exemplified here into text collections for corpus linguistic study. The DigitalHerrnhut GERMAN corpus is part of a next-generation agile, multimodal, and multilingual reference corpus (NexGen Agile Reference Corpus, N-ARC) being built in collaboration with the Sächsische Landesbibliothek - Staats- und Universitätsbibliothek Dresden (SLUB). DigitalHerrnhut GERMAN compiles previously mentioned biographies (LB) from 1750 onwards, German-language narratives on mission history (NAR), and the printed NBG (1819-1894).

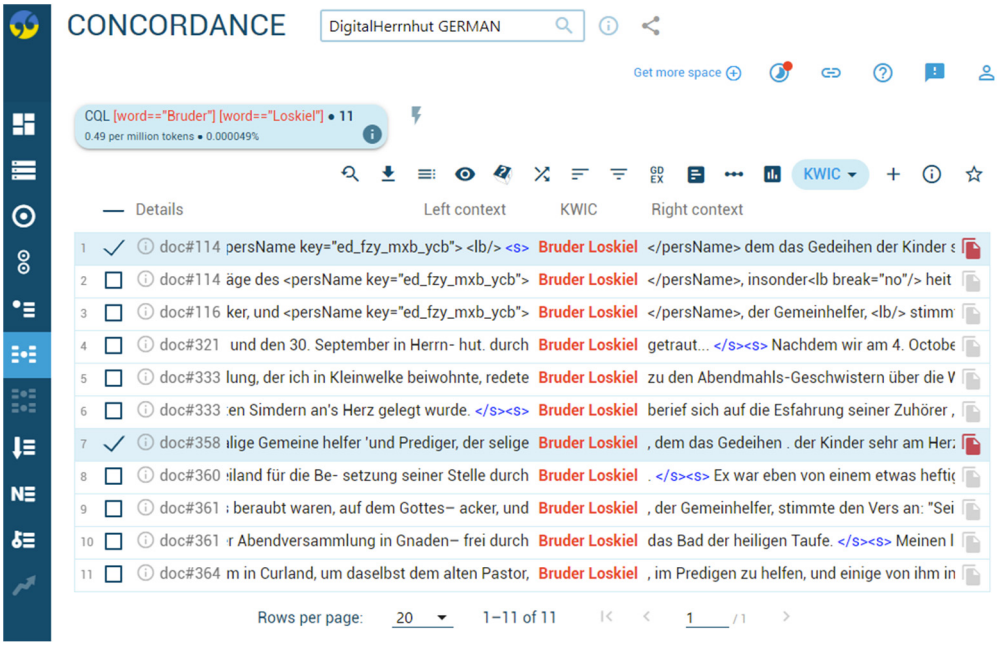

Fig. 7: The multi-word unit "Bruder Loskiel" in the DigitalHerrnhut GERMAN corpus. Highlighted are the two variants of the biography of Hastings in the Sorabicon and in the NBG.

Multi-word units, such as the close apposition "Brother Loskiel" (Fig. 6) can be reliably identified, for example, in SketchEngine (Fig. 7), which we use for teaching and research contexts.

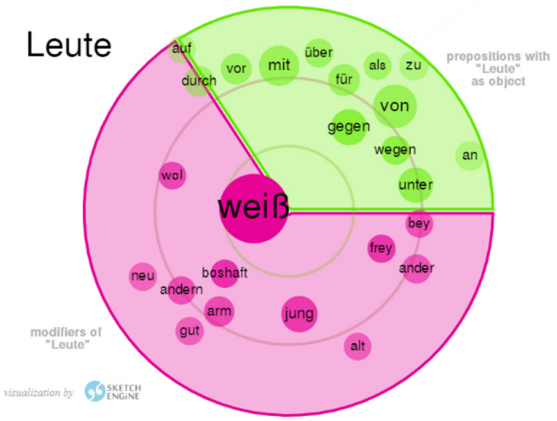

Fig. 8: Adjectival attributes of and prepositional groups with "people" as examples for the study of consolidated multi-word units (collocations) to reveal specific patterns of language use.

It becomes more interesting, however, when, for example, in mission narratives from North America such as that of Loskiel (1789), one measures the relationship between Native Americans and the Europeans, whom Loskiel, distancing himself as a Moravian, calls "white people".

Aspects like this, the use of pejorative terms in the North American corpus in DigitalHerrnhut GERMAN, are the focus of (post-)colonial linguistic studies ([9] Lasch (accepted)), for which machine evaluations of our sources become necessary in order to be able to subject them to linguistic analyses and provide interpretations. (Fig. 8) For by making visible specific linguistic patterns and collocations, i.e., solidified multi-word units such as "white people" (Fig. 8), not only can particular linguistic usages be studied, but also the relationships between people, places, and bodies of knowledge can be unlocked and traced coming from a virtual model. Students of historical linguistics thus not only learn about a special cultural-historical place and its community in the Virtual Excursion Kleinwelka, but are also introduced to the working practices and methods of the Digital Humanities. For they not only explore a model, but collaborate on it, creating machine-readable texts from image digitizations, which they can in turn examine corpus linguistically, revealing connections that invite interdisciplinary cooperation, for which, in conclusion, this herbarium record of a basil (Fig. 9, entry JACQ) can stand.

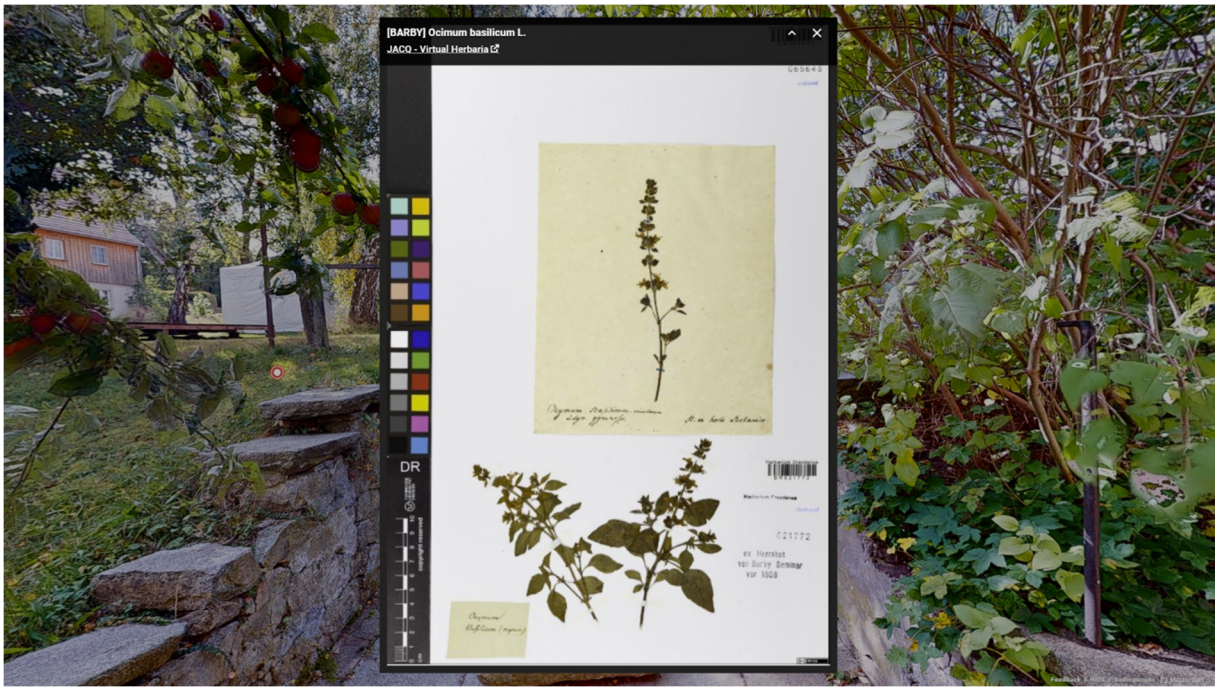

Fig. 9: Basil herbarium specimen of moravian provenance in the virtual model of the sisters' garden.

The specimen grew "in horto Botanico" of the Barby Seminary and was collected either by Friedrich Adam Scholler (1718-1785), Johann Jakob Bossart (1721-1789) or by one of their students, among whom was Georg Heinrich Loskiel, and described by Scholler in the highly influential *Flora Barbiensis (*1775) (cf. on the connections in international scholarly circles [16] Ruhland 2017). Today, the voucher belongs to the Herbarium Dresdense in the collection part of Moravian provenance, which is currently being indexed (also digitally) and integrated into the virtual model of the Sisters' Garden, before it may one day return, even if only virtually, to its historical place. But that is another story, which will be told above all by the botanists in the DigitalHerrnhut research hub.

The Virtual Excursion Kleinwelka is not yet used as a teaching tool to explore the Moravian knowledge archives, as the enrichment phase and especially the creation of tours through the house have not yet been completed and released by the Moravian Church. The examples used in this paper were created in teaching contexts, reflect indexing projects with partner institutions, and are contributions from research - so for now, the Virtual Excursion Kleinwelka is still more of a Virtual Sisters' House that will be prepared for exploration in the near future. An important step in this direction will be the Cultural Summer 2022 with the contribution from Kleinwelka, which will relate the model and the results on site.

Acknowledgement

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References

[1] Atwood C (2021): Nikolaus Ludwig Graf von Zinzendorf. In: Breul W (ed.): Pietismus Handbuch. Tübingen. 184-197.
[Breul W (ed.) (2021): Pietismus Handbuch. Tübingen.

[3] Faull K (2021): Digital Humanities. In: Breul W (ed.): Pietismus Handbuch. Tübingen. 11-18.

[4] Hermann K (2022): Herrnhuter Gemein-Nachrichten digital. A cooperation of the Unitätsarchiv and the SLUB Dresden. Sächsische Heimatblätter 68/1. 42-45.

[5] Lasch A (2005): Lebensbeschreibungen in der Zeit. On the communication of biographical texts in the pietistic communities of the Herrnhuter Brüdergemeine and the Dresdner Diakonissenschwesternschaft in the 19th century (Germanistik 31). Münster.

[6] Lasch A (2019): "The world is turning black". On the discursively constructed concept of "race" as the object of a discourse pragmatics. In: Gnosa T & Kallass K (eds.): Grenzgänge. 1-11. available online.

[7] Lasch A (2021): (Science) culture of digitality. In: Lessons Learned 1. DOI: https://doi.org/10.25369/ll.v1i1/2.27.

[8] Lasch A (ed.) (2009/2021): "My heart remained in Africa". An annotated anthology of Herrnhut mission reports from the edges of the world at the beginning of the 19th century (N.L. von Zinzendorf. Materialien und Dokumente 2, 34). Hildesheim, Zurich, New York. OpenAccess secondary publication via Qucosa.

[9] Lasch A (adopted): "who called them, Sunday *Indians or Shwannaks, that is, white people, the most opprobrious name they could invent". Powerful constructions in the service of verbal devaluation. In: Meier-Vieracker S & Schnick M (eds.) Discourse invective.

[10] Mahling L (2017): Um der Wenden Seelenheyl hochverdient - Reichsgraf Friedrich Caspar von Gersdorf. An investigation into cultural transfer. Bautzen.

[11] Mahling L (2019a): Verflechtungsraum Lausitz. Bohemian-Hungarian exiles and Lusatian Sorbs. Encounters and relations in the 18th century. (Small series of the Sorbian Institute 31). Bautzen. Available online.

[12] Mahling L (2019b): Mały Wjelkow - centrum serbskeho pismowstwa we 18. lětstotku [Little Velka - center of Sorbian writing in the 18th century]. In: Rozhlad 1. 14-19.

[13] May C (2011): August Gottlieb Spangenberg. In: Saxon Biography. Online edition: http://www.isgv.de/saebi/ (1.4.2022).

[14] Meyer D (2021) Herrnhut und Herrnhaag. In: Breul W (ed.): Pietismus Handbuch. Tübingen. 233-239.

[15] Roth K (2021): The text type life description as an object of research in text semantics. In: Bär J. A. (ed.): Historical text and discourse semantics (Jahrbuch für germanistische Sprachgeschichte 11). Berlin, Boston, 176-190. DOI: https://doi.org/10.1515/jbgsg-2020-0013.

[16] Ruhland Th (2017): Between grassroots scholarship and commerce: the natural history trade of the Herrnhuter South Asia Mission. In: Förschler S & Mariss A (eds): Actors, animals, things: modes of natural history in the early modern period. Cologne. 29-45.
[17] Schindler M (2022): Kleinwelka - Kanzel der Sorben und Drehscheibe der Mission. An interview with Andreas Tasche and Bernd Domschke. Publication on the project blog DigitalHerrnhut, in the podcast "lasch not least" in the Virtual Excursion Kleinwelka.
[18] Schmidt D, Lindau A-K & Finger A (2013): The virtual field trip as a teaching and learning environment in schools and universities. In: HJfG 35. 145-157. available online.
[19] Vogt P (2021): Mission fields and international relations. In: Breul W (ed.): Pietismus Handbuch. Tübingen. 568-578.
[20] Vogt P (2022): Herrnhut - "Republic of God" in Upper Lusatia. In: Sächsische Heimatblätter 68/1. 10-13.
[Zimmerling P (2022): Herrnhut - the first Christian community foundation of the Brüdergemeine. In: Sächsische Heimatblätter 68/1. 14-20.
[21] Zimmerling P (2022): Herrnhut - die erste christliche Gemeinschaftsgründung der Brüdergemeine. In: Sächsische Heimatblätter 68/1. 14-20.

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Learning journeys with digital whiteboards

S. Richter*

Digital Manager, Dresden International University

Abstract

Neues Lernen ist selbstorganisiert(er). Die Lernenden übernehmen selbst Verantwortung für ihr Lernen. Lehrende werden zu Lernbegleiter:innen und geben Impulse und unterstützen den Lernprozess. Um Lernszenarien zu gestalten, die auch hybrid und asynchron funktionieren, ist der Einsatz von digitalen Whiteboards oder Pinnwänden empfehlenswert, denn diese ermöglichen nicht nur das strukturierte Hinterlegen von Material, sondern sind auch Basis für Gruppenarbeiten und Brainstormings oder Austausch. Kollaboration wird immer wichtiger, deshalb ist es sinnvoll, dies bereits innerhalb des Studiums zu ermöglichen und auch zu üben. Die passive Teilnahme an Vorlesungen wird durch interaktive Formate abgelöst, denn viele Inhalte können die Teilnehmenden sich mit Hilfe von Büchern, Beiträgen im Internet, Videos oder Podcasts außerhalb der Lehrveranstaltung selbst aneignen. Die Kuratierung des vielfältigen Materials ist Aufgabe von Lernbegleiter:innen. Digitale Whiteboards oder Pinnwände geben Struktur und bestenfalls sind diese ansprechend als eine Art Lernreise aufgebaut, so dass Teilnehmende das Lernen positiv verknüpfen. Wichtig im New Learning ist, das Zusammentreffen der Lernenden und Lernbegleiter:innen in einer Lernveranstaltung dem Austausch, wertvollen Diskussionen und Übungen zu widmen.

New learning is (more) self-organised. Learners take responsibility for their own learning. Teachers become learning guides and provide impulses and support for the learning process. In order to design learning scenarios that also function hybrid and asynchronously, the use of digital whiteboards or pinboards is recommended, because these tools not only enable the structured storage of material, but are also the basis for group work and brainstorming or exchange. Collaboration is becoming more and more important, so it makes sense to facilitate and to practise it even during your studies. Passive participation in lectures is being replaced by interactive formats, because the participants can acquire much of the content themselves outside the course with the help of books, contributions on the internet, videos or podcasts. The curation of the diverse material is the task of learning guides. Digital whiteboards or pinboards provide structure and, ideally, are designed attractively as a kind of learning journey so that participants positively link learning. In New Learning it is important to dedicate the meeting of learners and facilitators in a learning event to exchange, valuable discussions and exercises.

*Corresponding author: sandra.richter@di-uni.de

1. Self Organized Learning

How can learning be designed in such a way that creativity, collaboration and also the joy of learning come into focus and the pure transfer of knowledge does not take up the entire learning space?

This is a question that concerns us at DIU Dresden International University because, on the one hand, we mainly help part-time students to develop and they are open to flexible learning models alongside their work, which can be fun. On the other hand, it is important to us to promote togetherness, which can then in turn flow into everyday working life in order to set impulses for a WE feeling there as well.

The principle of learning journeys supported by digital whiteboards is a good solution for our learning events. We have summarized our experience with it below.

2. What is a learning journey?

By learning journeys, we mean a guide through the learning event with a start, various stages and group or self-learning goals, an end, and in between and as conclusion, retrospectives to learn also from looking back. A learning journey combines synchronous and asynchronous phases.

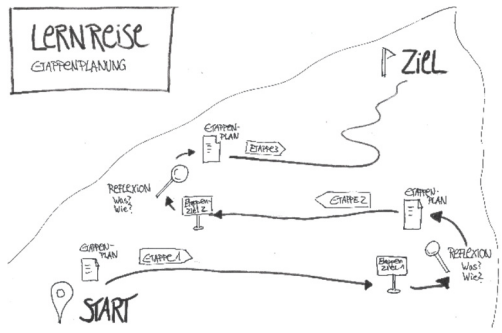

Fig. 1: Learning journey [1]

The beginning of the journey

Every journey begins with an introduction of the learning group and the definition of the goals. The purpose of the journey must be clear to everyone so that participants do not get off track during the journey.

First, participants and learning facilitators get to know each other. The focus is not necessarily on technical knowledge, but rather on the people who are embarking on this journey together. As with a vacation trip, an appreciative and happy atmosphere should be able to arise.

There are many methods and tools for a good start. One example is a combination of the Impromptu Networking method from the Liberating Structures method kit - see also https://liberatingstructures.de/liberating-structures-menue/impromptu-networking/ with the website https://www.checkin-generator.de/.

In Impromptu Networking, there are three rounds, each with a different grouping of two, who each spend four minutes exchanging ideas on a question that is quickly found with the help of the CheckIn generator. The method works both in analog and digital setting, and the possibility of automatic breakout rooms in video conferencing tools such as MS Teams or Zoom is very supportive. With the push of a button, groups are randomly thrown together and also automatically brought back into the plenum.

Tip:

The first two questions in Impromptu Networking can be warm-up questions from the generator such as "What was the worst movie you have ever seen?", because the initial aim is to get to know each other in as relaxed an atmosphere as possible. We recommend formulating the third question in such a way that it either already asks about expectations for the learning journey or leads to the topic of the journey. To conclude the method, depending on the size of the group, impulses from the small group can be brought into the plenary, orally or in writing. Digitally, we like to use a chat storm for this. For a chat storm, the participants write their contribution in the chat, but only send it on command. This prevents copying.

It is important in the getting-to-know-you round that all participants feel included and that a cooperation at eye level can develop.

The point of getting in the mood for the journey is to build trust and to see what the participants have in common.

We would advise against rounds of introductions in which each participant says a few words about him or herself. This is a lengthy process, especially in larger groups, and the participants probably don't even remember a quarter of the people and quickly lose track of their thoughts. A variation that is quite practicable in smaller groups: Groups of two are formed and the participants briefly introduce themselves to their counterparts. In the plenary session, the participants then each briefly introduce their counterpart. Give this a try. In our experience, this leads to a very pleasant feeling for all participants.

After everyone has gotten to know each other a little, it is very helpful to anchor a few short keywords on the whiteboard as well. The participants "make" virtual name tags and attach a photo, hobbies, and, if desired, links to social media profiles such as LinkedIn or Twitter or similar interesting information about the person. The criteria are best established in advance. The travel group is now ready to go and ready for their learning adventure.

The goals of the journey are formulated so that the framework is clear to everyone. We borrow the SMART formula from project management here:

Specific
Measurable
Attractive
Realistic
Timed.

The travelers therefore know the framework conditions for their journey and can start well equipped and self-organized.

Stages

A learning journey may consist of several stages. Groups can devote themselves to different topics, which they then present in plenary. Just like a journey, where some just walk to the viewpoint, while others ride the rental bike to the harbor. This is the self-learning time and - to stay with the image of "traveling" - the time that is individually available to explore the respective destination by oneself. One can freely decide whether to do this (partly) alone or with others.

Each stage ends with a retrospective - the findings become visible to all, so the participants figuratively show the photos of their journey and give recommendations on what could be optimized on the route.

We like to compare this with the evening interactive social program, where travelers get together, tell about their experiences and share what they have seen (learned) in a cheerful mood.

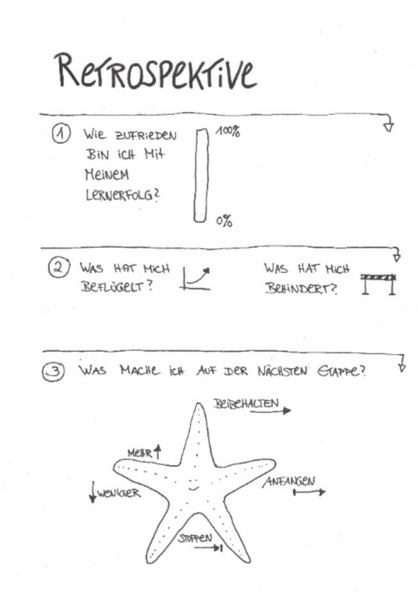

Fig. 2: Retrospectives [1].

Conclusion

Once the stages have been completed successfully, the end of the journey is in sight. After the predefined time, everyone comes together for a final celebration. The core of the event is to have achieved something and to be appreciated for it.

Therefore, the journey itself is rather individual, but the (intermediate) goals are clearly defined. An environment for collaboration is created, but no compulsion for group work is built up. It is important to always arrange regular meetings with all participants to provide support if necessary, because self-organized learning naturally also has pitfalls.

There is a reason why there are formats such as Working Out Loud or lernOS, which provide for regular meetings (for 12 weeks for one

hour each week) and self-learning phases between the meetings. After all, self-organized learning does not mean doing everything individually, but rather that the learner learns in the way that suits him/her best in terms of time, frequency, format, or the like.

3. Why whiteboards?

So how can digital whiteboards support such a learning journey?
They not only serve as a creative visualization of (partial) goals, they also provide a basis for information material provided by learning guides, which can be accessed flexibly and clearly arranged on the board at any time. In addition, whiteboards are a good way of documenting results, collecting and evaluating ideas, being creative and exchanging ideas collaboratively. The great advantage of digital whiteboards are the numerous functionalities from writing sticky notes to embedding images and icons to linking to websites or to other whiteboards or specific areas in the whiteboard. The voting function can also be very useful. A whiteboard can be built and designed to match the objective, stimulating creativity and setting a framework for the learning journey with colors, shapes and structure.

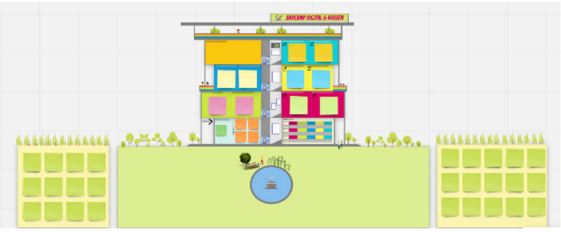

Fig. 3: Example Miro board for a creative barcamp

For digital whiteboards from Mural or Miro, for example, there are free education licenses for teachers:
https://miro.com/education-whiteboard/
https://www.mural.co/education
Conceptboard is GDPR compliant:
https://conceptboard.com/
Digital whiteboards are very similar in terms of handling, but there are also differences, however, these are usually only of importance when there is a requirement to support more extensive projects with a digital whiteboard.

Whether to use Mural, Miro, Conceptboard or rather digital pinboards such as Padlet or Taskcards is hard to decide if you don't look at the tools beforehand and don't know exactly what is possible with them.
Therefore, we have compiled some tips on Miro whiteboards below.

4. Tips for Miro boards at a glance

Miro is our whiteboard of choice, so we'd like to share our learnings from using it in a variety of contexts here.

Part I - Structure of the learning journey
Once you have built a whiteboard for the learning journey, it can be used again and again as a ready-made personal template. The structure can be quite elaborate and complex. This is also conducive to one's own creativity. Each structure should follow a clearly recognizable and comprehensible structure.

Think carefully about what you want to use the board for, what colors, images, and frames you need, and how you will connect them so that participants can find their way around. Arrows and connectors and unique icons can be very useful here. A layout that matches the theme of the learning journey can be inspiring. Or how about the idea of recreating the university building in the Miro board?

There are already many good templates, but they are mostly in English. For example, we like to use the template "Sticky Pack" (stacks of sticky notes), so you can always provide a stack right away at every corner where sticky notes are to be used.

Ask yourself specifically which elements need to be anchored so that participants can no longer change them (lock) and which elements should be editable.

Which board section should the participants see when they land on the board (start view)?

Use the "Link to" function if you want to link. This way, the links are always accessible, even if someone else is blocking the element with the link. Participants can always tell that a link has been created by the symbol in the top right corner of the respective element.

If you have already created a PowerPoint presentation for your course that you would like to use, you can upload it to the Miro board and extract all the pages there with one click so that they are displayed one after the other as images. You can also assign frames to the individual pages for questions or further information.
Think carefully about perhaps building multiple boards and linking them together.
Sometimes it makes sense to do this, if a part should better not be editable and therefore can be set to "View", while other frames should be changed during the event (e.g. areas for documentation of group work or a feedback and support corner).
For very complex boards, it is recommended to create a short explainer video for introduction. For this, we use OBS https://obsproject.com/de and record the screen while explaining what we show on the screen.
Including the link to the video conferencing tool or the information about the learning journey exclusively on the Miro board can cause difficulties. Some participants are not (yet) familiar with Miro and will not be able to find the link and other information. So send another message shortly before the learning journey with all relevant links and information and, ideally, also a One-Pager or link to the explanatory video explaining the whiteboard and plan time after the welcome for a short introduction on the board (tour with split screen). Assume that there are both beginners and experienced participants in your learning group when using whiteboards. To keep the pros from getting bored, think of a small exercise on the board that they can do during the introduction. The beginners stay with you in the main meeting, and the experienced participants are sent to a breakout room so they can share ideas without having to listen to the introduction.

PART II - during the learning journey
Use the "Hide collaborators cursors" function, otherwise it can become confusing, especially if there are a lot of participants.
Use the "Bring everyone to me" function so that all participants are always exactly where they are supposed to be working.

If all participants are beginners, post the link to the board via the chat only after the introduction, so that the participants do not access the board while you are still making the introduction. In this way, you avoid chaos and questions because one or the other would rather try out the board instead of concentrating on the introduction.
Feel free to use the Miro whiteboard as a presentation replacement as well. You can simply jump from frame to frame or use the presentation mode and thus move to the frames one after the other, which you have previously arranged in the correct order.

For group work, in which the various groups should not initially see what the others are visualizing or writing down on the whiteboard, it is a good idea to create separate whiteboards for each group and to send the respective link to the groups. In order to bring them together again, an area can be set up in advance in the main board that contains all the links to the group boards. This can be set to "invisible" before and during the group exercise. This functionality is very easy to use, especially with Miro, by clicking on the eye symbol that is open or closed as shown in the image below. This function is also useful if the participants do not yet see all the content, but should be able to work on the individual areas gradually.

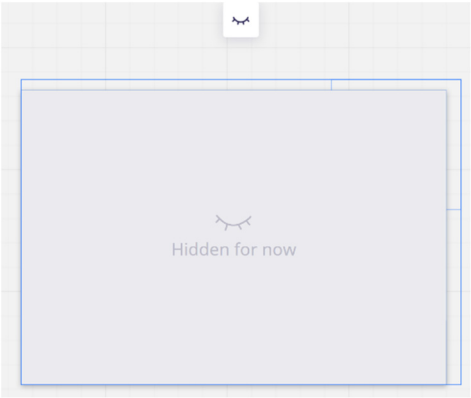

Fig. 4: "Hidden for now" functionality in the Miro board

Part III - after the learning journey

The export function makes it possible to save all results as PDF or PNG and to make them available to the participants afterwards.

If you want the Miro board to remain visible but not editable, it is possible to set the board to "View" mode. In this way, participants can use all links, but otherwise no longer change the board. In "Comment" mode, comments are also possible.

5. Whiteboard vs. pin boards?

Pin boards are ideal if you do not need a complex structure, but rather want to collect ideas or only provide material. Whiteboards can do much more, but are also initially more confusing to use and definitely require an introduction before use, so that there is no chaos and some participants become nervous already at the beginning.

Widely used and popular is the use of Padlet https://de.padlet.com/, because here participants can simply add a new card with a click on a + symbol and intuitively fill it with the desired content.

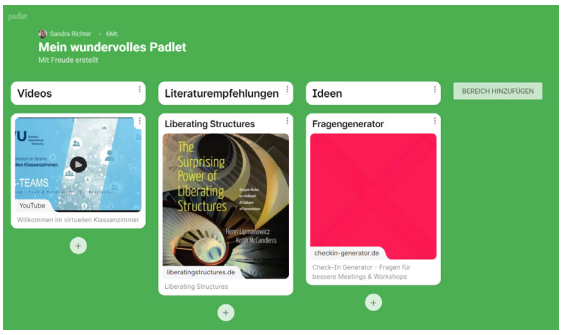

Fig. 5: Example of a padlet

As a GDPR-compliant alternative to Padlet, we recommend using Taskcards https://www.taskcards.de/. A big plus is that Taskcards was developed by a Schmalkalden-based company.

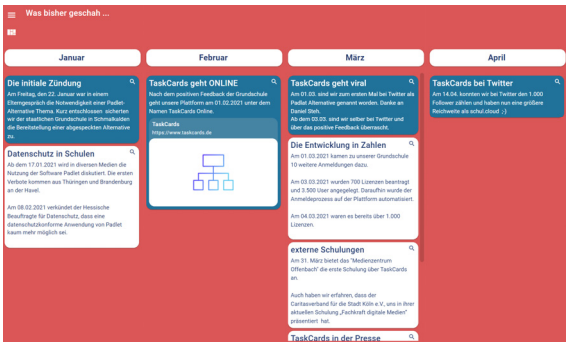

Fig. 6: Example of a pinboard of taskcards

Designing a complex learning journey is useful when you want to creatively and collaboratively guide the learning group toward a goal over an extended period of time.

Using whiteboards to their full potential is initially very complex. Setting up a reusable template that maps a learning journey with various synchronous and asynchronous self-learning and collaborative learning phases must be well thought out. A comprehensible structure is essential. Links must be correct and recognizable as such. Fixed content must be fixed in such a way that it cannot be changed or even deleted by the learners. Consequently, a lot of time, energy and concentration goes into building a complex board. This should not be underestimated. However, a whiteboard can also be designed gradually, so that not every possible hurdle has to be considered from the beginning. When building a structured whiteboard for the learning journey, you keep learning and developing yourself and the board.
It is important to provide a detailed introduction to the tool and the structure of the learning journey so that all users can easily find their way around. This is also a challenge that takes time and energy, because what seems logical to you is not necessarily comprehensible to others. Patience is required here. In the beginning, there will probably still be some difficulties, which is why we recommend not choosing a hybrid setting for the introduction to the board, as it is important to reach everyone equally.

Tip:
Find out who is directly comfortable on the board and who is not. Form mixed peer-to-peer learning groups as a first exercise after the introduction, as participants feel more comfortable asking comprehension questions in a smaller group.

6. Obstacles

Especially in the asynchronous self-learning phases, good planning is necessary, because self-organized learning is not infallible. We all know the procrastination of rather disagreeable tasks, the flood of information that threatens to overwhelm us or the many distractions that lurk in everyday life.

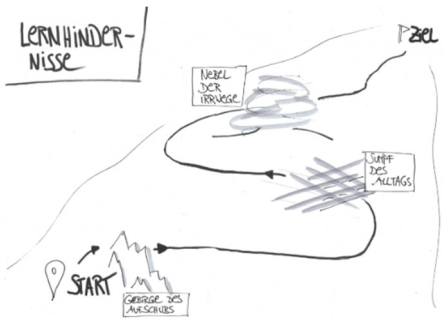

Fig. 7: Obstacles to learning [1].

A learning journey is always structured in such a way that all participants regularly meet synchronously and exchange ideas. This way you can see who is still on the right track, who may need support or a little motivation boost. These regular meetings should be anchored directly in the calendar.

One tip for the self-study phase is to keep focus time free in your calendar for this as well, so that distractions can be kept to a minimum and you can consciously embark on your learning journey.

In addition to synchronous learning events with a learning guide, learning circles can be encouraged. Learning circles consist of a maximum of 5 participants who meet regularly, for example for one hour a week, in analog or digital form, and discuss the tasks of the self-learning phase (similar to working out loud). Under certain circumstances, this helps to keep up with the topics.

7. Learning effect through sharing knowledge

DIUtalk is a regular exchange format for and with DIU faculty. Every other week, we meet for one hour, discuss and learn in a relaxed atmosphere.

In DIUtalk Deep Dive, our tool workshop format, we have already taken a closer look at Mural and Miro whiteboards, Padlet pinboard, and Taskcards with participating DIU lecturers and continue to offer regular two-hour workshops on a wide variety of tools. In addition, we have expanded our fortnightly DIUtalk to include DIUtalk Best Practices, in which lecturers present how they proceed methodically and what tools they use to support them. We have established a community for teaching and learning in LinkedIn, and there, helpful information and links to exciting blog posts or tools are shared.

Sharing knowledge, however, not only helps the consumer, but also the writer. They sort out their thoughts, summarize them, focus information and additionally may develop the good feeling that these references will be useful to someone. At this point, social media should be mentioned as a platform to share knowledge outside the learning journey. Twitter in particular, with its challenge of writing down the essence in 250 characters, is a wonderful way to focus on the essentials. It cannot be underestimated how many valuable impulses are shared via social media on a daily basis. The option of following certain hashtags or people, or even hiding topics, ensures that the flood of information is contained.

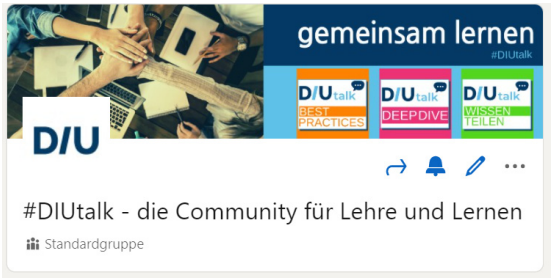

Fig. 8: #DIUtalk - the community for teaching and learning on LinkedIn

8. Material for the learning journey

What works on Twitter is also relevant for other formats.

Wemay often not be able to follow long videos or to read pages of factual texts in a concentrated manner. Every learner is different in this respect, of course, but short, intensive learning sequences are generally easier to integrate into everyday life. The self-learning phase should therefore contain rather short learning bits.

The type of material should ideally be very diverse. Take advantage of the wealth of possibilities, link to an exciting podcast, explanatory videos, articles in trade journals or blog articles. Feel free to recommend excerpts from reference books, but avoid giving participants a book to read without focusing on topic areas.

Our internal DIU WIKI features short learning snacks with helpful screenshots and One-Pagers or explainer videos that are no more than 12 minutes long, or at best only 5 minutes. This was also a learning process. The first learning video created was 18 minutes long and caused complaints that this length was excessively long. So it's important to focus on the essentials and, if necessary, divide content sensibly into several formats, videos, documents or the like.

9. Hybrid learning journeys

Learning journeys combine asynchronous self-learning phases with synchronous exchange phases. In each phase, participants are free to participate online or offline, however, all participants must have portable devices that enable the use of virtual meetings and digital whiteboards.

For participation in the DIU rooms, they are equipped with mobile video conferencing technology that allows image and sound to be transmitted both into the room and out of the room to the virtual participants.

In the asynchronous group learning phases, participants are also free to choose their learning location. In some groups, they may meet in a completely analog beer garden, in others - virtually. Mixed forms are particularly interesting here as well. Good coordination is required in the groups if not everyone is at the same physical location or everyone is there virtually. This is also a competence that needs to be tried out in order to be able to move confidently in the hybrid working and learning world. With Miro boards in particular, even virtual participation with a smartphone is quite feasible, as there is a viable smartphone app.

Tips for hybrid learning and working environments:

Set concrete dates in advance for the synchronous meetings of all participants that fit the respective tasks to be considered asynchronously either self-organized or in the group. Fixed anchor points in the calendar are important so that learning is as focused as possible and participants can concentrate. Provide a contact option for queries during self-learning time. The chat function in the board or a Q&A space per (sub-)objective is suitable for this. It should be noted, however, that you clearly regulate that you, as a learning journey guide, participate in certain appointments to look into the board to answer the questions.

Round-the-clock care is strongly discouraged. Find dedicated students who you can entrust with specific tasks, such as chat support, so that you can focus on moderating hybrid events. If you are there with participants offline yourself, while some participants join virtually, moderation is especially important. In DIUtalk, we also thought about and discussed this together. One thing was particularly important to us: Whoever speaks has the camera on. During a talk, i.e. when only one person is speaking for a longer period of time and a presentation is being shared, it's perfectly fine to turn off the camera, but when it comes to conversations, it's a matter of courtesy that the people who are talking also able to see at each other.

We have also found that, quite independently of technical requirements, the attitude with which participants and learning facilitators engage with the hybrid setting is also very important. It is easier to involve everyone in a cheerful, relaxed group. The more active the participation, the easier it is to involve all participants, no matter where they are located. So it's very much a matter of wanting to and creating settings that are interactive, creative and collaborative so that the desire to learn is not dampened by the fact that not everyone is in the same room. In any case, it helps to actively address the online participants by name repeatedly so that they do not sit back passively but participate in the learning process.

Fig. 9: Results from the DIUtalk on hybrid teaching

10. Conclusion

Learning journeys with digital whiteboards can support synchronous and asynchronous learning phases, both, analog or digital, but also hybrid. It is important to consider whether the benefits are worth the effort, or whether a digital whiteboard is too much of a good thing. In any case, whiteboards and pin boards provide a helpful basis for interactive collaboration and the documentation of ideas and results. They invite the sharing of information of any kind and thus support exchange and networking. The diverse design options can also stimulate creativity.

Acknowledgement

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Literature

[1] Sternberg, A., Fuchs, C., Urbild, J., Gehrke-Vetterkind, L., Richter, S. (2021), New Learning - your learning guide for individual learning.

Free download:

https://sandra-richter.com/Portfolio/Business-Coach/

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Digital and hybrid teaching in medical education using the example of the Medical Interprofessional Training Center (MITZ)

Impulses and development potential

A. Röhle, E. Bibrack*

Medical Interprofessional Training Center, Carl Gustav Carus Faculty of Medicine , Technische Universität Dresden

Abstract

Mit Beginn der COVID-19-Pandemie wurde die Durchführung der praktischen Lehre vor große Herausforderungen gestellt. Das Medizinische Interprofessionelle Trainingszentrum (MITZ) ist diesen mit der Implementierung neuer Lehr-/Lernformate erfolgreich begegnet und hat die Chance genutzt, weitere Projekte zu initiieren. Vor dem Hintergrund sich verändernder beruflicher An- und Herausforderungen wird damit zugleich der zunehmenden Kompetenzorientierung in der Hochschullehre Rechnung getragen, indem Lehr-/Lernprozesse die Lernenden als aktiv Handelnde in den Fokus stellen. Neue digitale Formate und Technologien haben das Potential, den Wandel hin zu einem eigenverantwortlichen und personalisierten Lernen zu vollziehen. Im Folgenden wird unter methodischen und bildungswissenschaftlichen Aspekten die Neuausrichtung der praktischen Lehre im MITZ vorgestellt.

With the onset of the COVID-19 pandemic, the implementation of practical teaching was faced with significant challenges. The Medical Interprofessional Training Center (MITZ) has successfully met these challenges by implementing new teaching/learning formats and has taken the opportunity to initiate further projects. Against the backdrop of changing professional requirements and challenges, this also takes into account the increasing competence orientation in higher education by focusing teaching/learning processes on the learners as active agents. New digital formats and technologies have the potential to bring about a change towards independent and personalized learning. In the following, the new orientation of practical teaching at MITZ is presented under methodological and educational aspects.

*Corresponding author: eva.bibrack@uniklinikum-dresden.de

1. Introduction

With the onset of the COVID-19 pandemic, the implementation of practical teaching was faced with significant challenges. The Medical Interprofessional Training Center MITZ has successfully met these with the implementation of new teaching/learning formats and has taken the opportunity to initiate further projects. In the following, the reorientation of practical teaching at MITZ is presented under methodological and educational aspects.

2. Introduction of the Flipped Classroom Model during the COVID-19 pandemic.

The MITZ, the skills lab of the Faculty of Medicine Carl Gustav Carus Dresden, prepares students of human medicine and dentistry for their future professional life: The compulsory curriculum of the human medicine study program provides for 35 and that of the dental medicine study program for 14 trainings of basic practical and communicative skills. Teaching takes place in small groups in a peer-teaching format [1].

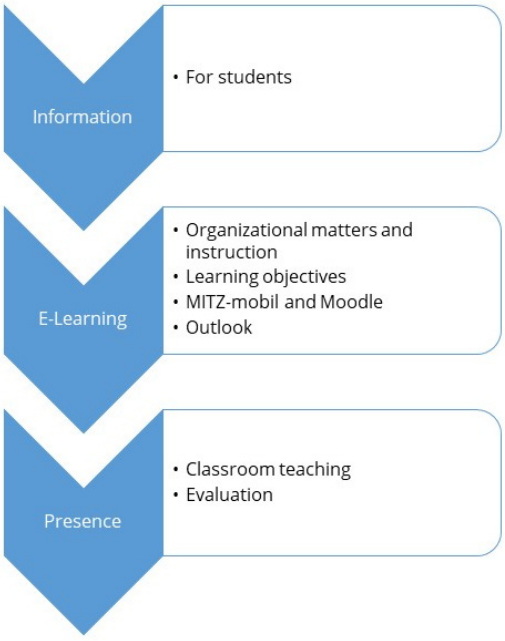


Fig. 1: Overview of the implementation of the ICM at MITZ.

In order to maintain teaching during the COVID-19 pandemic in the summer semester 2020, the teaching/learning format Inverted Classroom (also Flipped Classroom - ICM) was implemented [2]. In this didactic concept, learning content is developed by the students in self-study and taken up during the face-to-face course (Fig. 1). As a variant of blended learning, this concept combines the advantages of digital learning with those of classroom teaching. The self-study phase focuses on learning at a lower level of cognitive processes, which are nevertheless essential in necessary preparation for the classroom phase. This paves the way for activating learning to enable the acquisition of more cognitively demanding skills.

The self-learning phase was structured using the learning management system Moodle in combination with the website www.MITZ-Mobil.de [3] (Fig. 2). After piloting the ICM, the teaching/learning format was also implemented for the winter semester 2020/2021 [4] and firmly established and further developed from the summer semester 2021 [5].

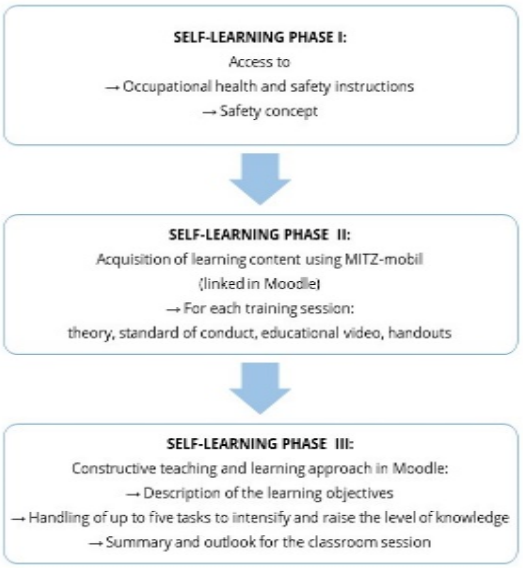


Fig. 2: Structure of the preparatory e-learning in the Moodle learning management system

Accompanying the implementation and stabilization of the ICM, the evaluation on the part of the students was carried out with an online questionnaire based on EvaSys [https://www.electricpaper.de/] survey and examination software.

3. Further development of the ICM

The separate assessment of e-learning and face-to-face training within the evaluation provided further clues for potential improvements [5], which primarily concern the provision and adaptation of interactive teaching materials to the learners' technical requirements (Tab. 1).

In addition, there was an overarching need for adaptation based on constructive alignment [6] and the requirements of the National Competence-Based Learning Objectives Catalogue for Medicine (NKLM) 2.0 [7], which relates to the learning needs-based adaptation of learning objectives and teaching methods.

With an extended evaluation for e-learning starting in the summer semester 2022 as well as the revision of learning objectives and teaching methods, the demand-oriented compulsory teaching in MITZ is to be further consolidated and expanded.

The success of the realignment of practical teaching in MITZ, as well as the piloting of new innovative hybrid concepts in the context of practical teaching, is justified below from an educational science perspective.

Tab. 1: Adaptations at different levels of the teaching/learning format

Subarea of the ICM	Adjustments made
MITZ-mobil	Additional instructional videos and visuals
	Clarification and adaptation of individual contents
Moodle	Layout more user-friendly
	Individual issues sharpened and solutions deposited
Learning objectives	Differentiation of learning objectives into e-learning objectives and classroom objectives
Tutor guides (training of peer tutors)	Basic didactic revision
	Linking the learning locations MITZ-mobil, Moodle, classroom teaching
	(New) familiarization of all tutors
Classroom teaching	Structural sequence of the practical teaching unit: teaching outline adapted in favor of practical training time

4. Digitization as an opportunity for competence-oriented university teaching

"In the lecture halls [...] of today, there is a generation of [...] students with new technological needs, the 'millennial generation'. This results not only in new content and new lecture hall environments, but also in a new pedagogy."[1] *[8]*

A look at the campus of a university confirms it: the "digital natives", students who have grown up with smartphones, tablets and the like, have long since arrived in everyday university life. They interact digitally in almost all areas of life and presumably expect their digital lifestyle to be taken into account in the academic teaching/learning environment as well [8]. Contradictory to this statement, however, it can be stated that this young generation nevertheless does not act as a driver of digitization. In terms of learning and successful completion of their studies, their focus is much more on obtaining credit points. They seem to be less interested in how teaching is actually structured [8]. Most university lecturers also stick to existing teaching formats - lecturers who are very open to digitization tend to be considered "exotic" [8].

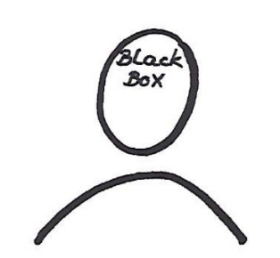
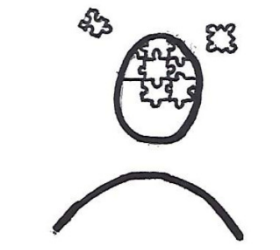
As a major digitization driver, the COVID-19 pandemic has increasingly forced teachers to relocate their teaching to new digital learning venues since the beginning of 2020 and thus to redesign the learning environment. Even if this transformation has been forced and many teachers would like to switch back to previous teaching formats after the pandemic, this time of crisis should be understood as a great op-

[1] This reference has been translated for the English version of the paper.

portunity to carry out necessary restructuring. Against the background of a changing educational ideal in recent decades, the paradigm of learning theory has shifted from objective-behaviorist to subjective-constructivist approaches (Tab. 2). The assumption is no longer that knowledge is objectively available, but that individuals need skills to access, prioritize, and structure knowledge in order to represent it individually. The focus is less on the creation and availability of knowledge and more on knowledge management, i.e., dealing with an ever-increasing amount of knowledge [9]. The significance of such interdisciplinary, methodical skills is becoming increasingly important in order to adequately prepare students for professional, but also for societal demands and challenges. The shift from content orientation to competence orientation in studies is expressed by the term *shift from teaching to learning* [9]. This paradigm shift requires restructuring measures - teaching/learning processes must be modified, learning environments must be increasingly learner-centered to meet the needs of learners. Learning must encourage independent thinking and practice and self-directed complex problem solving. Accordingly, teaching must be designed in such a way that students act as active agents in their learning process, while teachers take on more of an accompanying, supporting, moderating role. As a consequence, the learning environment must be adapted and enriched with new media (e.g., through blended learning formats) [9].

The period of crisis could accelerate the progress of digitization at German universities. In necessary adaptation to future challenges facing society as a whole and the profession, this further development should be accelerated instead of falling back into old teaching patterns.

Tab. 2 Comparison of learning theories

Behaviorism	**Constructivism**
Learning as a "black box“ 	Learning as a construction process 
Focus is on generation and availability of knowledge: "Deposit of knowledge".	Focus is on tapping, prioritizing and structuring knowledge: "Knowledge management".
Goal: Acquisition of (factual) knowledge→ Giving correct answers	Goal: Acquisition of competence→ Coping with complex situations
Learners act in an externally/externally controlled manner	Learners act self-directed
Teacher as authority figure	Teacher as coach, companion:in

5. Learning in a personalized learning environment

With the pandemic introduction of the Flipped Classroom model, MITZ has taken a significant step toward realigning future-oriented teaching. Hybrid learning at ICM complements digital and analog teaching in a coordinated concept that integrates the digital content instead of letting it exist merely as a supplement or in isolation alongside the classroom components. e-learning and classroom teaching form a precisely coordinated unit and, as such, lead to the achievement of the defined learning objectives.

MITZ's hybrid teaching model offers good conditions for increasingly integrating students as active designers of their learning process in a new learning environment. Learning is to be

designed in a more personalized way and oriented towards the respective individual. In a personalized learning environment, prior knowledge, experiences and interests of the learners are the focus. At the same time, students are responsible for independently identifying strengths and deficits with regard to their own acquisition of competencies. This self-assessment leads to measures being taken to achieve the desired and required learning goals. The learning process is thus characterized by the students becoming active. The teachers are by no means passive or do not bear any responsibility on their part, but have to create a stimulating environment for this kind of learning. Central demands on this learning environment are:

- Enabling students to independently explore and tackle complex problems.
- Enabling exchange with other learners.
- Ensuring feedback on learning success.

In order to meet these requirements and to complement the existing hybrid compulsory courses in MITZ, the individual needs of students are to be increasingly addressed in the form of optional learning opportunities. With the help of digital assessments, for example, feedback procedures are to be developed that provide students with feedback on their learning success. The establishment of a personalized learning environment has numerous advantages, both for the structural conditions in MITZ and with regard to the comprehensive acquisition of competencies:

- Existing teaching/learning scenarios of hybrid compulsory teaching serve as a basis for the conception of optional offerings; already existing (digital) media can be taken up and expanded.
- The offers can be used flexibly, i.e. independent of personnel and time resources.
- Digital competencies of the students are promoted.
- Digital learning opportunities as a chance to include students who are not able to participate in face-to-face courses.
- Self-assessment skills are encouraged.
- The acquisition of professional competence is promoted on an overarching level.

The Flipped Classroom model as a pandemic teaching concept has not only ensured the continuation of compulsory teaching, but has also created numerous points of contact for the expansion of digital learning opportunities at MITZ, thus paving the way for a new personalized teaching/learning culture at MITZ.

6. Perspectives in the virTUos project

It can currently be stated that digital teaching/learning formats are not yet used comprehensively and integratively in medical training, but their added value has become increasingly relevant in the course of the necessary adjustments due to the COVID 19 pandemic, among other things. In addition, the need for augmented integration of digital teaching is justified against the background of participation in education and by the changed learning behavior of students. The merely selective enrichment of teaching with digital media does not correspond to the present and the still expected need for a fundamentally changing learning culture. The increasing change towards teaching that accompanies the self-directed learning process [10] and a more intensive interaction with learners offers the opportunity to permanently create a teaching offer that enables demand-oriented and user-oriented learning free of structural and temporal conditions.

With this goal in mind, various sub-projects are to be realized within the framework of the virTUos project in the field of medicine - on the one hand, the establishment of telepresence robots in teaching and, on the other hand, the development and introduction of a digital assessment for the evaluation of skills and abilities in the self-directed learning process.

7. Telepresence Robot

In the future, telepresence robots will make MITZ teaching/learning offerings accessible at a low threshold. Students who are unable to participate in classroom teaching will not be impaired in their studies. The use of telepresence robots is therefore seen as an opportunity to make teaching at MITZ more inclusive, to enable digital distance learning and

thus to allow all students to participate in the teaching/learning opportunities and to have a positive influence on a successful course of study.

8. HybParc

In addition, a particular challenge of practical teaching at MITZ is coping with the individual learning needs of a large number of students. Developmental learning support for each individual student is not feasible due to limited human resources. Against this background, it is necessary to develop assessments that nevertheless address individual learning needs by setting up a self-learning environment. Students should increasingly recognize their own potential and deficits in the learning process and take advantage of appropriate training and self-learning opportunities. For feedback and assessment, an automated feedback system will be used, which will be developed, piloted and implemented in the subproject HybParc in an interprofessional innovation team. The focus is on the use of video recordings and sensor data for the (partially) automated analysis of action sequences within training/examination courses. In addition to increasing efficiency in the teaching of practical skills, the HybParc subproject also promotes the development of digital skills among students.

In addition to sensor-based feedback, teaching/learning scenarios for virtual realities will be designed in the HybParc subproject. Virtual realities are able to simulate real situations and dynamic facts and make it possible to experience them. In the future, learning in VR learning environments will be another way to provide additional learning opportunities for students.

9. Conclusion

The experience gained from the Covid-19 pandemic has generated important insights in the field of digital teaching. The progress should be used as an opportunity to further advance digital teaching and learning and not to fall back into old teaching patterns. However, the opportunities and limitations of digitization should also be weighed up critically as a meaningful supplement to established classroom teaching. In this context, digital teaching/learning formats must be embedded in a coherent didactic concept and always used in a justified manner to complement other teaching formats.

The current development of practical teaching at MITZ points the way to trends that will significantly influence the learning environment and teaching/learning formats and make teaching more personalized, interactive and mobile - MITZ plays an exemplary role in the field of medical education.

Literature

[1] Alvarez S, Dethleffsen K, Esper T, Horneffer A, Reschke K, Schultz JH. An overview of peer tutor training strategies at German medical schools. Z Evid Fortbild Quali Gesundhswes. 2017;126:77-83. doi: 10.1016/j.zefq.2017.09.009.

[2] Röhle et al. Practical teaching in undergraduate human and dental medical training during the COVID-19 crisis. Report on the COVID-19-related transformation of peer-based teaching in the Skills Lab using an Inverted Classroom Model. GMS J Med Educ 2021;38(1):Doc2. DOI: 10.3205/zma001398.

[3] Weber T. MITZ-mobil - Contemporary learning at the Carl Gustav Carus Medical Faculty in Dresden. In: Annual Meeting of the Society for Medical Education (GMA). Bern, Sept. 14-17, 2016. Düsseldorf: German Medical Science GMS Publishing House; 2016. docDE25-616 . DOI: 10.3205/16gma265.

[4] Röhle A, Hübsch G. Necessary steps of further development of practical teaching after implementation of COVID-19 conditional blended learning concepts. In: 15th International SkillsLab Symposium 2021. sine loco [digital], 18-20 Mar 2021. Düsseldorf: German Medical Science GMS Publishing House; 2021. DocV3.3. DOI: 10.3205/21isls32, URN: urn:nbn:de:0183-21isls329.

[5] Poweleit G, Krumm K, Willemer M-C. In press. The further development of the 4th learning site at the Medical Interprofessional Training Center (MITZ) Dresden. Demand-oriented adaptation of e-learning offerings to promote learning motivation and learning effect of students of human medicine: iSLS 2022 - online event of Karl Landsteiner Private University for Health Sciences, Krems, Austria, University of Bern, Switzerland and University of Cologne, Germany. 2022.

[6] https://www.e-teaching.org/didaktik/konzeption/constructive-alignment (last accessed 4/12/2022)

[7] https://www.medizinische-fakultaeten.de/themen/studium/nklm-nklz/ (last accessed 4/12/2022)

[8] Handke J. Handbuch Hochschullehre Digital. Guide to modern and media-appropriate teaching. Badeb-

Baden: Tectum; 2020: 19-44. DOI: 10.5771/9783828875302.

[9] Bachmann H. Competence-oriented university teaching. The need between coherence of learning objectives, forms of assessment and teaching-learning methods. Bern: h.e.p; 2011: 14-31.

[10] Pädagogisches Landesinstitut Rheinland-Pfalz Speyer. Changing perspectives in the education system: from input- to outcome-oriented thinking. Available at www.kmk-format.de/material/Fremdsprachen/1-2-7_Outcome-Orientierung.pdf (last accessed 12.4.2022).

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Creation of a subject-specific task pool based on two examples of the academic success projects OSA 3.0

C. Czichy[1], A. Abdel-Haq[2], S. Odenbach[1*]

[1]*Professorship for Magnetofluiddynamics, Measurement and Automation Technology, Institute for Mechatronic Mechanical Engineering, Faculty of Mechanical Engineering, TU Dresden*
[2]*Project Online Self-Assessments, Dean's Office, Faculty of Electrical Engineering and Information Technology, TU Dresden*

Abstract

Die Gruppe der Studieninteressierten ist bzgl. Wissenstand und Interessenslage sehr heterogen, so dass es eine Herausforderung darstellt, z. B. den Vorlesungsstoff entsprechend des Vorwissens aufzubereiten, Praktika spannend zu gestalten oder eine adäquate Prüfungsvorbereitung anzubieten. Ebenso sind Ideen gefragt, um das eigene Wahlmodul vorzustellen oder für die Vertiefung an sich zu werben. Eine Lösung stellt ein fachspezifischer Aufgabenpool dar. Wie die Wissensstände in Erfahrung gebracht und Interesse geweckt werden kann, wird anhand des Studienerfolgsprojektes OSA 3.0 erläutert, wobei OSA für Online-Self-Assessment steht. Die einzelnen Prozessschritte werden im Detail beschrieben und die Entwicklung von zwei Aufgaben wird exemplarisch für diese Schritte gezeigt.

The group of prospective students is very heterogeneous in terms of knowledge and interests, so it is challenging to prepare the lecture material according to prior knowledge, to make practicals exciting or to offer adequate exam preparation. Ideas are also needed to present one's own elective module or to promote the specialization itself. One solution could be a subject-specific assignment pool. The academic success project OSA 3.0, short for online-self-assessment, will be used to explain how knowledge levels can be ascertained and how interest can be aroused. The individual steps of the process are described in detail and the development of two tasks is shown as examples of these steps.

*Corresponding author: stefan.odenbach@tu-dresden.de

1. OSA 3.0 - What's the point?

The abbreviation OSA stands for Online Self-Assessment and has entered 2020 its third stage with Mechanical Engineering after Mechatronics and Electrical Engineering. The OSAs at the TUD are an academic success project aimed at people interested in studying STEM subjects (SI). Subject-specific tasks with a total working time of 90 minutes are offered, which in this case are intended to represent the mechanical engineering course of study. On the one hand, an impression of the challenges in the course of study is to be conveyed, whereby the focus is on the requirements in the basic modules. On the other hand, the specialisations and the possible work perspectives are presented. On the basis of this, the SI can test whether the course of studies would be suitable for them and what they can expect during their studies and beyond. The SIs can then better judge, what is expected of them and what is involved in the very broad field of mechanical engineering. This helps to dispel misconceptions about studying in general and for mechanical engineering in particular, with the aim of reducing the number of students quitting.

This offer is particularly important, if potential first-year students are unable to gain an insight beforehand, be it due to logistical, financial or time barriers or organisational problems such as the cancellation of events, e.g. the Open Day or the Long Night of the Sciences (LNdW). Likewise, in times of digitalisation, spatial distances can be bridged and a time-independent offer can be made, which, apart from internet access, does not require any financial preconditions on the part of the SI.

How such specialised tasks were developed will be explained step by step in the following and thus a guideline will be given. Steps 2 to 5 are explained with the help of two concrete example.

2. The initial Situation

First of all, the task can be clarified quite well with a black box, as shown in Fig. 1. On the one hand, the general requirements and expectations, as mentioned in the introduction, flow in as input variables. The necessary requirements or those to be integrated into the tasks are additional input variables, which, however, must first be collected in the process. The definition of the goal, in this case an OSA for the mechanical engineering course of study, serves as a starting point.

The creation of the tasks themselves is an iterative process.

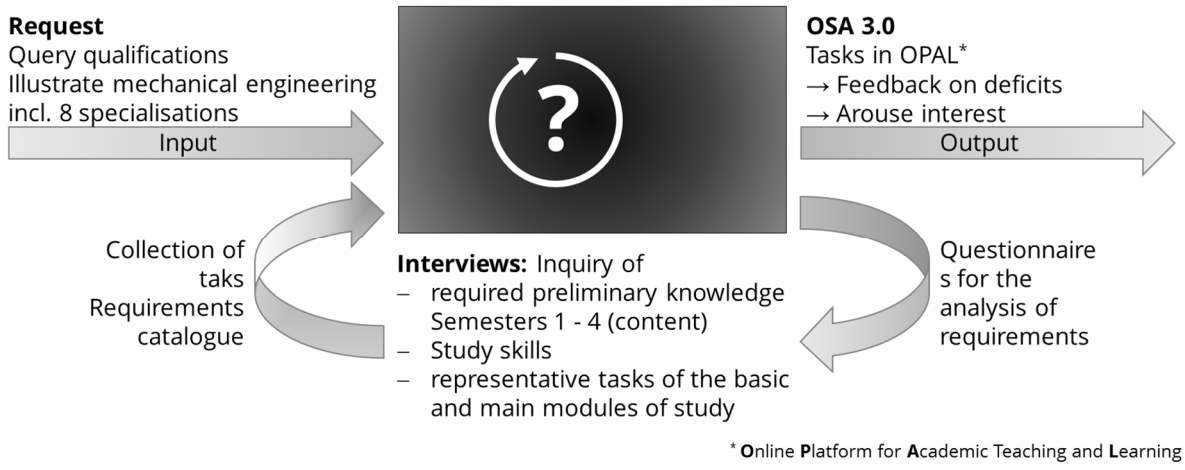

Fig. 1: Requirements and objectives of the OSA project as a black box

3. Step 1 – Analysis of requirements

In the first step, it had to be determined, which concrete contents should be included in the tasks. The analysis of requirements was chosen as the methodology, as it is flexible in its creation and could thus be adapted exactly to the content to be requested.

Lecturers from the basic modules were interviewed in order to determine the required prior knowledge for the relevant modules of

the first four semesters, and on the other hand, to inquire about beginner's tasks. Furthermore, lecturers in the specialization modules were also interviewed in order to obtain examples or ideas for subject-specific tasks that should reflect the specialization modules. Further, all lecturers were asked to provide information on study competences, as skills and abilities are also tested by the category of question.

All respondents were given a standard questionnaire with open questions and they could decide which ones they wanted to answer and to what extent. These answers were preferably recorded in interviews, although it was also possible for the respondent to fill them in directly. The questionnaires and explanations were given to the interviewees a week in advance so that they could prepare for the appointment.

Questions and follow-up questions during the interview were designed in such a way, that the respondents were not influenced.

After the interviews were completed, all answers were summarized in a structured way in temporary requirement catalogues. Afterwards, in order to create a checklist of the most important requirements the respondents were given these catalogues for weighting. Only items that were identified as necessary were included in the technical tasks, as only a limited time of 90 minutes was set aside for handling them.

4. Step 2 - The general concept

In order to make the situation more realistic for the SIs and thus maintain the desire to solve the tasks, an overarching story was created. For the OSA 3.0, an internship in an SME[1] was constructed as a scenario in which insights into different areas of work are provided. The collected ideas, suggestions and examples for the specialist tasks were grouped together with the own ideas, that arose through the interviews, with the focus on overlaps and topics. In the end, four departments emerged to which the tasks were assigned: conception, dimensioning, production and logistics.

Under conception, tasks are found that are aimed at research skills, gaining an overview and collecting ideas.

Dimensioning focus on the calculation and detailing of the ideas gained in conception. This area also includes design, simulation and programming.

Production includes tasks of shop floor management and manufacturing.

The last area, logistics, includes tasks related to the flow of goods, work routes and transport.

Example 1:

With regard to the insight into the study of mechanical engineering, suggestions were made from the fields of design with regard to technical drawings. This was assigned to "dimensioning".

Example 2:

From different modules, e.g. physics, technical mechanics, as well as logistics and automotive engineering, motion sequences and the calculation of distance, time and speed were suggested as key aspects. The resulting task was noted under "logistics".

An attractive design of the OPAL page goes hand in hand with the activation of the SI. The page layout should encourage the user to try it out. For this purpose an illustration was made for each department, which can be seen in Fig. 2.

[1] Small and medium-sized enterprises

Fig. 2: Visualization of the 4 departments for the appealing display on OPAL

5. Step 3 - Assignments of the requirements

After the general concept was established, the requirements of the weighted catalogue of requirements were assigned to the tasks. On one hand, the required preliminary knowledge (K) gave the tasks their content, on the other hand, the study competences (C) flowed into the structure of the tasks and into the questioning of results. Subsequently, the tasks were divided according to their importance into obligatory, elective and additional tasks.

Obligatory tasks (OT) require basic skills and knowledge. These must be solved by the SIs, when completing the OSA.

In the elective tasks (ET), the SIs can decide which ones they want to work on according to their interests, and thus get a taste of the specialization modules.

The additional tasks (AT) are usually evaluated subjectively, since for example creativity is required. These tasks are also time-consuming and serve as in-depth training.

Ex. 1: Component views (OT)

K: Sketches as an important tool of communication for an engineer (to present information in a clear way).

C: Three-dimensional imagination, visual intelligence

Ex. 2: Sprinter loading (OT)

K: Motion equations, integration

C: Logical thinking (recognizing connections and processes), ability to abstract (simplification of movement processes)

6. Step 4 - The implementation in OPAL

Before the tasks could be designed, objective evaluation criteria had to be defined and the associated implementation on the chosen platform had to be checked. In this example, the tasks were implemented in OPAL, which allows various types of questions such as cloze texts, diagrams and numerical value queries, but is also subject to restrictions. In order not

to lose the interest of the respondents, attention was paid to making various solution of the questions.

Ex. 1: Component views

The implementation of this question takes the form of a table, as shown in Fig. 3. In this table, the name of the object and the different views are to be entered, whereby only one view or the name is given for each component. The missing elements can be added by means of a drop-down menu or by dragging them from a stock to the desired place.

Ex. 2: Sprinter loading

In this task, different types of questions are combined. On one hand, results are requested by directly entering numerical values. On the other hand, a diagram can be generated by clicking on grid points. In addition, integrals are to be set up and solved. These equations can be entered directly and can be compared with a stored answer if the variables are specified.

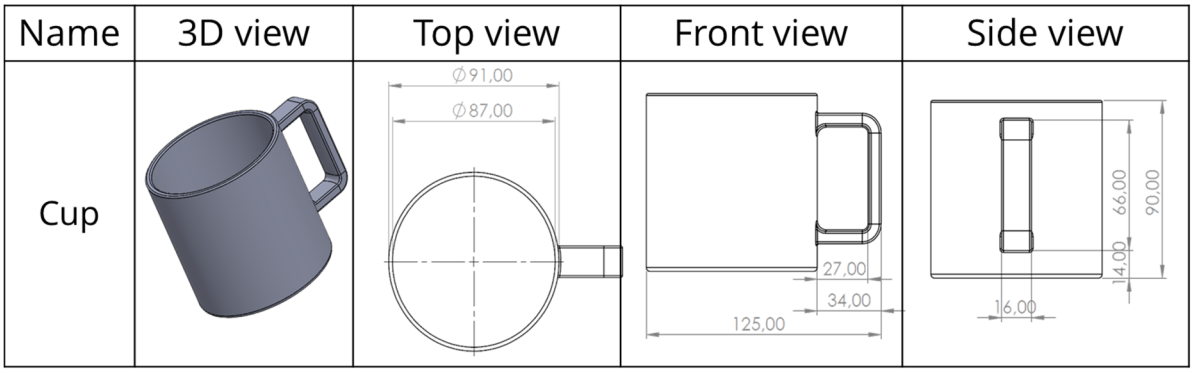

Fig. 3: Implementation of example 1 "Component views"

7. Step 5 - The concretization

When designing the tasks, the expected level of knowledge (in this case secondary level 2) should be taken into account. During the preparation of the mathematical path, it is useful to note down hints, stumbling stones and advance knowledge. For example, a concrete formula may not yet be known to the SIs, which is why it is given, but the transformation of the equation should be within the range of skills. Usually there is an introductory text that puts the task into context and contains the information needed to solve it. This text is then followed by the concrete task, as in the following examples.

Ex. 1: Component views

Introductory text:

As part of a small project, various items need to be created as 3D objects for review and submitted as technical drawings for production.

Task:

Create an overview of the components under different views by completing the following table with regard to product description, 3D view, top view, front view and side view.

Ex. 2: Sprinter loading

Introduction text:

After determining how many boxes will fit into the sprinter, the loading time must be calculated. The boxes are loaded from the warehouse into the sprinter using a forklift truck. The forklift truck must drive several times, so in addition to loading and unloading, the empty runs must also be taken into account.

Task:

The forklift truck manages 3 cartons per trip, with loading and unloading taking 10 s each. The distance from the warehouse to the Sprinter is 120 m. The forklift has a maximum speed of 20 km/h, which is not affected by the

mass of the packages, and accelerates to 10 km/h in 8 seconds. The acceleration can be considered constant.

1. What time is needed for the 600 m with the forklift truck without loading and unloading time?
2. Draw the v-t and s-t charts for one trip by clicking on the points in the grid.
3. What are the integrals and the integrated equations for the velocity v and the distance s, if the following applies a(t) = m t with m = 0,5 $\frac{m}{s^3}$ and a = $\dot{v}$ = $\ddot{s}$?
4. How long does it take for the entire loading process, i.e. until the last box is loaded into the Sprinter?

The hints for the tasks are given on basis of the expected level of knowledge depending on the number of attempts to solve the problem. The students have 2 attempts at their disposal. In the first attempt (level 1), there are already hints that can be folded out and are available to the SI as needed with regard to their existing knowledge from school. In level 2, after the first failed attempt, concrete hints are given, e.g. in the form of intermediate results. After the second failed attempt, the solution is presented in level 3, including the solution path.

Ex. 1: Component views

Level 1: general information

As a supplement to the introductory text and the example of a cup given therein (see Fig. 3), another illustration (Fig. 4) is shown in order to give a better impression of the views or their allocation.

Level 2: Hints after failed attempt

The following text appears:

"The products are: ...

in this order.

There are also views that are not assigned to any component or represent a view that is not required."

Level 3: Solution

The following text appears:

"The complete overview is provided here as a PDF:" *Link to download the PDF*

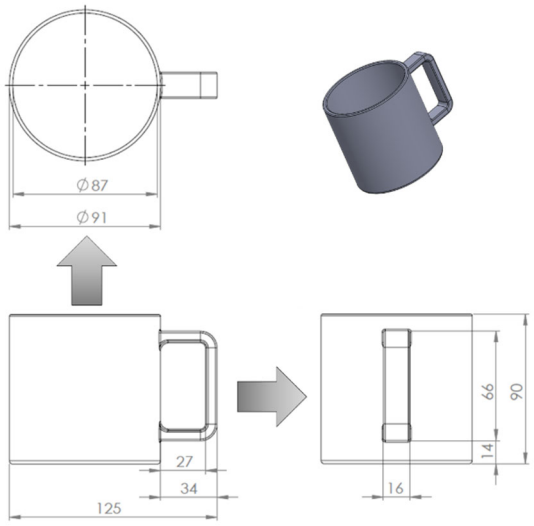

Fig. 4: Hint field of the 1st stage for the example 1 "Component views".

Ex. 2: Sprinter loading

Level 1: general information

The following text appears:

"Check your conversion of units.

The dots above a variable indicate the level of the derivative with respect to time."

Level 2: Assistance after failed attempt

The help depends on the subtask.

to 1. The sequence of movements is: Acceleration from rest to 20 km/h (uniformly accelerated movement) - constant speed (uniform movement) - braking to a standstill (uniformly decelerated movement).

to 2. Check that you have not made a misclick. Have you added up the values for the individual sections?

to 3. See Fig. 5

to 4. How often does the driver have to drive there and how often back? This is only about the loading time.

Level 3: Solution

At this point, formulas, results and the diagrams are shown.

When formulating the tasks, attention should be paid to using gender-appropriate language in order to address all SI. For the tasks, an inclusive choice of words was taken into account, as this builds bridges. The OSAs are a flagship

of the TU Dresden and reflect a (world-)open and tolerant policy.

If necessary, alternative versions should be written in different languages or in simple language.

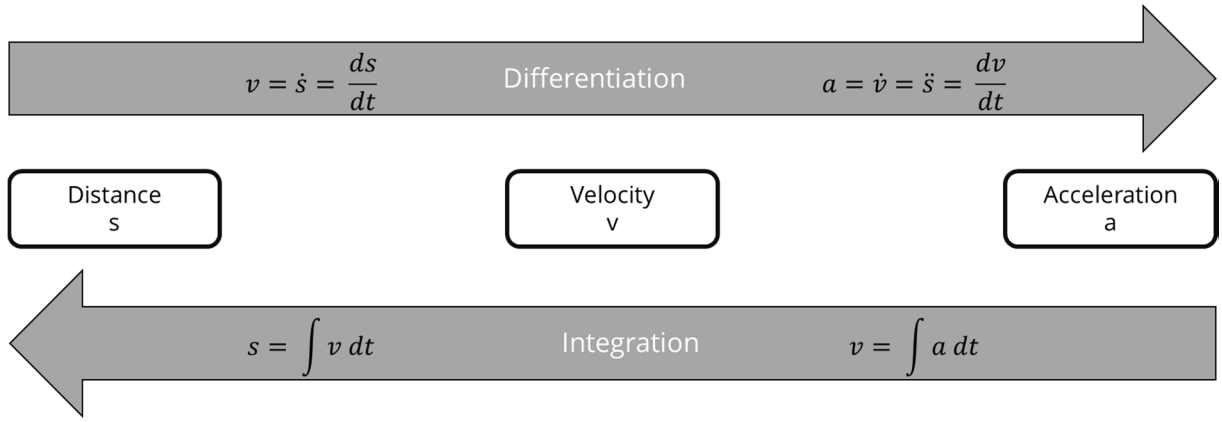

Fig. 5: Level 2 hints for task 3 of example 2 "Sprinter loading"

8. Step 6 - The evaluation

The tasks are adjusted several times. First, a comparison is made with the catalogue of requirements to see whether all relevant points have really been processed. Secondly, test runs are carried out first internally, then externally by the target group (in this case secondary school students). After each run, feedback is gathered and appropriate adjustments are made. Through this iterative process, stumbling stones and technical hurdles are to be removed so that a representative, user-friendly range of tasks is created in OPAL.

9. Possible applications

Now the procedure of developing tasks tailored to the requirements can also be transferred to one's own exercises, practicals or other (pre-) examinations, as Fig. 6 shows. Be it to arouse interest, to offer variety or to deepen knowledge. It can also be used as a guideline for developing new tasks to complement digital teaching.

Subject tasks in the form of an introductory test can also be used at the beginning of a semester in general or at the beginning of studies in particular. This can give an impression of the module and at the same time test (prior) knowledge in order to identify gaps.

This is helpful both for the students to work on deficits and for the lecturers, who can adapt their lectures on the basis of the results and incorporate repetitions if necessary. In particular, the knowledge gaps caused by the Covid 19 pandemic can be identified in this way and adapted measures can be taken.

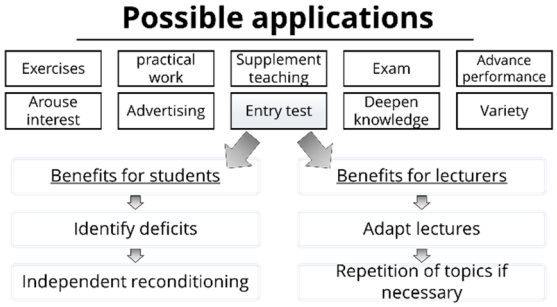

Fig. 6: Possible applications in everyday teaching.

10. Summary

Finally, the single steps should be summarized in Fig. 7, so that it can be used as a checklist for the creation of one's own subject-specific task pool.

Acknowledgement

Thanks to the colleagues from the OSA 3.0 project for the great cooperation.

We would also like to thank all the interviewees for their interesting conversations and insightful answers.

Thanks also go to Simon Schmitt for designing the images for OPAL.

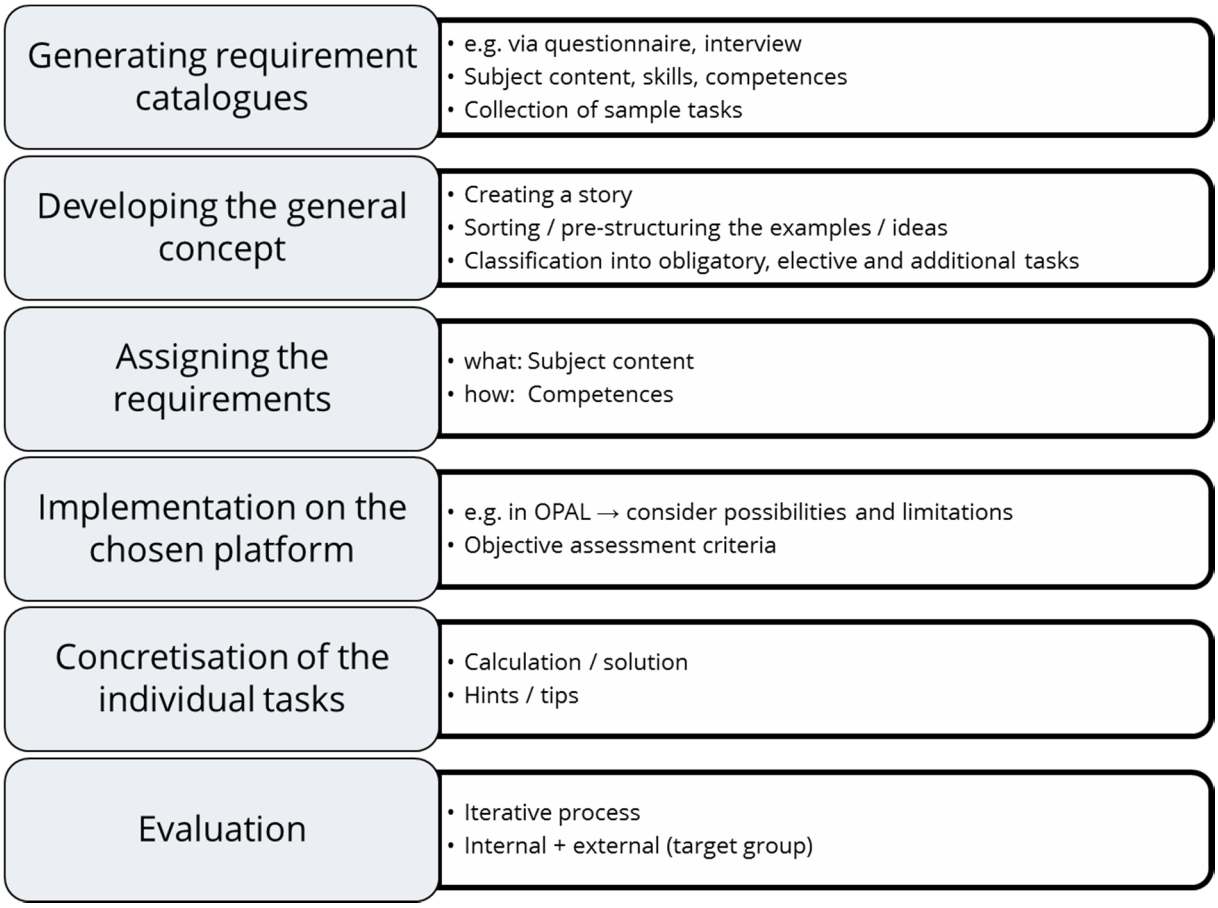

Fig. 7: Summary of the single steps for creating a subject-specific task pool.

Further information

https://tud.link/w0un
or try it out directly on OPAL:

Electrical engineering
https://tud.link/nyyl

Mechatronics
https://tud.link/sqk0
Mail: osa@tu-dresden.de

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Findings from tutorial work under pandemic conditions

B. Schlegel[1*], M. Ludwig[2]

[1]*Professorship for Magnetofluid Dynamics, Measurement and Automation Technology, Institute of Mechatronic Mechanical Engineering, Faculty of Mechanical Engineering, TU Dresden*
[2]*Team TUTORING, Project MTC II, Center for Continuing Education & Institute for Professional Studies, Faculty of Education, TU Dresden*

Abstract

Mit diesem Beitrag werden Erkenntnisse in der Tutorienarbeit an der TU Dresden während der SARS-CoV-2-Pandemie herausgestellt, die einerseits auf den Erfahrungen in Qualifizierungsmaßnahmen beruhen und andererseits auf Evaluationsergebnissen. Diese werden unter anderem im Beitrag vorgestellt und diskutiert. Es ergaben sich neue Herausforderungen für Tutor:innen und damit auch eine veränderte Aufgabenvielfalt: größere Gruppen, Online-Tutorien, Interaktion anregen - um hier nur die wichtigsten zu nennen. Unterstützend dabei wirkten vor allem die Betreuungspersonen, ein stabiles Beschäftigungsverhältnis und psychologische, methodische Unterstützung bei Krisen und schwierigen Situationen sowie Wertschätzung und Motivation durch gezielte Qualifizierung. Neben den Erkenntnissen und der veränderten Aufgabenvielfalt während der Pandemie werden in diesem Artikel die Potentiale von Tutorienarbeit, Unterstützungsoptionen für Tutor:innen und Schlussfolgerungen für die nach-pandemischen Semester bezüglich der Qualifizierung von Tutor:innen aufgezeigt.

This paper highlights findings in tutorial work at the TU Dresden during the SARS-CoV-2 pandemic, which are based on experiences in qualification measures on the one hand and on evaluation results on the other hand. Among other things, these are presented and discussed in the article. New challenges arose for tutors and thus also a changed variety of tasks: larger groups, online tutorials, stimulating interaction - to name only the most important ones here. Supporting factors were above all the tutors, a stable employment relationship and psychological, methodical support in crises and difficult situations, as well as appreciation and motivation through targeted qualification. In addition to the findings and the changed variety of tasks during the pandemic, this article highlights the potential of tutorial work, support options for tutors and conclusions for the post-pandemic semesters regarding the qualification of tutors.

*Corresponding author: Beatrice.schlegel@tu-dresden.de

1. Introduction and overview of tutorial work

The aim of this article is to illustrate the findings of the tutorial work in the pandemic semesters at the Technical University of Dresden. It is intended to highlight "learnings" on the basis of which it is possible to qualify tutors in a more targeted manner in the post-pandemic period so that they can transfer the acquired knowledge into their own teaching. Finally, the knowledge gained can also help to make tutorial work and tutor qualification more targeted and attractive - for everyone involved: tutors, their supervisors, students and qualifiers.

First, after the introduction to the subject of tutorial work and the project framework in which the project "TUTORING" operates is touched upon. Then, the potential of tutorial work for the students are highlighted, which have become more evident in the pandemic semesters. Finally, it is worked out which support and which concrete measures are necessary in order to fully exploit the potentials of tutorial work. Surveys and evaluations conducted within the project are included in the analysis. The questions of what helps tutors to cope with their changed variety of tasks and how the findings can be used for the post-pandemic period are answered.

2. Tutorial work and the TUTORING project

Tutorial work refers on the one hand to the teaching activities of tutors and on the other hand to the support of tutors in their work, such as the qualification of the TUTORING project.

About tutors

Tutors are an important part of teaching at universities, because they help to ensure the quality of teaching, supplement the course offerings with integrative or additive offerings, and support and relieve full-time teachers.

Tutors design teaching-accompanying or advisory offerings, primarily in the form of tutorials, workshops, practice groups, internships, writing workshops, or student advising.

About qualification offers for tutors

In 2018, the position paper of the Netzwerk Tutorienarbeit an Hochschulen [6] (Network for Tutorial Work at Universities), which now includes 70 universities in Germany, clearly stated, with reference to the recommendations of the German Council of Science and Humanities and the German Society for Higher Education Didactics, that "a reliable qualification and support offer for tutorials, embedded in the overall university context (...) is the prerequisite for the acceptance and effectiveness of tutorials". In the tutorials themselves, the teaching quality also influences the learning and study success of the participants: "In some cases, the quality of support for tutors with training is judged better than for tutors without training" [4]. The extent to which tutorial work is actually promoted effectively and to a high quality via seminars, further training or other qualifications is up to each university itself.

About TUTORING

The ESF-funded project TUTORING [7], located at the Center for Continuing Education of the Dresden University of Technology, supports tutors of all departments in planning their (digital) tutorials and advises them on difficulties that arise during the semester. The following qualification modules form the content basis of the project.

Qualification modules

- Basic modules: didactic and methodological basics,
- Workshops: Deepening specific topics, such as "Stimulating Interaction" or "Presenting with Confidence."
- Peer meetings: Exchange among tutors and collegial case consultation as well as
- Coaching and shadowing in tutorials: Work on individual resources with peers or TUTORING staff.

The qualification modules differ in terms of the number offered and the time periods in which they are offered. While the one-day basic modules are held shortly before the start of the

new semester to give new tutors in particular a good start, the remaining modules are offered during the semester and usually comprise one and a half to three hours. Participation in the individual modules is free of charge.

The following learning objectives for tutors are pursued with the help of the qualification modules:

- Sharpen didactic knowledge,
- Learn methods and tools for leading tutorials,
- Strengthen own existing competencies and self-confidence,
- Understand and communicate their own role as a tutor, and
- Master online and face-to-face teaching.

The target group is all student tutors - this includes subject tutors from all degree programs as well as student assistants who are tutorial, exercise and internship leaders.

3. What is the role of tutors for students?

During the pandemic, it has become even clearer that the potential of tutorial work can go far beyond providing technical support to students in their learning process.

Particularly in the area of social interaction, tutors did an excellent job in the pandemic semesters by giving students an orientation, absorbing frustration and uncertainty caused by the initial chaos in the summer semester 2020, and fulfilling their mediator function between students and full-time lecturers far beyond the previous level. In mentoring first-year students, these functions occupied a large space in the tutorials. The frequently cited peer effect appears to be much stronger here than before the pandemic.

On the peer effect:

The greatest advantage of tutors, compared to other teachers, is their proximity to the students. Since tutors themselves have first completed the appropriation and learning processes that they accompany in their tutorial work with students, they often have a very deep understanding of the difficulties in these processes. They can comprehend why something is not understood or where the hurdles lie in the appropriation process. Misconceptions are often more understandable to them than to full-time faculty. Due to the similar background of experience and the same status, tutors can work with students at eye level. This lowers the hurdle for students to reveal their own gaps in knowledge.

In the following, we draw on research findings on peer effects in youth research that are transferable to tutorial work and highlight potentials that should be discussed in more detail in the context of tutorial work in future research.

Tutors as the driving force of the development from school into studies

In addition to supporting their own (professional) development and emotional security, peers promote "further development of social and emotional competencies" [...] by challenging each other, providing or asking for social support, comparing and giving feedback to each other, but also by pushing each other to examine their points of view, set boundaries, and solve conflicts and problems together." [8]

These findings from the field of youth education can be transferred to students, especially when they enter university. Developments such as the formation of one's own identity, career orientation and the exploration of one's own abilities are often not yet complete. They (the students)experience irritations or impulses in the context of the transition from school (or other contexts) to study, which can also lead to a reorientation. Here, tutors as peers can - so the assumption - be a driving force to promote the development of high school graduates into reflective, critically thinking and self-confident students.

Tutors as door openers

In the context of youth research, Behrens and Rabe-Kleeberg assume that peers can assume the function of door openers who enable "access processes of individuals to institutions" [2]. In this way, they could provide students entrusted to them with access to counseling and

contacts. On the one hand, "this can be done by passing on information, but on the other hand also by passing on contact data or by the concrete recommendation of certain persons." [2]

Discourse practice for the working world

Discourse in lectures and seminars was given far less space in the pandemic semesters than before. This was partially compensated for in the tutorials, where students were more confident to address the tutor.

If students engage in professional discourse with their tutors and vice versa, they are practicing and training, so to speak, for the later world of work, in which they interact with colleagues, some of whom have a similar or even a different background of experience, but a similar status. In the context of youth research, Betz states that "by interacting with peers [...] conflict strategies are developed, learned, and practiced that can be used for professional and private life and represent a central component of social participation." [3] In addition to internships in companies or other institutes, this can be good preparation for the increasingly complex world of work, in which the ability to communicate and collaborate is a fundamental prerequisite for meeting the demands of the working world. In addition, tutors practice imparting knowledge in a university context, which can be exceedingly beneficial for a career in science.

In summary, tutors have a high potential for the development and academic success of their students in many ways. They enable social inclusion, serve as a bridge to university representatives, and support students' competence development towards cooperation and collaboration.

4. Changed variety of tasks in the pandemic for tutors

The "roles" of tutors outlined above already play an important role under "normal" study circumstances. Under pandemic conditions, this role was reinforced in communicative terms, as tutors - even while still studying - experienced many of their fellow students' needs and concerns first-hand and were therefore often preferred as contact persons - this was made clear in direct conversations with tutors. According to their statement, communicating with and advising students, far from providing professional support, was a greatly increased area of responsibility during the pandemic.

Another challenge was the larger groups in online tutorials. Thus, one tutor stated in an interview with TUTORING:

"My challenge? How, since tutoring funds have been cut, I can keep almost double the amount of students in tutorials and encourage them to participate. Participation continues to drop over the last two semesters." (Tutor, Department of Humanities and Social Sciences; statement in anonymous questionnaire, summer semester 2021)

The following changed tasks resulted:

- Set up and coordinate breakout sessions for smaller groups,
- Clarify organizational issues accordingly,
- Organize interaction between students online by motivating participation in the online context and collaboration,
- Make student solutions visible to each other online,
- Record the learning status of the students online as well as
- Create videos and online materials.

5. What helps tutors accomplish their many tasks?

From the tasks presented above, it is clear that in addition to technical knowledge, tutors also urgently need methodological-didactic skills as well as support in the area of online teaching.

Additionally, in times of uncertainty and few options for planning security, according to this survey (conducted Dec. 2021 - Jan. 2022) of 27 TU Dresden tutors, they need above all:

1. Backing of caregivers,
2. Stability of the employment relationship,
3. Psychological as well as methodical support in crises or difficult situations, so that they can deal with them confidently and self-assuredly,

4. Appreciation for the tutorial work and
5. Motivation through targeted qualification.

On the last point, there was an important finding in the survey of tutors: they work as tutors in particular because they enjoy teaching and teaching others something (Figure 1). The motivation for this can still be promoted through targeted qualification.

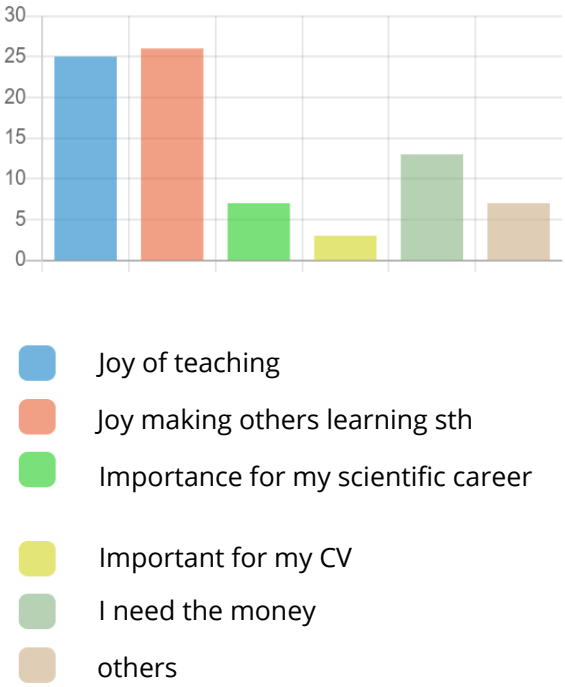

Fig. 1: Result of the survey of tutors (conducted in Dec. 2021 - January 2022) - question about the motivation for working as a tutor

The above-mentioned desirable support measures are also emphasized by lecturers and supervisors. This is shown by the following statements made in the context of the above-mentioned survey of eleven supervisors:

"Would be important to value tutorial work more as a learning format for tutors as teachers and learners - also in terms of financial support."

Another quote illustrates several aspects of needs:

"In my eyes, too little funding is provided for tutorial work, the 'paid'" hours do not correspond to the effort. In addition, in my eyes, the importance of tutorials should be emphasized more as a supplement to teaching, also through obligatory attendance. Thus, the relationship between teacher/examiner and tutor can be strengthened and supported, because the position as a hinge between students and lecturers is elementary."

Re 1: The support of tutors can be promoted on the one hand by supporting them in their function. The workshop "Let it work" provides them with important information on how tutors can be supported and involved (onboarding of students) as well as an opportunity for intensive exchange with other tutors. On the other hand, the support of tutors can be supported by the appreciation of tutorial work on the part of the university management. Informative articles in university media and newsletters can make a valuable contribution here.

Re 2: The stability of the employment relationship can be established primarily through the following points:

- Early recruitment and longer periods of employment,
- University leadership's stance on tutorials as an important instructional component.

Re 3: Psychological and methodological support in difficult situations can be implemented by the following measures, among others:

- Course offering on "Difficult Situations in Tutoring",
- Collegial case discussion in the form of peer meetings in which tutors have the opportunity to exchange information on specific incidents,
- Coaching offered by institutional agencies such as TUTORING staff,
- Basic attitude of the qualifiers and supervisors, which is based on the experience values and concretely experienced scenarios of the participants.

The decisive factor in qualification is that tutors receive practical help rather than theoretical input. A trusting atmosphere is also crucial, so that even unpleasant situations can be addressed and emotional support can be given.

The positive effect of peer meetings is primarily that tutors understand that they are not alone with their questions. In addition, it should be emphasized that fault tolerance in oneself and towards students is an important mental hygiene factor - especially in times of pandemic.

Re 4: Appreciation for the tutorial work can be expressed ideally, but also monetarily:

- Fair remuneration of the activity (pure tutorial time vs. tutorial time + preparation + follow-up + supervision between tutorials),
- Affirmation by university leadership that tutorials are an important instructional component,
- Targeting tutors by the supervisor with a thank you for the work they have done, and
- Joint event as an expression of appreciation.

Re 5: Support motivation: Above all, the joy of teaching is in the foreground for tutors as an important motivational factor. Thus, a targeted qualification can be derived as a measure to add the corresponding didactic competencies to the joy of teaching:

- Demand-oriented qualification,
- Professional and human involvement of full-time teachers in the qualification in order to emphasize importance and import professionalism (e.g.: "leading calculation exercises") as well as
- Clarify degrees of freedom for tutors in their work.

On the last point, there was an interesting finding in the survey of tutors: Some tutors are not aware of their degrees of freedom in designing the tutorials. In some cases, they also said that they had no degree of freedom. Six out of 29 tutors interviewed said they had neither organizational nor content-related degrees of freedom. Only half of the respondents stated that they could freely design the tutorial (for degrees of freedom in design: Figure 2).

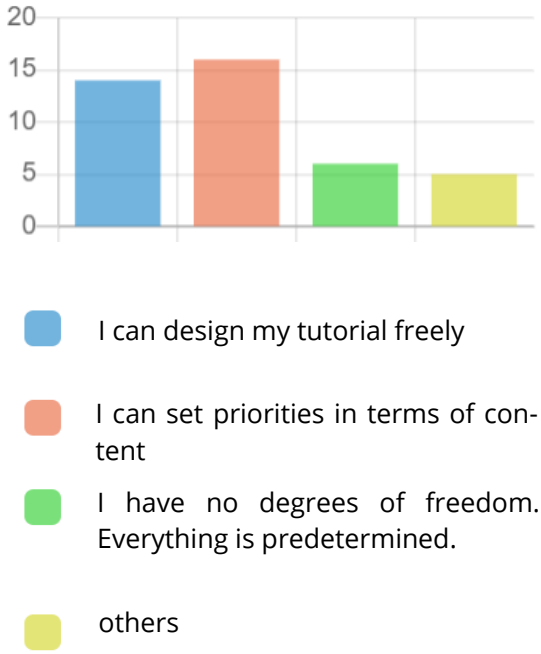

Fig. 2: Result of the survey of tutors (carried out in Dec. 2021 - January 2022) question about degrees of freedom in design

All of the supervisors interviewed, on the other hand, stated that there were certain degrees of freedom in terms of content. In the pandemic semesters, especially in the summer semester 2020, completely new design options opened up. For example, choices existed regarding a suitable tool for conducting an online tutorial or in designing a digital computing exercise with breakout rooms. This discrepancy could be bridged through good communication: Tutors directly ask for design leeway and, on the other hand, supervisors clearly communicate the organizational and content-related degrees of freedom.

6. How can the lessons be used for the post-pandemic period?

Metatutors as part of the qualification

In the pandemic and beyond, the constant change of needs in tutorial work was and is cushioned more than before by the involvement of experienced tutors in the qualification: Tutors act as metatutors, peer experts, and idea suppliers. They help other tutors in collegial case consultation, describe teaching designs and make them available. They give

workshops or lectures in the basic modules. Here, too, the peer effect takes hold and enables agile and target-group-oriented further development of the qualification offerings. Tutors also contribute unconventional and original ideas that sometimes help other tutors more than pedagogically and psychologically sound assistance. This is illustrated by the following example of a tutor: sticking googly-eyes next to the camera in the online tutorial directs the tutor's gaze more frequently to the camera. Thus, students at the home laptop on the other side feel more addressed in the online tutorial (see Figure 3).

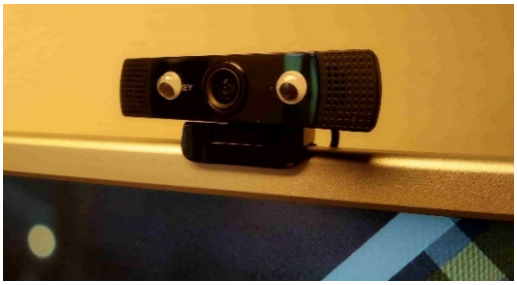

Fig. 3: Tutor promotes his look into the camera with googly-eyes.

The metatutor concept also serves to meet emerging needs in the post-pandemic period - for example, when switching to face-to-face mode (predominantly face-to-face + digital supplement).

Tutors as multipliers in teaching development

Tutors are multipliers for students' needs because of their proximity to them. This role was very significant in the pandemic for the development of qualification offers of TUTORING. There is often speculation about what students actually need in teaching, what would actually help them. In some cases, this discussion is based on surveys of students. Rarely is there an opportunity to develop concepts for needs-based teaching based on extensive surveys. Tutors are important sources of information here and should be included in brainstorming and conceptualizing new teaching ideas.

Compressed basic qualification

In the course of the pandemic, the basic qualification was repeatedly modified shortly before the start of the semester and adapted to the special conditions of the respective pandemic phase. The qualification conducted in March 2022 in an online format with 20-minute short impulses related to the number of participants was one of the most frequently attended qualifications to date, with over 40 participants. The following aspects were particularly well rated: "The short and regular breaks were great (this is otherwise far too often forgotten)" and "I think it's good that the individual topics are not "picked over" for too long, but that many topics are dealt with in short blocks".

The tutors thus had enough time to discuss with each other and deepen the topics even between the content-related impulses.

This was followed by longer themed workshops in the afternoon. In-depth content was offered for engineering, economics and the humanities - in some cases by full-time lecturers from the departments.

The participants were able to organize the program freely and according to their needs, which was evaluated positively, as also confirmed by the following feedback: "good choice of (the) program points (in) the afternoon".

90% of the participants saw their expectations of the event in the final evaluation as "Rather fulfilled" to "Very fulfilled".

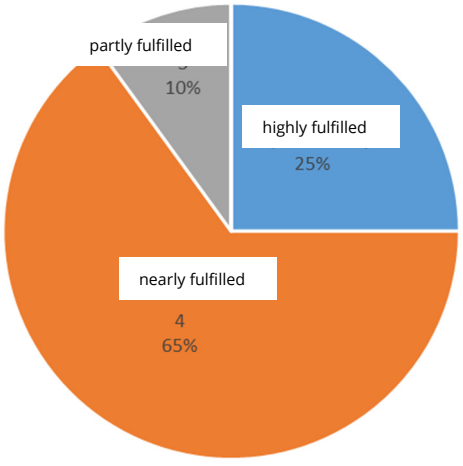

Fig. 4: Result of the evaluation of the basic qualification March 2022 of tutors - question about the fulfillment of their expectation of the event.

The basic qualification should also be implemented in this concise, very effective form in the coming semesters.

Online/hybrid tutorial workshops

The potential that arose from the difficult conditions of the pandemic semesters flowed directly into the course offerings of the TUTORING qualification program and will continue to be offered in order to be ready for all eventualities: continuing education courses on online topics, face-to-face events and hybrid formats are in demand.

In the context of the SARS-CoV-2 pandemic, the following offerings emerged within days and weeks:

- Facilitate online tutorials,
- Work with interactive online tools,
- Promote interactions online,
- Design and lead hybrid tutorials and
- Presentation workshops on the theme "Back to Teaching in Presence".

Hybrid teaching will continue in the current summer semester and beyond. Students will be confronted with a mix of online and face-to-face offerings. They can use this positively for themselves, choose well and familiarize themselves with a wide variety of working tools and styles. Tutors can also support them in this.

Appreciation and visibility

In the course of the pandemic, TUTORING has shown appreciation to tutors and their work through different formats and has noticed how much the tutorial work at TU Dresden benefits from appreciation. Potentials can be recognized and understood if they are reported again and again. The TUTORING staff has published interviews and teaching designs and launched a monthly TUTORING newsletter [8]. They also award the best tutorial once a semester and repeatedly make the work of tutors the focus of discussions at TU Dresden on various levels (meetings of qualifiers, talks with the Prorectorate for Education, workshops on the teaching mission statement, etc.).

In addition, the "Let it work" format for instructors was developed, which addresses how tutors can be involved in the teaching team and integrated in the best possible way to relieve their own areas of responsibility.

Empower tutors to engage students socially

In a study program that began in the anonymity of online courses and the corresponding social isolation, in the post-pandemic period there is a need for people who facilitate access to the actors of the university (teachers as the 'face' of the university) and to its culture. Tutors are predestined to take on this role because, on the one hand, they have a head start in terms of experience, have already been able to establish themselves in the university context and are in contact with teaching staff, and, on the other hand, act at eye level with their students, linked by the same status.

7. Conclusion and outlook for TUTORING

At best, the TUTORING qualifications will be supported by permanent positions on the part of the rectorate in order to prevent the current project character and the associated loss of knowledge due to fluctuation. TUTORING also aims to expand the qualification of tutors in the coming months. Hybrid formats and online educational resources should address a variety of topics. On the one hand, the subject institutes need thematic and content-related input for the subject specifics, in that tutors and full-time teachers help to shape content and clearly communicate expectations. On the other hand, structural support is needed, e.g. qualification times are equal to working hours and are paid or otherwise recognized. Thanks to its extensive experience to date, TUTORING remains flexible in its choice of face-to-face or digital offerings.

The qualification will also be supplemented in the future by the individual offers presented above. TUTORING staff members are also constantly furthering their own qualifications and are committed to the TU Dresden's accreditation, which is recognized throughout Germany, within the framework of the "Netzwerk Tutorienarbeit an Hochschulen" (Network for Tutorial Work at Universities).

Acknowledgement

We thank all tutors and caregivers who enrich our offer with their wealth of experience for their openness and commitment.

Literature

[1] Behrens, J./Rabe-Kleeberg, U. (2000): Gatekeeping im Lebenslauf. Wer wacht an Statuspassagen? In: Hoerning, E. (Hrsg.): Biographische Sozialisation. Stuttgart: Lucius und Lucius. S. 101-135.

[2] Beierle, S. (2013): Die Rolle von Peers, Neuen Medien und Online-Communitys bei der Berufs-orientierung. Deutsches Jugendinstitut. https://www.dji.de/fileadmin/dji/pdf/1152_16751_Peers_DJI_Abschlussbericht_Stand_03_2013.pdf

[3] Betz, T. (2004): Bildung und soziale Ungleichheit: Lebensweltliche Bildung in (Migranten-)Milieus. Trier: Zentrum für sozialpädagogische Forschung der Universität Trier, S. 84. - (Arbeitspapiere des Zentrums für sozialpädagogische Forschung der Universität Trier; II-16)

[4] Glathe, A. (2017): Effekte von Tutorentraining und die Kompetenzentwicklung von MINT-Fachtutor*innen in Lernunterstützungsfunktion. Darmstadt, Technische Universität, [Dissertation].

[5] Lüpschen, N./von Salisch, M./Kanevski, R. (2012): Ganztagsschule. Ort der Freundschaft. Imform 1/2012. LVR-Landesjugendamt Rheinland. S. 16-20.

[6] Positionspapier: Tutorienarbeit an Hochschulen. (Beschlossen auf dem Netzwerktreffen am 13.03.2018 in Würzburg). http://www.tutorienarbeit.de/fileadmin/pdf/Flyer/Zukunft_der_Tutorienarbeit_an_Hochschulen_Positionspapier_15052018.pdf

[7] TUTORING - Qualifizierung für Fachtutorinnen und Fachtutoren aller Studiengänge https://tu-dresden.de/karriere/weiterbildung/zentrum-fuer-weiterbildung/tutoring

[8] TUTORING-Newsletter: https://tu-dresden.de/karriere/weiterbildung/zentrum-fuer-weiterbildung/tutoring/newsletter

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Study 2.0 - Presence, Digital or Hybrid?

M. Fiedler*, J. Kaliske, M. Kästner

Professorship for Numerical and Experimental Solid Mechanics, Institute of Solid Mechanics, Faculty of Mechanical Engineering, TU Dresden

Abstract

Bis 2019 war die Titelfrage noch einfach zu beantworten. Veranstaltungen an der TU Dresden waren in der Regel in Präsenz, selten gab es Unterlagen und Kurse, die ein digitales oder hybrides Studieren möglich machten. Seit dem Beginn der Coronapandemie hat sich das Bild der TU Dresden jedoch deutlich gewandelt. Neben dem Präsenz- entstand ein Digitalcampus, der Studierenden und Lehrenden neue Perspektiven und Möglichkeiten eröffnete. Zukünftig muss sich deshalb damit beschäftigt werden, wie dieser neue Campus genutzt werden kann, wenn Präsenz-Lehre wieder möglich ist. Diese Veröffentlichung beleuchtet die Vor- und Nachteile der synchronen und asynchronen Digital-Lehre und zeigt Szenarien auf, wie Hybrid-Lehre zukünftig an der TU Dresden realisiert werden könnte.

Until 2019, the title question was still easy to answer. Events at TU Dresden were usually face-to-face, and there were rarely any documents or courses that made digital or hybrid studying possible. Since the beginning of the corona pandemic, however, the picture at TU Dresden has changed significantly. A digital campus has emerged alongside the classroom campus, opening up new perspectives and opportunities for students and teachers. In the future, therefore, it will be necessary to consider how this new campus can be used when face-to-face teaching is possible again. This publication highlights the advantages and disadvantages of synchronous and asynchronous digital teaching and shows scenarios of how hybrid teaching could be realized at the TU Dresden in the future.

*Corresponding author: melanie.fiedler@tu-dresden.de

1. Introduction

More than two years after the first lockdown in Germany at the end of March 2020, society in 2022 is still far from pre-pandemic normality. Over time, however, coexistence and acceptance of restrictions have become commonplace. The Corona pandemic has also had a significant impact on teaching at universities and changed it permanently. Hygiene regulations continue to be adhered to, room capacities are observed, and digital or hybrid teaching is offered whenever possible. With the start of the 2022 summer semester, most teaching returned to the lecture hall. However, statistics on the extent to which face-to-face teaching is implemented in lectures and tutorials at TU Dresden are not currently available. The Corona pandemic has created two worlds at the TU Dresden: The "old" presence campus and the "new" digital campus. In the future, this will allow face-to-face, hybrid, and digital students to study at TU Dresden. The challenge of the future will be to connect these two worlds and create a collaborative campus whose digital and presence offerings interact with each other in a meaningful way. Inclusion is the key word here. The advantages and experiences from the past digital semesters should be used to enable a broader offering and more individualized learning.

2. definition presence, digital and hybrid

Before an adequate assessment of teaching operations can be made, the terms "face-to-face teaching," "digital teaching," and "hybrid teaching" are first defined.

The origin of the German word "Präsenz" leads via the French word "présence" to the origin in Latin: "praesentia", which means "presence" or "presence". Presence teaching can thus be understood as teaching with the presence of students and teachers. Until 2019, this term was thus clearly defined. Presence meant the physical presence of students and teachers within the campus of TU Dresden. However, since the development of the digital campus and the accompanying development of digital teaching content, this definition can be questioned.

Digital teaching can be delivered synchronously and asynchronously, [1]. In the case of synchronous provision of digital content, students and teachers are still present at the same time; only the actual physical location differs. In asynchronous digital teaching, students and instructors are also present, but at different times and not necessarily at the same physical location. While digital asynchronous teaching can thus be clearly distinguished from the word presence solely by the requirement of simultaneous presence, synchronous digital teaching can be understood as an alternative form of classic presence teaching, which can only be distinguished from one another by the term "physical".

In addition to the terms digital and face-to-face teaching, the term hybrid teaching has also been increasingly used since 2020. The hybrid teaching concept or often also referred to as "blended learning" represents a combination of physical presence and phases of digital offerings [3].

A hybrid student can therefore be understood as a person who uses both digital and physical teaching to a similar extent, while face-to-face and digital students each have a clear preference for using one of the two forms of teaching.

3. current state of the art in teaching operation

Due to the pandemic, classroom teaching at the universities was no longer possible to a large extent in 2020 and 2021. Digital and hybrid concepts had to be developed in order to cope with the new restrictions and to be able to continue teaching. The experiences gained by teachers and students were documented and processed in numerous publications.

Particular emphasis is also placed on the freedoms gained as a result of digital and hybrid teaching. For example, recorded or asynchronous formats mean greater flexibility in the processing and development of teaching content, [4, 6, 10, 12]. Students can acquire course offerings at different times and at different paces. This results in greater educational equity, since groups of the population can now

participate in the content that would otherwise not have been able to do so, for example, due to time constraints. Also in [5], the advantages of digital teaching and learning are seen in the independence from physical presence and individualizable time allocation. However, the lack of interaction opportunities with instructors and other course participants is described as a limitation of digital teaching. However, it is also emphasized that digital teaching opportunities promote accessibility to higher education. In [2], on the other hand, synchronous digital streams are positively highlighted as preserving the familiar "lecture feeling" of traditional physical face-to-face teaching, on the grounds that lectures continue to be attended at regular times and students do not need to be particularly self-motivated. [7] documents student problems with digital learning. These include lower motivation with distance learning combined with an unsuitable home environment. Students also reported problems due to the lack of interaction opportunities in the digital space compared to the classroom or seminar room. In [6], evaluation results (297 students, 15 instructors) on digital teaching in engineering are presented. In this context, students also mention the lack of activating methods in online lectures and refer to survey tools such as Kahoot. In addition to many advantages, on the other hand, teachers see problems due to the lack of face-to-face interaction between students and teachers. Accordingly, [6] see the key to successful digital teaching as:

- Effective teaching strategies
- Use of activation methods such as surveys.
- Active student engagement in the online classroom.
- Fairness and variation of tests
- Interaction with students (listening and responding)

In [9-12] the chances, advantages and disadvantages of hybrid teaching concepts are described. By using hybrid teaching, it is possible to implement new and modern methods of imparting knowledge, to obtain higher active participation by deviating from frontal teaching and to leave the choice of learning method to the students themselves, [10]. Digital teaching units also make it easier for the instructor to access external resources and speakers by eliminating travel costs, [12]. This makes the teaching content more interesting and vivid.

[11] found in a study that exam results tend to be better when hybrid or digital formats are used. Here, the results of female participants are constant, but male participants performed significantly better in hybrid and digital teaching formats. This shows that there are differences in preferences and associated performance among students.

[10] and [12] highlight that theoretically unlimited numbers of participants are possible through digital events. This suggests opening university events to interested parties and promoting interdisciplinary discourse. More students off campus also means a cost degression effect, as more students can be taught in fewer buildings, [12].

However, digital formats also pose challenges. For example, attempts must be made to compensate for the lack of interaction in the lecture hall through discussions in breakout rooms, [9]. In addition, students are expected to take much more responsibility for themselves, [11]. In [12], it is also mentioned that the success and quality of learning essentially depend on the prerequisites regarding digital competencies. As soon as students have problems with the Internet connection, no microphone for communication or the teacher does not have a proper microphone, teaching suffers from severe limitations. A face-to-face event that is streamed at the same time poses a special challenge for instructors. For example, according to [12], the face-to-face room and the digital lecture room must be handled simultaneously. It is described that students quickly felt neglected when the instructor focused on one of the two spaces. This balancing act can lead to the teacher being overwhelmed due to the additional workload, [12].

4. implementation concepts of digital and hybrid teaching at the TU Dresden.

Within the TU Dresden, there are various forms of implementation of digital and hybrid teaching, see [13]. Within this paper, the focus will be on the standard concepts regarding lectures and exercises. Special forms, such as the

digitalized presentation of practical courses, cf. [8], will not be discussed further.

In the practical implementation of synchronous digital teaching at the TU Dresden, the following formats can mainly be found in lectures and tutorials: Digital streams of the physical presence lectures as well as digital consultations and synchronous presentation of applications of the teaching content.

The provision of digital streams enables students to be digitally present while the lecturer is physically present. The advantage of this implementation of digital teaching is the integration of digital students into face-to-face teaching. Compared to an inclusive integration, the integrative approach allows students to participate in the event, but they do not have the opportunity to interact with the physically present students and lecturers. Thus, if a live chat is used to interact with digital students, interaction with the instructor can succeed, but the instructor must also always simultaneously supervise and observe the digital space during the face-to-face lecture. As described in [12], this can quickly lead to an unintentional unequal treatment of digital and face-to-face students and a feeling of neglect. Streaming also means that students are bound to fixed lecture times, and in some cases do not have the opportunity to pause the stream or to look at facts that remain unclear repeatedly. The advantages that digital teaching can offer students can therefore sometimes not be used if the lecture is streamed live in the digital space without subsequently being made available as an asynchronous recording.

Asynchronous formats, on the other hand, promote the freedom to design one's own learning process and often allow for a much more flexible study routine, which can accommodate the diversity of students. Students with children, part-time jobs, or similar commitments are thus able to adapt teaching to their own pace and daily routine. As an example, we can mention recordings of the lecture, videos or online assignments for supplementary reinforcement of the teaching content, and digital games (quizzes, simulations, drawing games), cf. [5]. In contrast to synchronous digital teaching, however, asynchronous digital teaching involves a complete decoupling of the classroom and digital campuses.

If both digital and face-to-face students exist, they must be supervised and administered independently of each other. This can result in significant additional work for teachers. Students can also perceive the additional offerings on both campuses as an advantage or disadvantage. As an advantage, for example, because lecture videos can be watched again on the digital campus and topics can thus be repeated more easily, as a disadvantage, because a large number of additional offerings can sometimes also lead to excessive demands in terms of the scope for exam preparation.

An intermediate path can be created by hybrid teaching, which specifically combines the advantages and disadvantages of both campuses. A frequently practiced variant in recent semesters was to make the lecture available as a recorded video file and to have the associated exercises take place in person. In other words, a mixture of asynchronous digital teaching and physical face-to-face teaching in which students specifically used both campuses. The advantage of this variant is the flexibility with which students can view the asynchronous digital lectures, but the possibility of interaction with fellow students and teachers is missing. A forum can only compensate for this to a limited extent. Interaction can again take place through the classroom exercises, although this is usually limited to the exercise content and must take place at fixed times. Hybrid students are thus students who experience part of the course as face-to-face students and another part as digital students. Thus, hybrid students still have two clearly separated campuses, but they can move freely on them.

5. application example subject technical mechanics for industrial engineers

The previously described differences, advantages and disadvantages between classroom, digital and hybrid teaching could be observed in the basic subject "Technical Mechanics for Industrial Engineers". The modules

"Technical Mechanics I+II" for industrial engineers" have a scope of two SWS lecture and one SWS exercise each. In this introductory course, fundamentals of technical mechanics are taught in the 1st and 2nd semester.

Presence teaching (before 2020)

Before 2020, both the lecture and the exercises were offered only in presence. Over the course of the semester, one lecture was given weekly in the lecture hall. The script was available for students to download, but it contained empty fields that students had to fill in with sketches and example exercises during the lectures. This activated the students to think along and participate in class, which also had a positive effect on the lecture hall volume.

The classroom exercises were offered weekly, with the exercises changing every 2 weeks. At the beginning, a short thematic introduction and instructions were given by a research assistant, and then the students worked independently on the exercises. The role of the tutor was to provide assistance and to discuss solutions. Support was provided by specially hired student assistants. Exemplary solutions for the tasks of the first exercises were uploaded, for the remaining exercises no short solutions were provided. The face-to-face exercise thus had several positive effects:

- The exchange in small groups led to the learning of the professional discussion.
- Exercise content was worked out independently and the lecture content was thus repeated and deepened.
- The exercise introduction gave a clear summary of the lecture content.

The negative effects, however, were:

- The strong heterogeneity in knowledge transfer depending on the supervising academic staff member.
- Inquiries and reviews were limited to face-to-face operations.
- Fixed practice times resulted in some students not being able to attend practices due to other commitments.

Digital teaching (from 2020)

Due to the progression of the Corona pandemic, the engineering mechanics modules had to be offered exclusively digitally. Lectures were recorded and made available to students asynchronously. Communication with students took place via an online forum or via the weekly synchronous digital exercises. The exercise itself was offered as a digital video conference. The organization of the

The course of the exercise was left to the respective supervisors. This resulted in different teaching concepts in the various exercise groups: While in one exercise group subrooms were made available for small groups so that students could work together on the exercise content and ask the staff members specific questions, in the other exercise group work was done only in the main room, where complete exercises were also regularly presented by way of example. Students were thus able to choose between two different teaching concepts. In addition, introductory videos and short solutions to all exercise tasks were made available in the digital campus to enable self-review and independent processing of the tasks outside of the regular exercise.

The number of questions within the exercises decreased due to the use of the short solutions, which guided the students through the exercise more closely than in the face-to-face mode and made it possible to check the intermediate results. The digital exercise thus had several positive effects at once:

- The previous strong heterogeneity in knowledge transfer by different supervisors was mitigated by lecture videos, recorded exercise introductions, and provided short solutions.
- Students could replay the lecture videos as many times as they wanted and work through them at their own pace.
- Reviews and exercise processing were not limited to face-to-face use due to the short solutions.
- Fewer staff were needed to answer the questions.

The negative effects, however, were:

- Students tended to share less in small groups and thus did not learn professional discussion.
- The content of the exercise was only partially worked out independently, as the solution path was more closely described by the short solution.

- Less than 30% of the students participated in the exercises.
- Interaction among students and between students and instructors was significantly limited by cameras and microphones that were not activated.

Hybrid teaching (since WiSe 21/22)

Falling infection numbers enabled a return to the lecture halls of the TUD. The lectures of the modules were offered completely in presence, however, the recordings of the lecture of the previous digital semester were made available asynchronously on the digital campus. This allowed students to choose their own form of teaching to enable the most individualized teaching possible. Repeated viewing of the lectures for exam preparation was also possible. Since the exercises only changed every 2 weeks, face-to-face and digital exercises were offered in alternation. The number of participants in the face-to-face and online exercises fell compared to 2019. The online exercises were particularly hard hit, with only a few students attending some of them.

6. possibilities of hybrid studies at the TU Dresden

Since the summer semester of 2022, lectures and tutorials at the TU Dresden will again be offered predominantly in presence. Teachers are free to decide whether and in what form additional digital teaching is offered. A complete digital study or hybrid study is therefore currently not possible at the TU Dresden. If the TU Dresden is to permanently focus on hybrid studies, different variants are conceivable.

The first variant of hybrid teaching at the TU Dresden would be a simultaneous, independent provision of the presence and digital campuses, as it is currently already implemented in many courses. Students would then have the option of attending lectures and exercises either in presence or in digital. Lectures would be held in presence, pre-recorded lectures would be made available asynchronously or alternatively streamed synchronously from the lecture hall (and subsequently saved as an asynchronous recording), and synchronous presence as well as digital exercises would be offered. This way of extended hybrid teaching follows a most inclusive approach by continuing the integration of different needs and preferences regarding learning habits and by adapting the teaching system to the students. This will improve the already existing inclusive system, which, compared to an inclusive system, only accepts habits but does not change. This would no longer exclude students who, for example, rely on digital teaching because they have to work during the day. This variant would thus allow face-to-face, digital and hybrid studying, but would also mean a significantly increased supervision effort, since both campuses would have to be supervised by teachers at the same time. As soon as it is no longer possible to fall back on the already digitized content of 2020-2021, but the digital teaching content would have to be revised or even created from scratch, additional effort would arise.

If both campuses are to be used by students in a targeted manner, for example by offering digital lectures and classroom exercises, it is difficult to constantly switch between the campuses in students' schedules. Timetables should be adjusted so that students move between one of the two campuses on a block or day basis. In Figure 1, this has been exemplified once for the Simulation Methods major, 6th semester. Figure 1 above shows the current timetable. Exercises and internships are highlighted in blue as face-to-face teaching. In the current form, students would have to attend face-to-face exercises on Thursdays in the 1st + 2nd DS, followed by a digital lecture, then face-to-face again, then digital again. In order to attend the digital events, students would need a room to view the digital event on their laptop. A reduction of the necessary room capacities, as described in [12], would not be possible in this way. In contrast, scenario 1 in the middle of Figure 1 shows a block-by-block alternation between face-to-face teaching and digital campus in the timetable. The basis for such a scenario would be an extended lunch break for a campus change. Scenario 2 depicts a daily switch between face-to-face and digital campuses. Both scenarios would lead to a decrease in the utilization of the teaching rooms and a better utilization of the time grid of the TU Dresden. In scenario 1, the 8th semester Simulation Methods could then have face-to-

face courses on Monday to Thursday mornings, mirroring the 6th semester, and use the digital campus in the afternoons.

Aktuell: Sommersemester 2022, Stundenplan Simulationsmethoden (6. Semester) — Digital-Lehre / Präsenz-Lehre

	Montag	Dienstag	Mittwoch	Donnerstag	Freitag
1. DS		Ü Num.Ström.mech.	P Exp.FK-Mechanik	Ü S+A Prod.modelle	
2. DS	V MKS - Dynamik	P Mess-/Autom.te.2	P Exp.FK-Mechanik	Ü Num.Ström.mech.	
3. DS	V Stab/Flächen-TW	P Mess-/Autom.te.2	Ü Stab/Flächen-TW	V Exp.Ström.mech.	
4. DS	V Gasdynamik	V Kontinuumsmech.	Ü Kontinuumsmech.	Ü Produktdatenman.	V Konstr. mit CAD
5. DS	V Num.Ström.mech.	V Multifkt.Strukt.	Ü MKS - Dynamik	V Exp.FK Mechanik	Ü Konstr. mit CAD
6. DS	Ü Gasdynamik	V Mess-/Autom.te.2	Ü Mess-/Autom.te.2	V S+A Prod.modelle	
7. DS			V Fachpraktikum MB	ÜF Mess-/Autom.te.2	

Szenario 1: Blockweise Campus-Wechsel

	Montag	Dienstag	Mittwoch	Donnerstag	Freitag
1. DS	V MKS - Dynamik	V Num.Ström.mech.	V Mess-/Autom.te.2	V Exp.FK-Mechanik	Ü S+A Prod.modelle
2. DS	V Stab/Flächen-TW	V Kontinuumsmech.	V Fachpraktikum MB	V S+A Prod.modelle	Ü Num.Ström.mech.
3. DS	V Gasdynamik	V Multifkt.Strukt.	V Exp.Ström.mech.	V Konstr. mit CAD	Ü Produktdatenman.
4. DS	Campuswechsel und Mittagspause				
5. DS	Ü Gasdynamik	Ü Stab/Flächen-TW	P Exp.FK-Mechanik	Ü MKS - Dynamik	P Mess-/Autom.te.2
6. DS	Ü Num.Ström.mech.	Ü Kontinuumsmech.	P Exp.FK-Mechanik	Ü Mess-/Autom.te.2	P Mess-/Autom.te.3
7. DS			ÜF Mess-/Autom.te.2		Ü Konstr. mit CAD

Szenario 2: Täglicher Campus-Wechsel

	Montag	Dienstag	Mittwoch	Donnerstag	Freitag
1. DS	V MKS - Dynamik	P Exp.FK-Mechanik	V Mess-/Autom.te.2	P Mess-/Autom.te.2	Ü S+A Prod.modelle
2. DS	V Stab/Flächen-TW	P Exp.FK-Mechanik	V Fachpraktikum MB	P Mess-/Autom.te.3	Ü Num.Ström.mech.
3. DS	V Gasdynamik	Ü Gasdynamik	V Exp.Ström.mech.	ÜF Mess-/Autom.te.2	Ü Produktdatenman.
4. DS	V Multifkt.Strukt.	Ü Num.Ström.mech.	V Exp.FK-Mechanik	Ü MKS - Dynamik	Ü Konstr. mit CAD
5. DS	V Num.Ström.mech.	Ü Stab/Flächen-TW	V S+A Prod.modelle	Ü Mess-/Autom.te.2	
6. DS	V Kontinuumsmech.	Ü Kontinuumsmech.	V Konstr. mit CAD		
7. DS					

Figure 1: Timetables of current (top) and hybrid teaching scenarios (middle + bottom).

With this variant, pure face-to-face study would no longer be possible. However, teachers would no longer have to work twice as hard by using both campuses at the same time. If lectures were to be offered permanently asynchronously in digital form, communication channels would have to be created between teachers and students. This could, for example, be in the form of a Zoom consultation that the lecturer holds from his office during his digital lecture. Students could thus directly clarify questions about the digital lecture videos. In the case of purely digital lectures, the keys to successful digital teaching described in [6] should also be observed, which also recommend activating methods such as surveys.

A third variant would be a complete restructuring of teaching at universities. The previous strict concept of lectures and exercises would be abolished and replaced by subject blocks that are more free of specifications and in which the focus is on the subject matter. A course that currently consists of 2 SWS lectures and 1 SWS exercise would in future only be offered as a course with 3 SWS. Previous lecture videos could be thematically prepared into shorter video blocks of 20-30 minutes each, and exercises could be supported by self-learning scenarios such as Opal tests with solution instructions, cf. Figure 2. Students attending a thematic block of a course could then decide for themselves whether they would like to fill it with 90 minutes of lecture videos, lecture videos and exercises in alternation, or entirely with exercises. The lecturers are also welcome to make a recommendation. The advantage of this variant would be a better link between the theoretical lectures (listening) and the practical exercises (application).

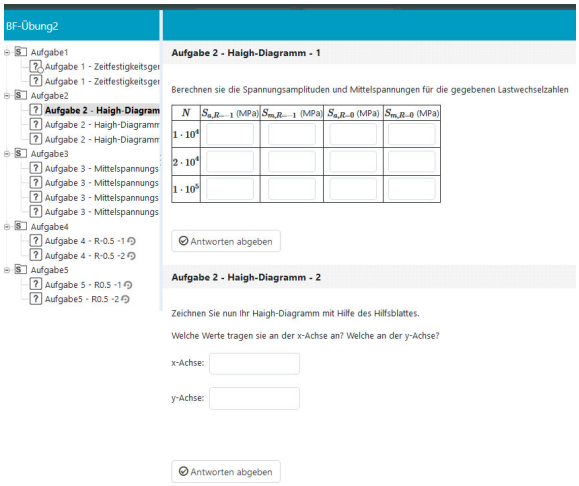

Figure 2: Self-learning scenario for checking the intermediate solutions of the classroom tasks

The heterogeneity of prior knowledge and the diversity of learning types could also be well addressed by this concept, in which students determine their own pace. Teachers would then be able to respond more individually to individual questions and problems in the lecture hall or seminar room and could thus provide students with more targeted support. In such a variant, it would make sense to group students into learning groups that attend the course together. This approach would make it possible to link the presence campus with the digital campus for presence students, since digital content would be used in presence.

The inclusion of digital students in the presence campus can also be easily ensured within this variant by distributing tablets to several student groups within the subject block, which are synchronously connected to zoom breakout rooms and enable the inclusion of digital students in the presence student group. In this way, instructors still only have to address student questions in presence, regardless of whether they come from presence students or digital students connected in the

small groups. The presence and digital campuses thus become one overall campus of the TU Dresden for synchronous digital, presence or hybrid students, which does not have to be supervised independently of each other.

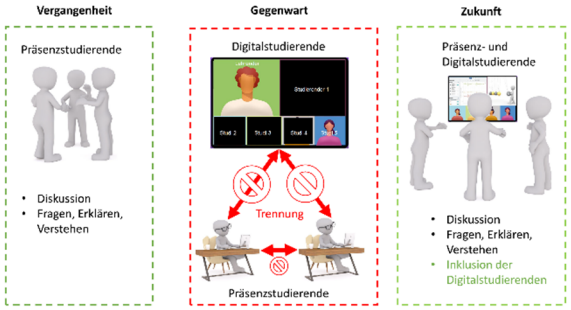

Figure 3: Inclusion of digital students in face-to-face courses

For asynchronous digital students, the lecture videos and self-learning scenarios for exercises would continue to be available digitally.

In [14], initial experiences with such an agile form of teaching and learning (eduScrum) in university teaching have already been documented. The participating students subsequently stated in a self-assessment that they had developed significantly higher technical competencies, social competencies and independence through agile learning than in other seminars with "classic" teaching concepts. Positive effects that are also described in other forms of agile learning, such as the methodology of the "inverted classroom" [15] or project-based learning [16]. All these concepts have in common that students are more actively involved in the design of lessons and thus build up a better understanding and higher professional competence.

7. Summary

Since the beginning of the corona pandemic, a new, extensive digital campus has been created at the TU Dresden. Video recordings of many lectures were created, which can be made available asynchronously in the future. For exercises, introductory videos, wikis or other self-learning scenarios have been developed that can also be used without additional effort. However, the question arises how these digital materials can be used to enable digital and hybrid teaching at TU Dresden without generating an increased supervision effort by the two campuses. Within this publication, different scenarios of hybrid teaching were discussed. The scenarios differ in their impact on face-to-face teaching, in their degree of inclusion of digital in the face-to-face campus, in the consideration of diversity in prior knowledge and knowledge transfer as well as in the implementation effort and space planning, cf. table 1. Depending on the weighting of the different decision criteria, a preferred variant for hybrid teaching can thus be selected.

Table 1: Comparison of the variants of the hybrid gauge

	Var. 1	Var. 2	Var. 3
Impact on-Presence teaching	0	+	++
Inclusion Digital-in Presence Teaching	-	0	+
Diversity	+	0	++
Implementation effort	++	+	-
Spatial planning	0	++	0

Literature

[1] Reinmann, G. (2021). Face-to-face, online or hybrid teaching? Towards the post-pandemic. Impact Free 37. Hamburg. URL: https://gabi-reinmann.de/wp-content/uploads/2021/06/Impact_Free_37.pdf

[2] Lackner, E. Kopp, M. (2014). Learning and teaching in virtual space. Challenges, opportunities, possibilities - In: Rummler, Klaus [Ed.]: Designing learning spaces - Thinking educational contexts diversely (pp. 174-186). Münster et al : Waxmann. DOI: 10.25656/01:10101

[3] Bosse, E., Barnat, M., Szczyrba, B. (2021). Research impulses for higher education development in the context of hybrid teaching. Cologne. URN: urn:nbn:de:hbz:832-cos4-9471

[4] Samuel, Kehinde G., Umar Abdulrahman, and Samuel BF Ajakaiye. "DIGITAL LEARNING IN THE POST COVID-19 PANDEMIC." APWEN 2021 NATIONAL CONFERENCE. Vol. 3.

[5] Nanjundaswamy, C., S. Baskaran, and M. H. Leela. "Digital Pedagogy for Sustainable Learning." Shanlax International Journal of Education 9.3 (2021): 179-185.

[6] Ahmed, Vian, and Alex Opoku. "Technology supported learning and pedagogy in times of crisis: the case of COVID-19 pandemic." Education and Information Technologies 27.1 (2022): 365-405.

[7] García-Alberti, Marcos, et al. "Challenges and experiences of online evaluation in courses of civil engineering during the lockdown learning due to the COVID-19 pandemic." Education Sciences 11.2 (2021): 59.
[8] Khutz, Moritz; Kupfer, Robert; Kirvel, Christian; Hornig, Andreas; Modler, Niels; Gude, Maik: The Practical in the Virtual - Digital Teaching at the ILK; Lessons Learned Journal, Vol. 1, 2021.
[9] Weissmann, Yaël, Mirdita Useini, and Jörg Goldhahn. "COVID-19 as a chance for hybrid teaching concepts." GMS Journal for Medical Education 38.1 (2021).
[10] Beckmann, Astrid. "Implementing hybrid education using the mathedu digital-teaching concept-an example from maths teacher education." Proceedings of INTED2021 Conference 8th-9th March 2021. 2021.
[11] Little, P., & Jones, B. (2020). A Comparison of Student Performance in Face to Face Classes versusOnline Classes
versus Hybrid Classes Using Open Educational Resources. Journal of InstructionalPedagogies , 2020(24). https://eric.ed.gov/?id=EJ1263878
[12] Bulow, Morten Winther. "Designing synchronous hybrid learning spaces: challenges and opportunities." Hybrid Learning Spaces. Springer, Cham, 2022. 135-163.
[13] Kruppke, Benjamin. "It's all in the mix - Asynchronous, synchronous, inverted ... from slide dubbing to experimentation," Lessons Learned Journal, Vol. 1, 2021.
[14] Sturm, Nico, and Heike Rundnagel. "Agile learning digitally supported: The eduScrum method in higher education teaching." Shaping digitization in studying and teaching together. Springer VS, Wiesbaden, 2021. 577-598.
[15] Mason, Gregory S., Teodora Rutar Shuman, and Kathleen E. Cook. "Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course." IEEE transactions on education 56.4 (2013): 430-435.
[16] Hollstein, André, Ulrich Kerzel, and Damir Ismailović. "Project-based learning in online teaching." Practice-oriented university teaching. Springer Gabler, Wiesbaden, 2021. 351-361.

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Promotion of self and methodological competence in the digital biomechanics practical course

B. Kruppke*

Chair of Biomaterials, Institute of Materials Science, Faculty of Mechanical Engineering, TU Dresden

Abstract

Mit der Anpassung der Hochschullehre an den digitalen Raum wurden verschiedene Konzepte für Vorlesungs- und Seminarformate entwickelt, umgesetzt und evaluiert. Besondere Aufmerksamkeit wird deshalb nun Formaten gewidmet, deren Fokus auf praktische Lernerfahrungen gerichtet ist. Es ergibt sich ein Widerspruch aus dem Vorhaben Praktikumsveranstaltungen in den digitalen Raum zu verlegen, was im Folgenden durch die Erläuterung bisheriger Praktika in der Professur für Biomaterialien der Technischen Universität Dresden verdeutlicht wird.
Aufbauend auf dieser Betrachtung wurde eine Lernwerkstatt zum Thema „Biomechanik im Alltag“ unter Berücksichtigung der Limitationen und Möglichkeiten des digitalen Raumes entwickelt. Das Ziel der digitalen Lernwerkstatt ist eine kompetenzorientierte praktische Lernerfahrung zum Erwerb von Selbst- und Methodenkompetenz, im Vergleich zur Fachkompetenz-getriebenen Präsenzlehre. Die Lernwerkstatt wurde im Modul Werkstoffwissenschaft (2. Semester) als synchron-digitales Praktikum mit asynchronen Aktivitätsphasen durchgeführt. Zunächst wird die an Projektmanagementansätze angelehnte Durchführung der Lernwerkstatt erläutert. Daraus ergab sich eine individuell vollzogene Projektbearbeitung durch die Studierenden. Die abschließenden Erkenntnisse aus der Betreuung des Lehrformates führen zum Ausblick auf eine Lehrveranstaltung, die die Elemente des Projektmanagements mit den Fachinhalten verknüpft.

With the adaptation of university teaching to the digital space, various concepts for lecture and seminar formats have been developed, implemented and evaluated. Special attention is therefore now being paid to formats whose focus is on practical learning experiences. A contradiction arises from the plan to move internship events into the digital space, which will be clarified in the following by explaining previous internships in the Chair of Biomaterials at TU Dresden.
Based on this consideration, a learning workshop on the topic of "Biomechanics in everyday life" was developed, taking into account the limitations and possibilities of the digital space. The goal of the digital learning workshop is a competence-oriented practical learning experience for the acquisition of self- and methodological competence, in comparison to subject competence-driven classroom teaching. The learning workshop was implemented in the Materials Science module (2nd semester) as a synchronous digital practical course with asynchronous activity phases. First, the implementation of the learning workshop based on project management approaches is explained. This resulted in an individually completed project processing by the students. The final findings from the supervision of the teaching format lead to the outlook for a course that links the elements of project management with the subject content.

*Corresponding author: benjamin.kruppke@tu-dresden.de

1. Introduction

Lectures and seminars with online tools, in hybrid format, via synchronous web meetings or asynchronous work assignments, with inverted classroom [1–3], annotated PowerPoint slides, scripts, or audio files - all of these are state of the art in university teaching today.

The transformation of hands-on learning experiences is much more difficult to realize in this context, as individual digital lab courses are very strongly linked to the respective subject areas. For example, Lab@Home approaches with individualized courses in a computer lab can be implemented primarily for programming tasks, CAD courses, or modeling [4]. Practical experiments in the university context, on the other hand, often require complicated equipment or expensive measuring devices. These can be provided, for example, by mobile engineering cases [5]. However, again, the limits of the experiments and the number of students are quickly reached.

A low-threshold approach is represented by experiments that can be performed by students themselves at home using available components. It was shown that the students had the opportunity to work with the experiments over several weeks, to carry out extensive series of experiments, and thus to gain a deep understanding of the content aspects [6]. The intensive engagement with the method itself and the support of individual learning experiences can thus compensate for digital and distance learning limitations. In addition, comparative observations of individual students' results can provide another dimension of professional assessment [6].

The development of a learning workshop on the topic of "Biomechanics in everyday life" takes into account the limitations and possibilities of the digital space, with digital communication tools being used to coordinate and compare the individual experimental results of the students. Basically, the learning workshop is carried out according to guidelines of agile project management [7–9]. This is reflected above all in the iteration steps and the defined time limits of the project process. The different prerequisites in the self-study phases are also subject of the students coordinated planning of the learning workshop, whereby the presence of a cell phone or a similar portable device with acceleration and position sensors is a prerequisite. The learning workshop was designed and implemented as part of the materials science module (2nd semester) as a synchronous digital practical course with asynchronous activity phases. Here, synchronous teaching means that the teacher and the students participate in a course at the same time in a defined time frame, while asynchronous teaching is understood as the students' engagement with provided learing content independent of location and time. In future, a transfer of this format to the module Biomechanics (8th semester) is intended.

For a better classification of the subject-specific requirements for practical courses, laboratory experiments and experimental lectures, the sequence of classical practical courses in the field of biomechanics or biomaterials is first explained. As a result, the digital biomechanics practical course is planned in the form of a learning workshop with a shift in the primary focus from teaching of technical skills to the development of self and methodological skills.

2. Face-to-face lab courses

Within the framework of the practical course, two teaching formats are carried out, the classical laboratory practical course with a given procedure or the more creative learning workshop in the Chair of Biomaterials. The lab course focuses on the acquisition of technical and methodological competence. For this purpose, there is usually a very specific task, which is closely linked to the lecture. The execution of the practical course requires the students' special knowledge to be able to work on the problems independently and appropriately and to assess the results (specialist competence according to [10]). This requires the ability and willingness of the students to apply certain working methods (methodological competence, [10]).

Thus, classical lab courses on the subject of biomechanics focused, for example, on the analysis of the material properties of biological materials in order to gain information on the mechanical properties, e.g. using a piece of

bone. Thus, according to a buttom-up approach, i.e. starting from microscopic dimensions and molecular properties to deduce macroscopic composite properties, the fibrillogenesis of collagen as a basic component of bone was analyzed by means of UV/Vis spectroscopy and atomic force microscopy. Based on this, bone remodeling was characterized by degradation and cell experiments. This is based on the subject-oriented and methodological learning objectives that students are able to perform simple laboratory tasks and measurements. In addition, they will be able to explain relationships between bone components and their formation conditions and the degradation processes. Due to the actual tasks and the tight schedule of the lab curse, the students are generally not encouraged to contribute their own creativity or approaches.

The concept of learning workshops as a practical teaching format focuses on the students' independent research-based learning. As a subject-related learning objective, the students should be enabled to develop a concept for the analysis or imitation of a biological model. This requires that they independently agree on a strategy as a group and finally jointly prepare and present their results. In the technical context, the students learn to communicate in the group, i.e. to express their ideas in a comprehensible way and to listen actively both to criticism and to ideas. They have to learn, to jointly plan tasks and, if necessary, taking a step back themselves, which strengthens their social competence for constructive cooperation.

In most cases, a vaguely formulated task or question serves as an incentive to activate the creativity and curiosity of the students. By providing an extensive range of materials and methods as well as a space or platform for exchange between the students, a work plan is first developed [11]. The students are left to their own devices. The teacher is available as a dialogue partner and learning companion, without directly interfering in the student activities [11].

The established procedure is based - in accordance with the theoretical concept - on the direct involvement of the students with an impulse object (e.g. a crab shell or chicken bone) or a question (e.g. What makes the bone so resilient?). The available spectrum of methods is made accessible through a laboratory tour (at the Max Bergmann Center of Biomaterials, Institute of Materials Science).

Without a strict subject-specific instruction, the concept of learning workshops shifts the focus of competence acquisition more toward self-competence and social competence. This naturally places greater demands on the agility and improvisational talent of the teachers. However, the students' independently acquired technical and methodological competence can be particularly intensified in this way, albeit at a somewhat lower level.

3. Practical courses in the digital space

The explanations of the face-to-face lab course and especially the learning workshops indicated, that the transfer of learning objectives and the acquisition of competencies through a practical course in the digital space is particularly difficult.

Various digital teaching formats with practical relevance were primarily aiming at teaching technical skills. For this purpose, experiments were recorded as videos and made available to the students (Fig. 1a). Furthermore, experiment lectures were conducted as synchronous events with web-based interaction possibilities (chat, shared whiteboard, voting) by students and lecturers (Fig. 1b). [12]. In addition, following a classical practical course sequence, preparatory tasks were provided to students as pdf scripts, followed by asynchronous "presentation" practicals, produced by lecturers in advance. Here, the experiment execution and results are prepared in the form of presentation slides supplemented by short video sequences (Fig. 1c). The aim is to make the execution of the experiment and the acquisition of measured values as comprehensible as possible, so that the evaluation of the data provided can be carried out by the students in a final practical protocol.

As a result, however, it becomes apparent that the practical learning experience cannot be compensated by the high level of engagement in video creation and experiment demonstration. This was confirmed by student feedback

with quotes such as "prefer lab course on site" and "too much to read" about the accompanying material provided. It seems that the incentive for lengthy practical course preparation with detailed scripts decreases if these courses are subsequently available as a video or results presentation and can also be played through to the end more quickly. Furthermore, the training of students in the context of qualification works at the chair is also associated with greater effort, when practical experience in the laboratory is missing during studies, which resulted in a plan for more practical courses in the Chair of Biomaterials.

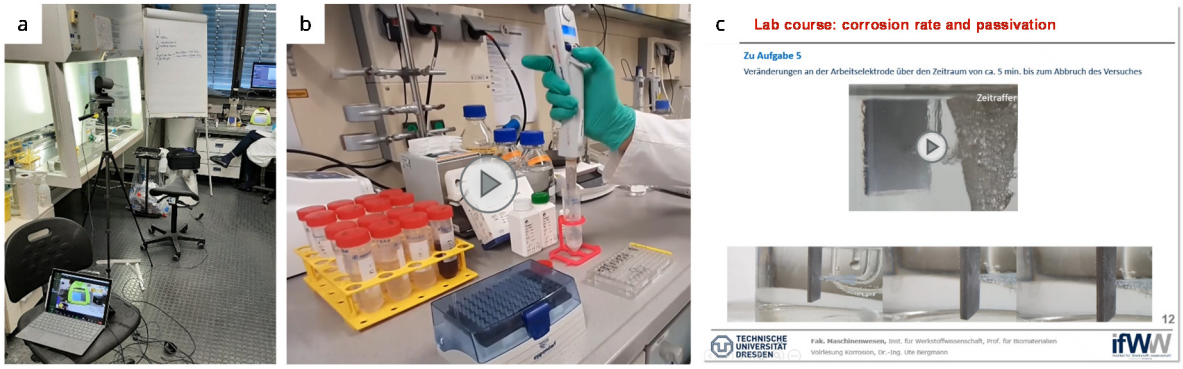

Fig. 1: a) Photo from a video recording from the cell culture lab, b) Video still from an experiment lecture, c) Experimental results as presentation slides (photos and time-lapse video) for evaluation by students.

4. Agile project management in university practical courses

Following agile project management, the students are confronted as a team with a problem that is outlined by several scenarios. Thus, they can decide for themselves which partial aspects they would like to work on, how to design a solution and which means are necessary and feasible for this. The lecturer is exclusively responsible for supporting the group organization (providing a communication platform, data exchange, etc.), for mediating any planned investigations and in conflict situations between the group members.

The organization of the group, such as a division into smaller expert groups dealing, for example, with theoretical principles, technical implementation and the consolidation of individual findings, is the responsibility of the group itself, for which a group leadership position is to be determined by the group members.

The project processing takes place in fixed time intervals, whereby a work plan for the current interval is always created at the beginning, which provides a presentable result as quickly as possible. By jointly presenting the result to the lecturer, the students quickly receive feedback on the requirements that still need to be implemented or new ones that arise. These are included in the work plan for the next interval (according to the prioritization by the students) and implemented.

With the help of this concept, students are given greater responsibility and freedom, which encourages creative and flexible problem solving.

After implementation it became apparent that agile project management can be seen as a learning objective so that the students are already familiar with agile methods, the personnel roles, artifacts and events provided therein for their later work and may transfer these to other departments.

5. The digital learning workshop

For the digital learning workshop, the concept was applied as follows. The primary goal was to redesign the practical course as an individual learning experience, so that the central points are 1) students autonomy, 2) the use of commonly available tools and methods and 3) a topic related to materials science (specifically: biomechanics). This was implemented by the students by deciding to record motion sequences of everyday activities using the sensors in cell phones.

Individual work should be possible, so that the group result is only achieved by digitally merg-

ing the individual results. The students should be able to participate in the digital workshop alone and equally.

A digital learning space (e.g. BigBlueButton, Zoom) provided on a scheduled basis was used by the students for exchange within the group, for designing experiments and for discussing results, while the lecturer was only available as an advisor.

Procedure

A short explanation of the learning workshop concept and the topic description (biomechanics) takes place during the kick-off event. The complexity of the acquisition of biomechanical parameters is explained by the teacher and reference is made to the various aspects: from cell structure, to biomaterial components, to sports biomechanics.

In the following, the students work out their plan for recording of biomechanical processes in everyday life as well as a work plan for the first interval. Synchronous consultations (every 2 weeks) serve to harmonize the individual tests and discuss the measurement results. From this, further methods are worked out in the following intervals in order to harmonize the individual results and to record them in a comparable way. Finally, the individual results are evaluated as a group result with transfer of the kinematic measured values to the dynamic load situation of the body as a presentation.

Results

Since biomechanics in the present case deals with the human musculoskeletal system, a way to characterize it had to be found first. For this purpose, the students chose cell phones as a commonly available measuring device. The motion sensors were recorded and read out using the app phyphox® (available for Android and Apple) [13,14].

Various potential motion sequences were noted by the students on a digital whiteboard and a selection was made. This selection was specified in the second interval after a first check of the recorded data and suitable boundary conditions (motion sequences, cell phone positioning). In addition, the possible characteristic parameters for data recording as well as the recording boundary conditions (number of movement repetitions, weights, pauses) were collected (Fig. 2).

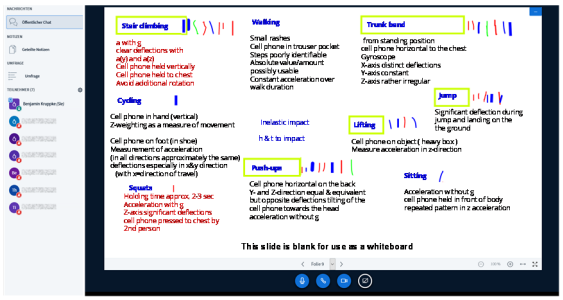

Fig. 2: Shared whiteboard: parameters and matching (vertical lines) for the motion sequences to be recorded (stair climbing, trunk bending, jumping, lifting, push-ups).

In the second interval, a platform (Google Sheets) was also selected for collaborative data visualization and analysis. A subgroup of the students took over the normalization and the staggered plotting of the data of all members.

In the third interval, the motion sequences of all students were recorded in 8-fold repetition with the phyphox function "acceleration without g". After an initial data comparison, the individual movement data were normalized to the respective total duration based on characteristic maxima or minima of the first and last repetitions (Fig. 3).

The comparison of individual data presented a particular challenge, as even slight deviations from the protocol resulted in different characteristic acceleration patterns of individual movements. Thus, in the last interval, the students scheduled a final outdoor presence session, which was conducted in compliance with the Corona protection measures. Here, selected sequences were recorded by all students simultaneously and under controlled conditions. The added value of the group activity was evident from the significantly more uniform movement curves. It should be noted that a purely digital approach to conducting the digital learning workshop would also have led to a meaningful result in terms of biomechanical movement sequences in everyday life.

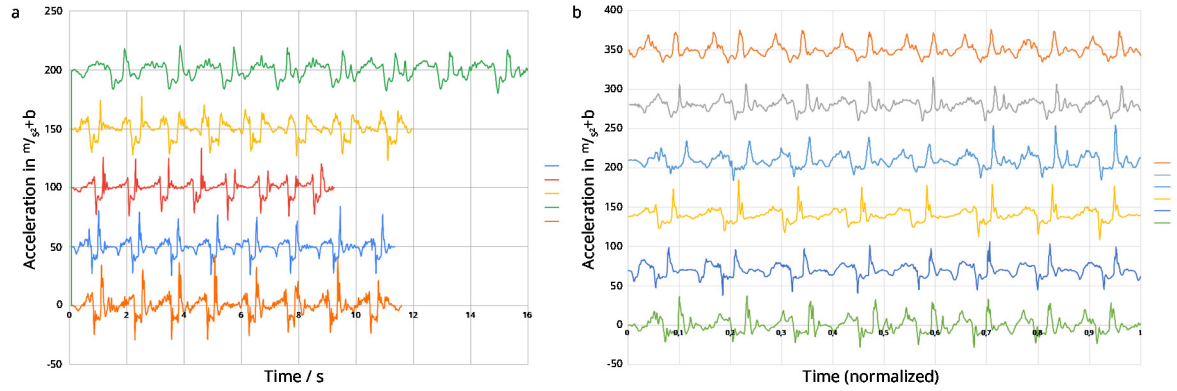

Fig. 3: Jump acceleration data of the students (8 repetitions each): a) raw data, b) normalized to respective total durations.

In addition to the technical component of the face-to-face meeting, the students were able to demonstrate the self-competence they had acquired through the measurements they had previously performed independently. For example, they pointed out to each other possible ways of improving the movement sequences, independently selected the execution locations and aids, and coordinated the timing. All students mastered the technical handling of the mobile phone-based measurement data acquisition without any problems. The evaluation and discussion of the results, as well as their presentation as a group, were also carried out to an extremely high standard considering the early semester of study.

In the context of further practical groups, a stronger focus is to be placed on the final transfer of the measured values to the load situation of the body. Here, the rapid transition from the determination of the movement sequences to the measurement procedure resulted in a neglect of the later significance and the inclusion of further possible measured values or methods. Thus, the students decided not to evaluate the stair climbing as well as trunk bending because of the limited informative value.

The implementation of the agile project execution led to a high level of commitment of the students. This was evident in the creative and time-consuming test phase of the measured data acquisition of various motion sequences.

In addition to the online meetings, all students carried out measurements of their movement sequences and independently entered the data into the shared table. Due to the agile, i.e. step-by-step implementation, this took place several times under changed boundary conditions (specifications that the students gave themselves for their measurements). The data of all students for all movement sequences were always inserted and evaluated according to the time specifications. Even in later project intervals, the comparability of the individual results was improved with great effort.

The insights gained during the digital learning workshop now serve as the basis for the redesign of various modules. These will be even more strictly aligned with the requirements of agile project management. Although the modules will be held in person or in a hybrid format, the experience gained, will make it possible to switch directly to the digital space if necessary. For these new modules, the digital lecture recordings produced during the last “Corona” semesters are made available in the sense of an inverted classroom approach in order to work on project tasks iteratively and creatively. The basic knowledge is thus applied instantly and the importance of this knowledge can be experienced by the students directly in the project.

6. Lesson learned

- Videos and interactive experiment lectures cannot replace hands-on learning experience (limited methods)
- Individually feasible learning workshops with cell phone as measuring device are comparably easy to implement (with high acceptance)

- Students acquire a high level of self-competence in learning workshops, which is reflected in active participation
- Digital teaching concepts can be more easily converted to face-to-face events (with PCs, if necessary)
- Agile iterative project processing promotes commitment and creative approaches to solutions

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Literature

[1] B. Kruppke, Der Mix macht's – Asynchron, synchron, inverted … von der Folienvertonung bis zum Experiment, Lessons Learn. 1 (2021) 1–12. https://doi.org/10.25369/ll.v1i1/2.2.

[2] N.T.T. Thai, B. De Wever, M. Valcke, The impact of a flipped classroom design on learning performance in higher education: Looking for the best "blend" of lectures and guiding questions with feedback, Comput. Educ. 107 (2017) 113–126. https://doi.org/10.1016/j.compedu.2017.01.003.

[3] A. Roehl, S.L. Reddy, G.J. Shannon, The Flipped Classroom: An Opportunity To Engage Millennial Students Through Active Learning Strategies, J. Fam. Consum. Sci. 105 (2013) 44–49. https://doi.org/10.14307/jfcs105.2.12.

[4] J.-O. Joswig, F.M. Arnold, Lab@Home: Individualisierte Computerpraktika, Lessons Learn. 1 (2021) 1–8. https://doi.org/10.25369/ll.v1i1/2.26.

[5] M. Beitelschmidt, Z. Wang, Ingenieurkoffer für Experimentalpraktika@home, Lessons Learn. 1 (2021) 1–8. https://doi.org/10.25369/ll.v1i1/2.16.

[6] S. Odenbach, J. Morich, L. Selzer, Praktikum ohne Präsenz - geht das?, Lessons Learn. 1 (2021). https://doi.org/10.25369/ll.v1i1/2.6.

[7] A. Jurado-Navas, R. Munoz-Luna, Scrum Methodology in Higher Education: Innovation in Teaching, Learning and Assessment, Int. J. High. Educ. 6 (2017) 1. https://doi.org/10.5430/ijhe.v6n6p1.

[8] M. Persson, I. Kruzela, K. Allder, O. Johansson, P. Johansson, On the use of scrum in project driven higher education, Proc. …. (2011). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.217.9885&rep=rep1&type=pdf.

[9] M. Muller-Amthor, G. Hagel, M. Gensheimer, F. Huber, Scrum higher education - The scrum master supports as solution-focused coach, IEEE Glob. Eng. Educ. Conf. EDUCON. 2020-April (2020) 948–952. https://doi.org/10.1109/EDUCON45650.2020.9125304.

[10] M. Cursio, D. Jahn, Leitfaden zur Formulierung kompetenzorientierter Lernziele auf Modulebene, https://www.med.fau.de/files/2015/09/31072014_leitfaeden_fbzhl_1_2013_lernziele.pdf, Erlangen, Nürnberg, 2013.

[11] Verbundes europäischer Lernwerkstätten (VeLW) e.V., Qualitätsmerkmale von Lernwerkstätten und Lernwerkstattarbeit, https://www.forschendes-lernen.net/files/eightytwenty/materialien/VeLW-Broschuere.pdf, Deutschland, 2009. http://www.forschendes-lernen.net/files/eightytwenty/materialien/VeLW-Broschuere.pdf.

[12] B. Kruppke, Digital Experiments in Higher Education—A "How to" and "How It Went" for an Interactive Experiment Lecture on Dental Materials, Educ. Sci. 11 (2021) 190. https://doi.org/10.3390/educsci11040190.

[13] Phyphox®, RWTH Aachen Univ. (n.d.). https://phyphox.org/.

[14] S. Staacks, S. Hütz, H. Heinke, C. Stampfer, Advanced tools for smartphone-based experiments: phyphox, Phys. Educ. 53 (2018) 045009. https://doi.org/10.1088/1361-6552/aac05e.

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Virtual² - Simulation practical course in digital space

M. Kuhtz*, B. Grüber, C. Kirvel, N. Modler, M. Gude

Institute for Lightweight Construction and Plastics Technology (ILK), Faculty of Mechanical Engineering, TU Dresden

Abstract

Im Praktikum zur Lehrveranstaltung Simulationstechnik besteht insbesondere in der digitalen Lehre zum einen die Herausforderung der Schaffung von Voraussetzungen zur häuslichen Bearbeitung der Aufgaben. Zum anderen sind die individuellen Voraussetzungen und Fähigkeiten der Studierenden im Sinne einer nachhaltigen Lehre zu berücksichtigen. Ein Lösungsansatz hierfür ist die didaktische Methode des Flipped Classroom, bei der die Stofferarbeitung anhand von vorbereiteten Materialien wie etwa Erklärvideos in individueller Verantwortung der Studierenden liegt. Dazu wird auch die Studentenversion der Simulationssoftware Simcenter Femap genutzt, die den Studierenden am heimischen Windows-PC kostenfrei zur Verfügung steht. Die eigentliche Praktikumszeit wird in der Anwendungsphase in Form von Konsultationen und digitalen Gruppenarbeiten nach der Methode des Aktiven Plenums zur Festigung und Vertiefung der erworbenen Kenntnisse genutzt.
Diese Methode bietet eine Reihe von Vorteilen in Bezug auf die didaktischen Herausforderungen wie etwa unterschiedliche Lerntempi der Studierenden oder Aktivierung der Studierenden. Insbesondere die digitale Gruppenarbeit in Form eines Aktiven Plenums fand großen Anklang bei den Studierenden, sodass viele Elemente dieses Lehrformat auch bei der Rückkehr in verstärkte Präsenzlehre beibehalten werden.

In the practical course for the course Simulation Technology, there is the challenge of creating the conditions for working on the tasks at home, especially in digital teaching. On the other hand, the individual requirements and abilities of the students must be taken into account in the sense of sustainable teaching. One approach to solving this problem is the digital method of the flipped classroom, in which students are individually responsible for working through the material using prepared materials such as explanatory videos. For this purpose, the student version of the simulation software Simcenter Femap is used, which is available to the students free of charge on their Windows PC at home. The actual practical training time is used in the application phase in the form of consultations and digital group work according to the active plenum method to consolidate and deepen the acquired knowledge.
This method offers a number of advantages in terms of didactic challenges such as different learning paces of the students or activation of the students. In particular, the digital group work in the form of an active plenum was very well received by the students, so that many elements of this teaching format will also be retained in the return to increased presence teaching.

*Corresponding author: Moritz.Kuhtz@tu-dresden.de

1. Didactic challenge

The practical course considered here for the course ***Simulation Technology*** is located within the module "Calculation of Lightweight Structures" (MW-MB-LB-04) and is offered each summer semester by the Institute of Lightweight Engineering and Polymer Technology (ILK). It is a compulsory module for students of lightweight design in the diploma program and in the diploma postgraduate program in mechanical engineering of the Technische Universität Dresden, whereby especially the postgraduate program is mainly used by foreign students. In addition, students of industrial engineering can take "Simulation Technology" as an elective subject in their specialized studies. This results in a very heterogeneous composition of the internship group with regard to previous knowledge, semester and language competence.

In terms of content, the practical course teaches methods for simulating lightweight structures. Essentially, the finite element method is used, the practical application of which is learned by means of the established software Simcenter Femap. This software is available to students free of charge as a student version for operation on a Windows PC within the framework of academic education [1], which is why it is predestined for the teaching-learning method used here. Furthermore, the included license is unlimited in time, and the model size is also not limited, so that the software can also be used beyond this course. On the one hand, this offers the advantage that students can consolidate and deepen the knowledge and skills acquired in the course later in their studies. On the other hand, this reuse motivates the students to learn how to use the software, as their personal competencies are expanded for a later professional activity.

As a result of the different study processes and learning levels with regard to the prerequisite knowledge, the prior knowledge of the students is very heterogeneous. Accordingly, five central didactic challenges arise: ***Different learning paces, learning success controls, activation of the students, linguistic competencies and adaptation of the examination***.

Due to their individual previous knowledge and their respective motivation, the students have very different learning speeds. Since the use of new software can rarely be learned "overnight", students receive feedback on their individual learning status through targeted learning success checks accompanying the course of the semester. In addition, it is necessary to activate students, as there is a risk, particularly in digital teaching-learning units, that students will not engage intensively with the subject content. In addition, the language competence (German or English) of many of the international students is insufficient for an intensive scientific-technical exchange from the teacher's point of view. Finally, the examination has to be changed according to the changed teaching-learning activities and the newly formulated learning objectives according to the concept of Constructive Alignment as well as due to the digital examination.

2. Solution approach: Flipped Classroom

The comprehensive teaching-learning concept established at the ILK, which includes the four dimensions of digital teaching: ***teaching and learning, advising and mentoring, testing and assessment,*** and evaluation and ***feedback,*** serves as the basis for successfully conducting teaching against the backdrop of the challenges described (Fig. 1).

The didactic method of the ***Flipped Classroom*** (also: Inverted Classroom) offers a number of advantages, especially in the teaching-learning activity presented here, and is therefore integrated into the context of the four dimensions of digital teaching. In this context, this method primarily addresses the area of teaching and learning. In contrast to classic forms of teaching such as a lecture, in which the subject matter is taught in the presence of the learner and applied to the learner, this method offers a number of advantages.

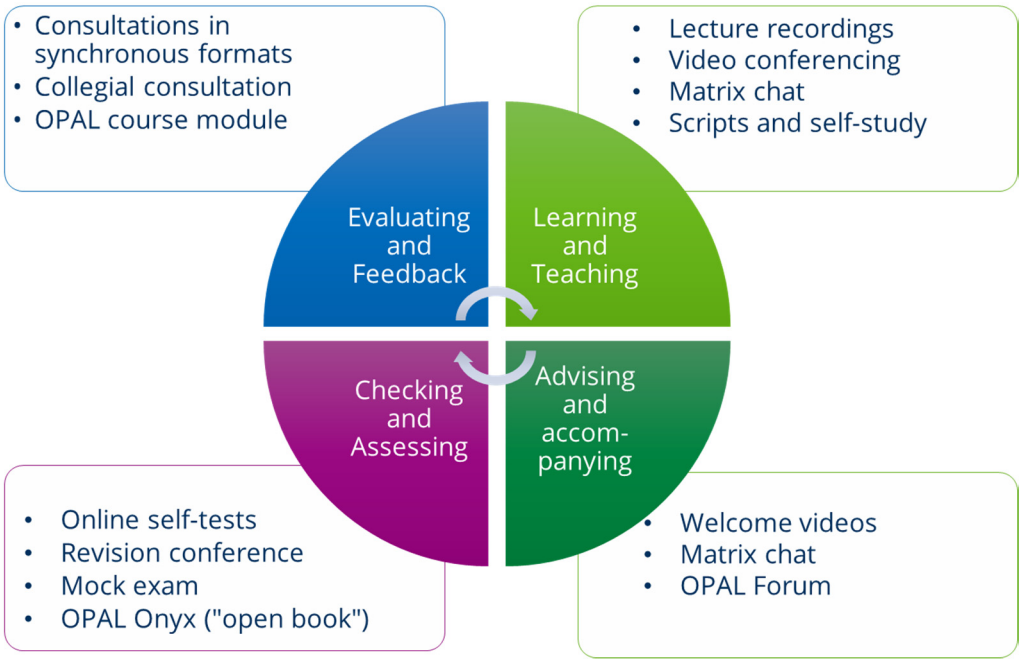

Fig. 1: Dimensions of the digital teaching-learning formats established at the ILK with exemplary fields of application [3].

This method reverses the roles of classroom and home learning [2]. Thus, in the asynchronous learning phase (development phase), the learning content is predominantly acquired by taking into account the learning objectives:

- watching the explanatory videos (tutorials),
- following the tutorials,
- the processing of the tasks and
- independent practice based on tasks without a sample solution

worked out independently by the students. In addition, the synchronous learning phase (application phase) is used to discuss, deepen and apply the learned contents. This method has already been successfully approached and implemented in many teaching-learning projects of the Faculty of Mechanical Engineering at TU Dresden [4,5] and beyond [6,7].

3. Teaching and learning

In the asynchronous learning phase (development phase), the learning content is primarily conveyed by tutorials with accompanying sheets. The videos were recorded as so-called screencasts with insertion of the teacher using the software ***OBS Studio*** and made available directly in the online platform for academic teaching and learning (OPAL) via the Video Campus Saxony. The production and provision of the teaching videos for the individual contents enables the students to work on the learning contents according to their personal prerequisites (learning speed, linguistic competence, etc.) and according to free time management. A consistent structure (introduction, main section and summary) and recurring stylistic elements in the videos provide a structure that students can use to orient themselves relatively easily. The insertion of a camera image into the screen recording makes the videos somewhat more personal and thus more enjoyable for most students, even in times of contact restrictions. The biggest challenge here is the time aspect of video production, which was significantly underestimated initially. In addition to minor technical difficulties such as noise in the home working environment, editing in particular is also very time-consuming. At the same time, the instructors are much more self-critical when re-watching a video with regard to linguistic formulations than in face-to-face events, which often leads to repeated recordings.

At the beginning and end of each semester, a synchronous online meeting takes place in the entire plenum. On the one hand, the first meeting serves to establish personal contact between teachers and students as well as to present and clarify the semester plan and organizational procedures. On the other hand, at the end of the meeting, a survey is conducted

on the previous level of knowledge, organizational and content-related issues, and motivation. The answers are used to better assess the learning group with regard to its performance, so that individual teaching-learning sequences can be adapted as needed. In addition, it has been shown in previous semesters that receiving feedback from students has a positive effect on student motivation and the atmosphere within the course.

Originally, two online meetings in the form of an ***active plenum*** [7] were planned (Tab. 1). In this case, the students are given the opportunity to work together on the solution of a task. A fixed format is used: Presentation of the task and clarification of arising questions in the plenum, work in small groups as well as presentation of the group work and summary in the plenum. The ***Zoom*** conference tool, for example, is suitable for this purpose, as it is comparatively easy to send participants to work in small groups and then bring them back to the plenary session.

This format was particularly popular with the students, and the work results were also far better than expected, which is why this format was prioritized during the semester to the detriment of office hours. The other times of online presence were in the form of 30-minute study group (LG) office hours. Here, students are given the opportunity to ask professional, technical or organizational questions and to clarify misunderstandings. However, this opportunity was only used sporadically. The reason for this was, on the one hand, the partly insufficient preparation of the students and, on the other hand, the need for improvement in the reflection of the individual learning status, which was only achieved to a limited extent through the formulation of open questions. The online meetings at the end of the semester serve to clarify content-related questions and to test the content and technical aspects of the practical part of the exam (mock exam).

During the synchronous events, students are also encouraged to share the camera image in order to create a more personal and thus more pleasant learning environment and at the same time indirectly motivate students to actively participate in the course.

4. Advise and accompany

In addition to online meetings, students essentially receive advising opportunities through synchronous online meetings in individual or small groups. Individual problems can be solved by arranging individual consultation time as online meetings. Furthermore, the module "Forum" is available in the OPAL course, which serves for the exchange among the students as well as for questions to the lecturers and was mainly used with regard to the examination phase.

5. Check and asses

In addition to the summative examination at the end of the semester and the aforementioned survey at the beginning of the course, an informative learning success check based on the internship examples is also carried out in Active Plenary with and without sample solutions. This format provides an opportunity for students to compare their respective learning levels with their peer group of fellow students.

For the preparation of the examination, the established methods of the development and application phase are used. Thus, two ***mock exams*** are offered for parts of the course within the module or subject examination. While the first one primarily addresses the content structure of the questions, the second one is mainly intended to clarify the technical functionality of the online examination. So far, this worked smoothly, and the students were able to cope very well with the tasks, which were very similar to the exercises.

The exam at the end of the semester is a module exam and was conducted this semester as an online exam in the form of an "open book exam". The tasks for the practical part of the simulation technology with Simcenter Femap were set.

Based on the audit results, two main conclusions can be drawn: First, it can be seen that students who actively participated in office hours and active plenaries performed well to very well. Second, students with low participation

Tab. 1: Semester schedule

	Preparation phase			**Application phase**		
	Learning content	Method	Material	Application	Method	Media/ material
1	Enrolment and Overview OPAL Course	Self-study	OPAL	Introduction	Online-meeting	Zoom
2	EET, Graphical User Interface, First Aid	Tutorial	Videos and accompanying sheets (AS)	LG1, LG2, LG3, LG4	Consultation	Zoom, Forum questions Begleitblätter
3	Create or import geometry, meshing, mid-surface modelling	Tutorial	Videos and AS	LG5, LG6, LG7, LG8	Consultation	Zoom, Forum questions AS
4	Task 2.1 Beam elements with constant pipe cross-section: Dead load	Self-study	Task sheet (TS)	LG9, LG10, LG11, LG12	Consultation	Zoom, Forum questions AS
5	Task 2.2 Shaft with variable pipe cross-section: dead load and shear force	Self-study	TS	LG1, LG2, LG3, LG4	Consultation	Zoom, Forum questions AS
6	Task 2.3 Troubleshooting	Self-study	TS	Task 2.2	Active plenary	Zoom
7	Task 2.4 Shell meshing and 1D connections	Self-study	TS	LG5, LG6, LG7, LG8	Consultation	Zoom, Forum questions AS
8	Task 2.5 Mid-surface modelling and parameter study	Self-study	TS	LG9, LG10, LG11, LG12	Consultation	Zoom, Forum questions AS
9	Laminate-Modeller, Solid-Laminate	Tutorial	Videos und AS	LG1, LG2, LG3, LG4	Consultation	Zoom, Forum questions AS
10	Task 2.6 Laminate modelling	Self-study	TS	LG5, LG6, LG7, LG8	Consultation	Zoom, Forum questions AS
11	Task 2.7 Volume modelling	Self-study	TS	Task 2.6	Active plenary	Zoom
12	Task 2.8 Solid laminate modelling	Self-study	TS	LG9, LG10, LG11, LG12	Consultation	Zoom, Forum questions AS
13	Free practice	Self-study	OPAL	Conclusion	Online-Meeting	Zoom
14	Free practice	Self-study	OPAL	Mock exam	Mock exam	Evaluation

have achieved at most satisfactory performance. This group consists mainly of postgraduate students whose native language is not German. Here, it is suspected that students' lack of language skills inhibits their active participation in interactive formats of the application phase, resulting in professional deficits. Although language requirements were taken into account in the teaching videos, only very few students in this group took advantage of the opportunities offered by the consultation hour or the active plenum. The better activation of students with German as a foreign language remains as a didactic challenge.

6. Evaluate and feedback

In addition to the evaluation by the faculty, there was also a continuous evaluation in the application phase. For example, there are always opportunities for queries in the online meetings. The office hours give students opportunities to give feedback to each other and to the instructors. In addition, students were able to compare their learning status by comparing their exercise results with the sample solution or through discussion in the forum.

In addition, student feedback regarding the course was elusive. In the face-to-face discussions of the office hours, methods and materials were rated as "good" or "very good". However, few students actively participated in more structured feedback sessions, such as informal surveys at the beginning or end of a synchronous course. The feedback received was exclusively neutral or positive. Obviously, there is a certain feedback fatigue on the part of the students, because also the survey of the Center for Quality Analysis of the TU Dresden on the course contents specifically on the internship unit could not be statistically evaluated, because less than ten answer sheets were handed in among 80 students enrolled in the OPAL-course.

7. Conclusion

The didactic method of Flipped Classroom offers a number of advantages in the context of digital teaching, such as consideration of different learning paces, and fits well into the dimensions of digital teaching-learning formats. Therefore, it is planned to retain many elements of this teaching format when returning to intensified face-to-face teaching.

Acknowledgement

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Literature

[1] https://www.plm.automation.siemens.com/plmapp/education/femap/de_de/free-software/student

[2] A. Roehl, S.L. Reddy, G.J. Shannon, The Flipped Classroom: An Opportunity To Engage Millennial Students Through Active Learning Strategies, J. Fam. Consum. Sci. 105 (2013), S. 44–49. https://doi.org/10.14307/JFCS105.2.12

[3] M. Kuhtz, R. Kupfer, C. Kirvel, A. Hornig, N. Modler, M. Gude: Das Praktische im Virtuellen – digitale Lehre am ILK. In: S. Odenbach (Hg.): Lessons Learned Band 1. https://doi.org/10.25369/ll.v1i1/2.28

[4] B. Kruppke: Der Mix macht's – Asynchron, synchron, inverted … von der Folienvertonung bis zum Experiment. In: S. Odenbach (Hg.): Lessons Learned Band 1. https://doi.org/10.25369/ll.v1i1/2.2

[5] E. Schoop, R. Sonntag, M. Altmann, W. Sattler: Stell Dir vor, es ist „Corona" – und keiner hat's gemerkt. In: S. Odenbach (Hg.): Lessons Learned Band 1. https://doi.org/10.25369/ll.v1i1/2.33

[6] K. Falconer, S. Hoffmann, A. Schadschneider: Lehre an Schulen und Hochschulen in Zeiten von Corona – Ein Erfahrungsbericht aus Sicht der Physikdidaktik. In: S. Odenbach (Hg.): Lessons Learned Band 1. https://doi.org/10.25369/ll.v1i1/2.29

[7] S. Richter: Lessons Learned an der DIU. In: S. Odenbach (Hg.): Lessons Learned Band 1. https://doi.org/10.25369/ll.v1i1/2.15

[8] L. Berger, J. Grzega, C. Spannagel (Hg.) (2011): Lernen durch Lehren im Fokus. Berichte von LdL-Einsteigern und LdL-Experten. Ein Workshop-Band zum LdL-Tag 2009 an der Pädagogischen Hochschule Ludwigsburg. Berlin: epubli GmbH.

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Control loop test - “from prototype to mass production”

L. Selzer*, B. Bust, J. Morich, S. Odenbach

Professorship for Magnetofluid Dynamics, Measurement and Automation Technology, Institute for Mechatronic Mechanical Engineering, Faculty of Mechanical Engineering, TU Dresden

Abstract

Aufgrund der Restriktion von Präsenzveranstaltungen ab dem Sommersemester 2020 sind die Praktika der Vorlesung „Mess- und Automatisierungstechnik” von Laborversuchen, die am Lehrstuhl durchgeführt wurden, hin zu Heimversuchen überarbeitet worden, die von zu Hause aus absolviert werden können. Bei der ersten Generation von Praktikumsversuchen dieser Art wurde auf eine Voll- oder Teildigitalisierung von ursprünglichen Versuchen, sowie der Neuentwicklung von Versuchen gesetzt, wobei gängige Alltagsmaterialien für die Versuche verwendet wurden, um den Materialaufwand von Seiten des Lehrstuhls zu minimieren. In der zweiten Generation sollte ein Materialpaket erstellt werden, welches in der Form eines Experimentierkoffers für die Durchführung vom Lehrstuhl ausgeliehen wird. Der Regelkreisversuch stellt einen dieser „Koffer-Versuche” dar und hat die Anwendung, Einstellung sowie Charakterisierung verschiedener Regler zum Inhalt. Die Entwicklung des Regelkreisversuches, sowie eine detaillierte Durchführung des Versuchs sollen in diesem Beitrag erläutert werden.

Due to restrictions in face-to-face teaching with the summer semester of 2020, the practical courses of the lecture "measurement and automation technology" got restructured from lab courses being performed at the institute to "at home" courses, which can be done by the students from their own home. In the first generation, existing courses received a full or partial digitalization and new courses were developed, which used everyday items. All these courses did not require any materials provided by the institute. For the second generation of "at home" courses a material bundle was designed, which students could borrow from the institute in the shape of a suitcase. The control loop course is one of these suitcase courses and encompasses the application, tuning and characterization of various control loops. The development of the control loop course, as well as a detailed testing of the course are part of this article.

*Corresponding author: Lukas.Selzer@tu-dresden.de

1. The initial situation

At the Chair of Magnetofluid Dynamics, Measurement and Automation Technology, due to the restrictions of classroom lectures for the summer semester 2020, practical experiments of the lecture "Measurement and Automation Technology" (MAT) were changed into home experiment variants, whenever this was possible with relatively little material resources. This was done either by using materials that can be found in the student environment, such as a smartphone camera for an experiment in digital image processing, or by completely digitizing experiments that had a high digital content in the original version, such as measurement dynamics [1]. However, for the summer semester 2021, practical experiments ought to be developed in which the materials are provided in the form of an experimental kit that can be borrowed from the chair and returned after completion of the practical course. Since it was also necessary to take into account those who could not do so due to their social situation, for example because they were no longer in the immediate vicinity, a do-it-yourself variant was also developed at the same time. The people concerned had to buy the necessary materials themselves and were thus still able to carry out the experiments. The basis of the experiments was the use of Arduino microcontrollers. The control loop experiment represents an experiment that was revised for this purpose and whose redevelopment will now be described in more detail below.

2. The original control loop test

First, the original control loop experiment will be described. This represents one of the first practical experiments developed at the chair and deals with PID controllers, their settings and the behavior of the system with different controller parameters. The experiment is made of a Plexiglas pipe (plant) into which water is pumped from a bucket via a submersible pump. The water level (controlled variable x) is determined by a pressure gauge and the output of the submersible pump (manipulated variable z) is controlled by a regulator according to the setpoint. The original setup is shown in Fig. 1 shown.

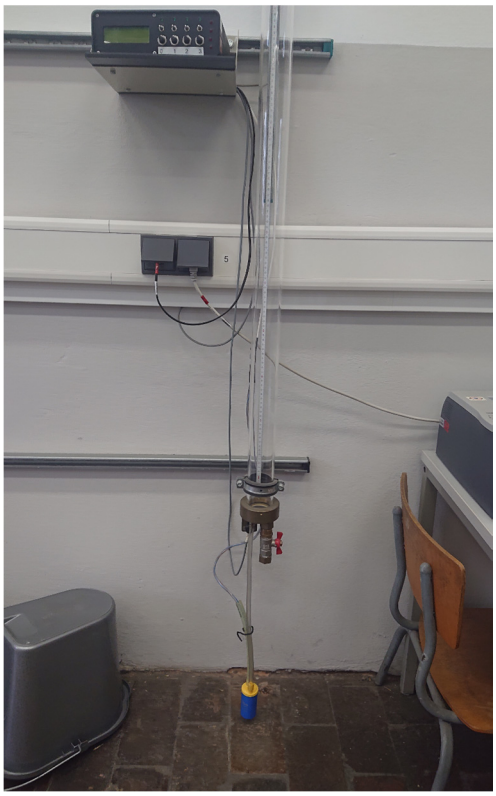

Fig. 1: Original control loop test with plexiglass pipe, submersible pump, valve and the controller box.

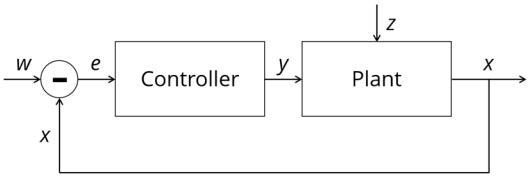

Fig. 2: Schematic representation of a control loop with the setpoint w, the controlled variable x, the control deviation e, the manipulated variable y and the disturbance variable z.

A schematic of a control loop is shown in Fig. 2. A great deal of this experiment is focused on the evaluation of the system responses for given controller parameters, but not on the various methods of determining the parameters themselves. The controller therefore remains a kind of "black box" in which the parameters are entered. Due to the large pipe diameter, the setup is also relatively slow, resulting in long execution times.

3. The first prototype

The new experimental setup was supposed to fit into a suitcase if possible, to have a faster performance and to allow a higher level of interaction with the controller itself. The first

prototype was made of a high-temperature pipe (plant), with the fan of a hair dryer at the lower end of the pipe, and a Styrofoam ball inside the pipe. Two cardboard boxes were used to hold the setup. An Arduino was used to measure the ball distance (d, controlled variable x) from the upper end of the pipe to the upper side of the Styrofoam ball by an ultrasonic sensor and the power of the fan was controlled by pulse width modulation (PWM, controlled variable y) accordingly. The set distance could be varied by a potentiometer. For the PID controller, the open-source library "Arduino PID Library" by Brett Beauregard was used, which covers the required functionalities [2]. Since the ball distance is measured and decreases with higher power of the fan, the PID controller is used in an inverse mode.

Fig. 3: Components of the first prototype consisting of a high-temperature pipe, a hairdryer fan, a Styrofoam ball, an Arduino and an ultrasonic sensor. The breadboard simplifies the wiring of all components. A 3D-printed socket is used to attach the fan to the pipe.

The change of medium from water aimed to significantly recuce the execution times, but also changed the physical relationships of the controlled variable and the manipulated variable. In the case of the water pipe, the pressure increases linearly with the water level and the power required by the pump. This linear relationship of controlled and manipulated variable is important for a PID controller. In the case of the air pipe, on the other hand, the pressure is constant along the length of the pipe, so that for the polystyrene ball with the buoyancy force F_A and the gravitational force F_G there are three cases to be considered:

- $F_A < F_G$: the ball falls
- $F_A = F_G$: the ball remains in its position
- $F_A > F_G$: the ball rises

However, this non-linear relationship between ball distance and motor power can be avoided by making holes in the high-temperature pipe along the length of the pipe. The pressure losses along these holes result in a linear relationship between motor power and ball distance. Thus, with this prototype, the ball distance could now be controlled with the help of a PID controller.

4. The mass product

While the first prototype represented a good milestone and proof of concept, it could not be manufactured in a high quantity, since, for example, removing the fans from 400 hair dryers is not economically or logistically feasible. In addition, the provisional mount made of cardboard boxes ought to be replaced by a more stable structure and a light barrier to be added to the setup to enable accurate load shedding tests. PC fans came forward as a replacement for the hair dryer fans, since they have a standardized size with a hole pattern, which simplifies the development of a mount. However, a high maximum airflow of the fans was required compared to normal use, while noise generation could be neglected. This significantly limited the models that could be used. For the production of the mount, it various manufacturing methods were found unsuitable, since, for example, 3D printing and the milling of many parts would have involved long manufacturing times and high personnel costs. However, high-output methods, such as injection molding, were also ruled out due to the finite number of pieces. Therefore, threaded rods, laser-cut steel plates and nuts were used to take advantage of the hole profile of the fans to obtain a stable experimental setup, as shown in Fig. 4.

The high-temperature pipe was replaced by a Plexiglas pipe, which makes the experiment much more vivid due to its transparency. Instead of holes, slots were milled in the sides and another opening at the bottom of the pipe.

An orifice can be inserted here to restrict the air flow and is registered electronically by a light barrier. In addition, a bridge for the ultrasonic sensor was glued on. The production of

the pipes required a large part of the manufacturing time due to the complex manual procedures involved. The potentiometer for changing the setpoint is no longer required, as this is now changed purely via the software.

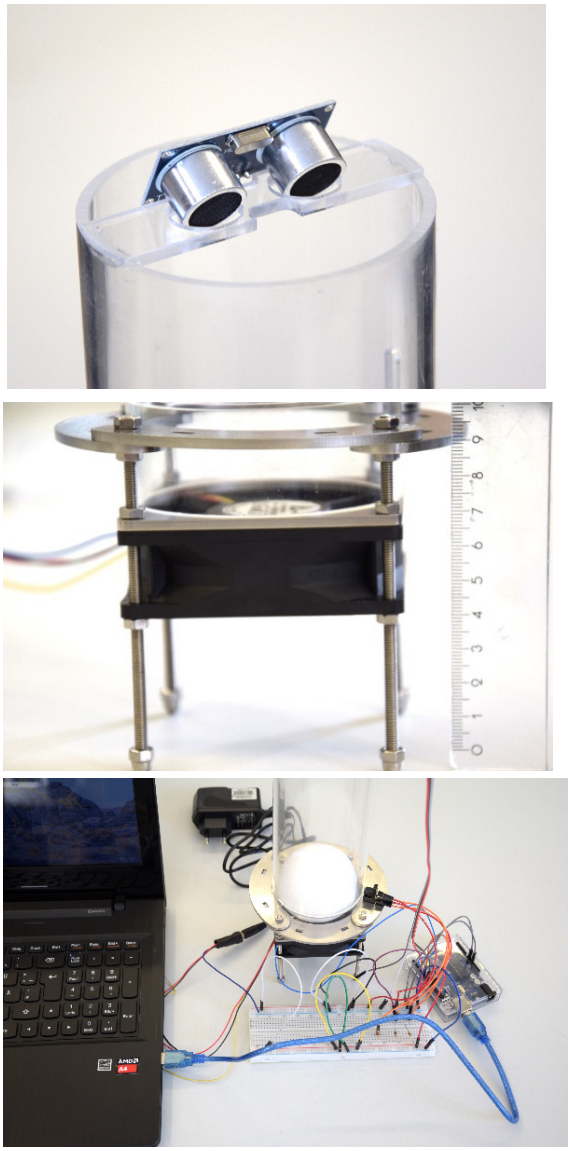

Fig. 4: From top to bottom. Upper end of the Plexiglas pipe with ultrasonic sensor. Lower experimental setup consisting of fan, threaded rods, nuts and laser-cut steel plates. Fully wired experimental setup.

5. The do-it-yourself variant

For those who could not get access to experimental suit cases, a special instruction was created describing an alternative experimental setup. This represents a mixture of the first prototype and the experimental setup given out at the end. The materials for this must be organized independently.

Fig. 5: Student's setup from a high-temperature pipe and clamping components [3.]

The same electrical components are used, but a high-temperature pipe or a cardboard pipe with a hole pattern is used as a controlled system, to which the fan is attached with adhesive tape. Cardboard boxes or books are suggested as mounts. In general, improvisation and personal engineering solutions were allowed here.

An outstanding student's setup using building blocks and a high-temperature pipe about one meter long is shown in Fig. 5 shown. A detailed view of the base is shown in Fig. 6. Because of the pipe length, the beam angle of the ultrasonic sensor was reduced to increase the

range of the sensor, as shown in Fig. 7. This example shows that very creative and sophisticated solutions can be stimulated with the help of the experimental and special instructions.

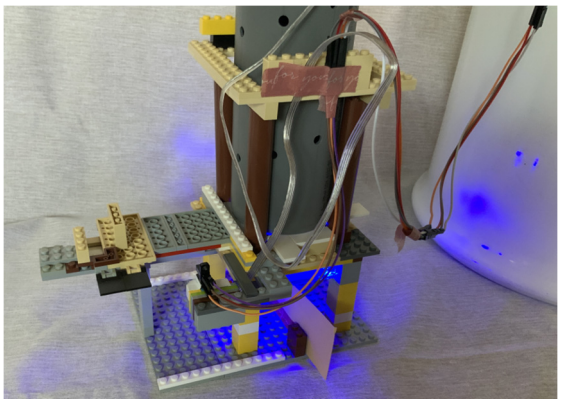

Fig. 6: Detailed view of the lower base [3].

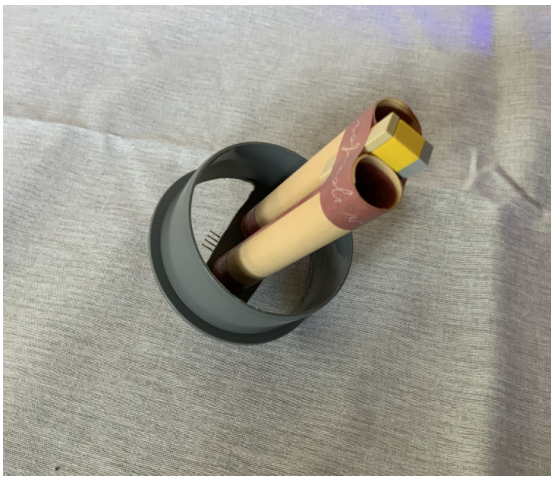

Fig. 7: Ultrasonic sensor with reduced beam angle for range extension [3.]

6. The didactic concept

Since system responses are now also handled by other experiments, the focus of the new control loop experiment should rather be on controllers in general and the PID controller and its setting in particular. Programs for the Arduino are provided by the chair for all tasks. Individual programming knowledge is not necessary for the execution of the experiment in advance, but the logic of the programs used must be understood so that small changes can be made, such as the insertion of numerical values. First, the controlled system must be characterized. For this, different powers of the fan are set, and the heights reached by the Styrofoam ball are measured. The relationship is then shown in a diagram. From the values determined, the operating range of the controller and important parameters for the further experiments are obtained, which must be noted. Now a simple two-point controller is measured and extended by a hysteresis. The measured curves are again to be displayed in a diagram and the frequency and amplitude of the oscillations are to be determined. As a transition from the two-point controller to the PID controller, a pure P controller is now used, whose three limiting cases of a subcritical, critical and supercritical controller gain are investigated. A presentation with diagrams is made to compare the cases. According to Ziegler and Nichols, the critical behavior can be used to determine the controller parameters of a PID controller, which will be used for the next experiment [4]. The self-determined PID controller is now characterized by recording a step response and load shedding of the system, plotting it and evaluating it using common criteria. An alternative method of determining parameters is shown by recording an uncontrolled step response of the system and determining proportionality and time constants from this system response, which allow PID parameters to be determined using the lambda method [5]. These settings will also be tested using controlled step response and load shedding. Lastly, the two controllers created according to Ziegler and Nichols and according to Lambda will be compared and discussed. Optional tasks, such as the variation of the hysteresis in the case of the two-point controller or the optimization of the controller parameters are an opportunity to familiarise oneself with controllers even more, depending on the individual interest.

7. The correction

Since approximately 500 persons participate in the practical course and approximately 250 protocols have to be corrected due to groups of two, the correction should be made as simple and time-effective as possible in order to minimize the time burden on the staff of the chair. Therefore, a high focus is put on diagrams in the tasks, because they straightforwardly point the correct execution of the experiment to the supervisors. A sample proto-

col was given in which diagrams and measured values had to be entered at corresponding placeholders. Open questions were only asked in a few places in order to avoid lengthy texts with higher correction effort.

8. The test

In the following the experiment is tested in detail, whereas the procedure used for this is beyond what is expected and required in the student execution of the practical course. The Arduino programs provided to the students were modified so that during a measurement the parameters are automatically changed incrementally according to time intervals, which allows fully automatic data recording with the exception of load shedding. The evaluation was performed via a Python script.

The characterization

To characterize the controlled system, the PWM value used to adjust the fan power was increased from 120 to 255 in increments of 2.5 every 30s. The mean values and the twofold standard deviation were determined for the ball distance d while the data for the first 10s per PWM value were discarded to consider only the equilibrium condition. The variation of the ball height *h* for the different PWM values is shown in Fig. 8. Initially, the ball remains at rest until it begins to float at PWM_{min} and above. The ball increases relatively linearly with the PWM-value until the upper end of the pipe is reached. Since the slots are not continuous, a more complex oscillating floating behavior of the ball occurs here, since the flow is dependent on the ball position itself. At higher PWM-value, the ball is pressed towards the ultrasonic sensor and falls below the minimum distance of the sensor. This leads to strongly fluctuating measurement results of the sensor. At even higher PWM-values this behavior does not change. PWM_{max} now represents the maximum PWM-value at which the ball still floats stable and does not fall below the minimum distance of the sensor. The change of the measurement fluctuation can be used as a determination criterion for PWM_{max} . The value of PWM_{max} is thus the highest PWM value at which there is still a significant distance, i.e. it is greater than its twofold standard deviation$_d$:

$$d > 2\sigma_d \tag{1}$$

The values of d_{max} and PWM_{min} were determined iteratively. First, the distance at the lowest PWMvalue was taken as the maximum distance d_{max} and the ball height *h* was calculated from the difference:

$$h = d_{max} - d \tag{2}$$

For PWM_{min} , the first PWM value at which there was significant ball hovering was used:

$$h > 2\sigma_d \tag{3}$$

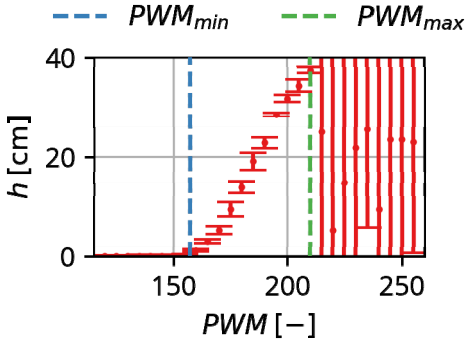

Fig. 8: Characterization of the controlled system. Plotted is the ball height against the used PWM-values.

Tab. 1: Values determined from the characterization.	
d_{max}	$(43{,}3 \pm 0{,}1)$ cm
$2\bar{\sigma}_d$	1,2 cm
PWM_{min}	157,5
PWM_{max}	210

Subsequently, d_{max} was calculated as the mean value of all values $PWM<PWM_{min}$ and the procedure was carried out again until convergence. In addition, the mean variation $2\bar{\sigma}_d$ for all *d* from PWM_{min} to PWM_{max} was determined. This is an indicator of how stable the setup is without a controller. The determined values are summarized in Tab. 1.

The two-point controller

Subsequently, a two-point controller with the determined values PWM_{min} and PWM_{max} and different hysteresis widths d_H was tested. For this purpose, values for $30\ s$ per each d_H were recorded and were ranged from $d_H = 0$ cm to $d_H = 24$ cm in steps of 4 cm. The time curve of h and the PWM-values for $d_H = 0$ cm is shown

in Fig. 9 is shown. The ball height shows a harmonic oscillation, while the PWM values show a square wave.

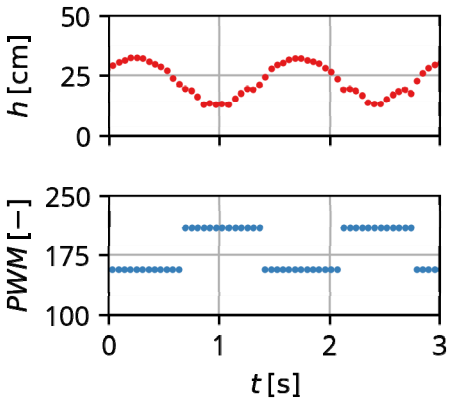

Fig. 9: Temporal progression of the height and PWMvalues for a two-point controller without hysteresis.

For the evaluation of the hysteresis influence, the frequency and amplitude of the oscillations were determined. Here, the first 10 s per d_H were discarded in order to consider only the equilibrium state. First, the difference of an oscillation to its mean value was formed and the zero points were determined, with a filter reducing closely spaced zero points caused by signal noise to a single zero point.

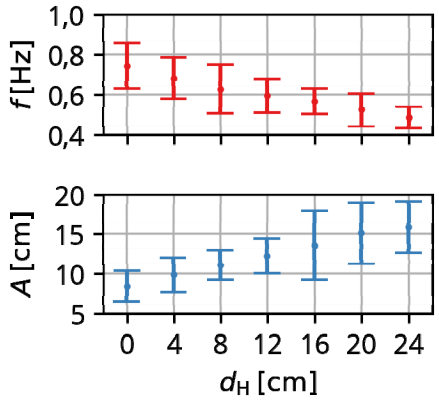

Fig. 10: Frequency and amplitude of the two-point controllers with increasing hysteresis width.

The period was determined by taking twice the mean temporal difference of the zero points and the frequency as the reciprocal. The mean values of the maximum amplitude between the zero points were determined as the amplitude of the oscillation. The frequencies and amplitudes are plotted in Fig. 10 against the hysteresis width. The frequency decreases with d_H while the amplitude A increases.

The P controller

For the determination of the critical controller gain $K_{P,Krit}$ first a pure proportional controller from $K_P = 1\ \mathrm{cm}^{-1}$ to $K_P = 15\ \mathrm{cm}^{-1}$ was tested and it was visually determined when an oscillation approximately starts. Subsequently, a series of measurements from $K_P = 2{,}5\ \mathrm{cm}^{-1}$ to $K_P = 5\ \mathrm{cm}^{-1}$ in steps of $0{,}1\ \mathrm{cm}^{-1}$ with each 30 s per K_P-value was performed. For the evaluation, the first 10 s per K_P-value were discarded to avoid effects from transient behavior.

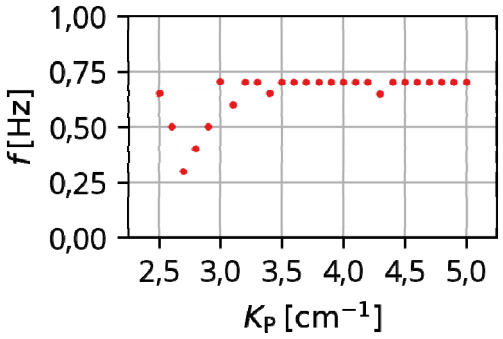

Fig. 11: Frequencies each with the maximum amplitude from the Furier transform for pure P controllers over different values of K_P.

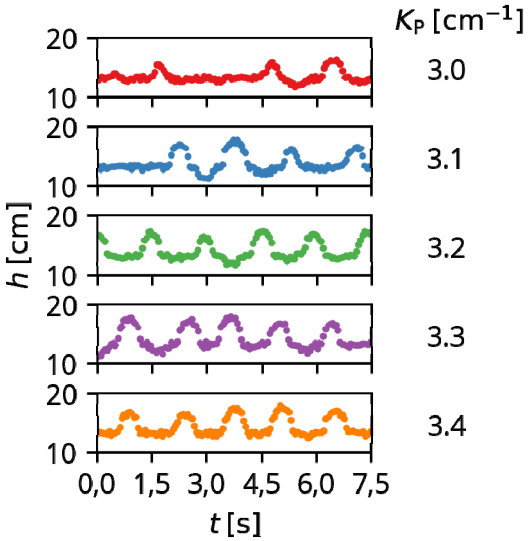

Fig. 12: Temporal progression of the height of a P controller with $K_P = 3{,}0\ cm^{-1}$ to $K_P = 3{,}4\ cm^{-1}$.

For each K_P-value, a Fourier transform was performed and the frequency with the largest

amplitude in the frequency spectrum was determined. The determined dominant frequencies are shown in Fig. 11. For K_P-values above $3\ \mathrm{mm^{-1}}$ a frequency of about $0{,}7\ \mathrm{Hz}$ stands out, while at low K_P-values, especially when looking at the frequency spectra themselves, rather random frequencies are present.

For a more precise determination, the curve progressions in the range from $K_P = 3{,}0\ \mathrm{cm^{-1}}$ to $K_P = 3{,}4\ \mathrm{cm^{-1}}$ are considered, as shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**. Here it can be seen that a stable harmonic oscillation only starts with $K_{P,Krit} = 3{,}2\ \mathrm{cm^{-1}}$. The period duration is $T_{Krit} = 1{,}46\ \mathrm{s}$.

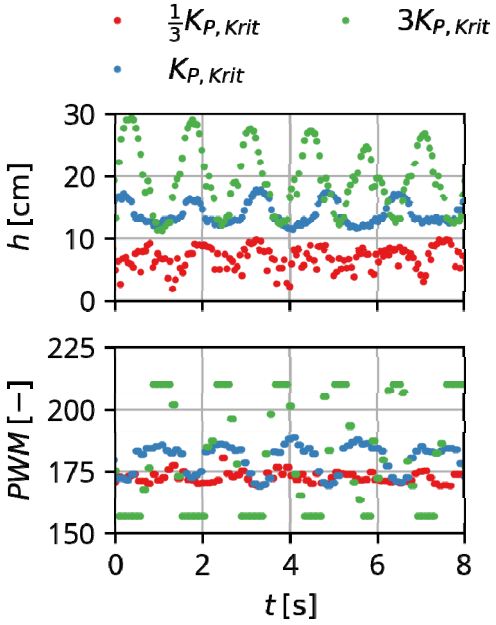

Fig. 13: Temporal progression of the height and the PWM-values of P controllers with subcritical, critical and supercritical controller gain.

To illustrate the P controller, controllers with subcritical, critical and supercritical controller gain were now tested. The time curves of h and PWM are shown in Fig. 13. For the subcritical behavior, both h, as well as PWM are nearly constant, with minor fluctuations occurring. In the case of critical behavior, these both form a harmonic oscillation, whereby these are shifted by $180\,°$ out of phase. The phase shift results from the calculation of h. For the supercritical behavior the mean height, as well as the amplitude of the oscillation increases. For the PWM-values, a transition from a harmonic oscillation to a rectangular oscillation becomes apparent.

The Ziegler-Nichols setting

With $K_{P,Krit}$ and T_{Krit} the controller parameters according to Ziegler and Nichols can be determined. The parameters are listed in Tab. 2. With the controller parameters set, three step responses were now carried out by changing the setpoint value d_S from $35\ \mathrm{cm}$ to $15\ \mathrm{cm}$.

Tab. 2: Values from the critical behavior and controller parameters according to Ziegler and Nichols.

$K_{P,Krit}$	$3{,}2\ \mathrm{cm^{-1}}$
T_{Krit}	$1{,}46\ \mathrm{s}$
$K_P = 0{,}6K_{P,Krit}$	$1{,}92\ \mathrm{cm^{-1}}$
$K_I = 1{,}2\frac{K_{P,Krit}}{T_{Krit}}$	$2{,}69\ \mathrm{cm^{-1}s^{-1}}$
$K_D = 0{,}075K_{P,Krit} \cdot T_{Krit}$	$0{,}34\ \mathrm{cm^{-1}s}$

The following parameters are determined for evaluation:

- σ_s, the standard deviation in the controlled state after the step in the equilibrium state.
- x_{os}, the relative height of the maximum overshoot, normalized to the setpoint value
- t_1, the time after which the $\pm 7{,}5\%$-band of the set point is reached for the first time.
- t_2, the time after which the $\pm 7{,}5\%$-band is kept at all times

The curves and mean values of the parameters are shown in Fig. 14. The step responses are quite reproducible in their dynamics despite fluctuations before the step. The parameters with statistical uncertainties are listed in Tab. 3. The shape is characterized by an overshoot of $14{,}1\ \%$ with a characteristic exponential decrease of the oscillation. The ball reaches the $\pm 7.5\ \%$-band after $732\ \mathrm{ms}$ and stays within it at all times after $1390\ \mathrm{ms}$. A metal shutter was used to throttle the airflow and load shedding was performed by pulling the shutter. For evaluation σ_s, x_{os} and t_1 are determined, where t_1 represents the time from which, after the overshoot, the $\pm 7{,}5\ \%$-band is reached again for the first time. The curves and mean values of

the characteristics are shown in Fig. 15. In the curves, there is initially an overshoot of 49,1 %. The ball reaches the ±7.5 %-band after 1200 ms but a relatively strong oscillation occurs afterwards, which leaves the ±7,5 %-band several times. This oscillation does not decrease with time. The determined parameters with statistical uncertainties are listed in Tab. 4.

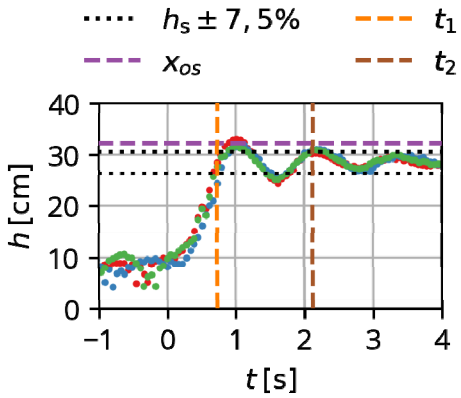

Fig. 14: Temporal progressions of three step responses and the mean values of the characteristic parameters for the controller according to Ziegler and Nichols.

Tab. 3: Evaluation of the jump tests for the controller according to Ziegler and Nichols.	
σ_s	$(1,6 \pm 0,1)$ cm
x_{os}	$(14,1 \pm 3,7)$ %
t_1	(732 ± 92) ms
t_2	(1390 ± 470) ms

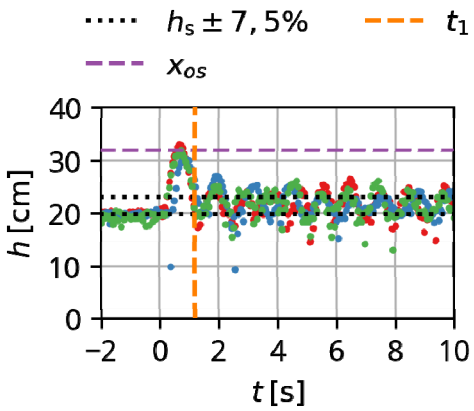

Fig. 15: Temporal progression of three load sheddings, as well as the mean values of the characteristic parameters for the controller according to Ziegler and Nichols.

Tab. 4: Evaluation of the load shedding for the controller according to Ziegler and Nichols.	
σ_s	$(7,4 \pm 2,2)$ cm
x_{os}	$(49,1 \pm 9,3)$ %
t_1	(1200 ± 140) ms

The lambda setting

In addition to the critical method, the controlled system can be characterized by means of an uncontrolled step response, where the specified PWM-value is changed. Three step tests are shown in Fig. 16.

The following parameters are determined for the characterization:

- $K' = \frac{\Delta h}{\Delta PWM}$ the quotient of the output and input value change
- t_t the delay time of the system until there is a significant change from h
- τ the time needed after the delay time until $0{,}63\Delta h$ is reached

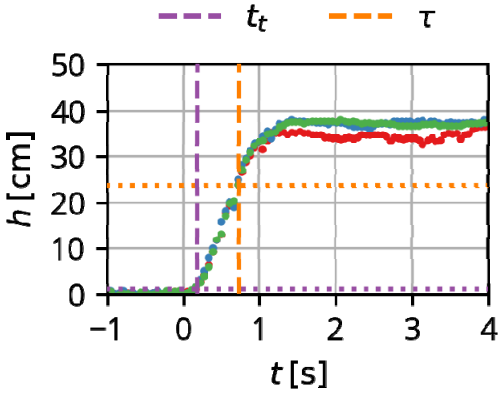

Fig. 16: Temporal progression of three uncontrolled step responses to characterize the controlled system.

The controller parameters can be determined from these values according to the lambda setting. The values and parameters are listed in Tab. 5. For the calculation of K_C a $N = 3$ was chosen, which should lead to a slow but stable controller. As with the Ziegler-Nichols setting, the controller is tested with a jump test and a load shedding. The curves of the step response tests are shown in Fig. 17 and their step responses are listed in Tab. 6.

Compared to the Ziegler-Nichols setting, the controller is much slower. The ±7,5 %-band is reached only after 2560 ms which corresponds

Tab. 5: Values from the uncontrolled step response and controller parameters after lambda adjustment.	
K'	$(0.69 \pm 0{,}02)$ cm
t_t	(187 ± 26) ms
τ	(551 ± 46) ms
$K_C = \frac{\tau}{K'(N\tau + t_t)}$	$0{,}43\ \mathrm{cm^{-1}}$
$K_P = K_C$	$0{,}43\ \mathrm{cm^{-1}}$
$K_I = \frac{K_C}{\tau}$	$0{,}78\ \mathrm{cm^{-1}s^{-1}}$
$K_D = 0$	$0\ \mathrm{cm^{-1}s}$

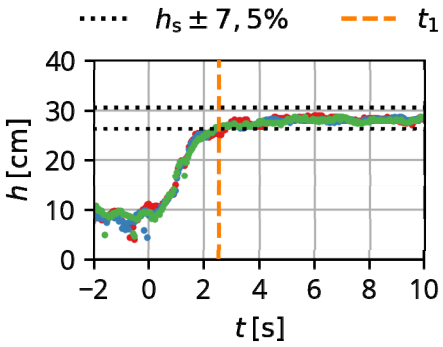

Fig. 17: Temporal progression of three step responses and the mean values of the parameters for the lambda setting.

Tab. 6: Evaluation of the step test for the lambda setting.	
σ_s	$(1{,}3 \pm 0{,}2)$ cm
x_{os}	(0 ± 0) %
t_1	(2560 ± 340) ms
t_2	(0 ± 0) ms

to three and a half times the duration of the Ziegler-Nichols setting, but is not left afterwards at any time. In addition, there is no overshoot and the oscillation in the equilibrium state is smaller. The curves of the load shedding are shown in Fig. 18 and their parameters are listed in Tab. 7. The load shedding shows a slightly higher overshoot of 66,3% and it takes 3840 ms until the setpoint is reached again. On the other hand, the oscillation after load shedding is only about half as large as the one observed with Ziegler and Nichols. The Lambda setting is therefore slower and more susceptible to external disturbances, but avoids overshoots when reaching a setpoint and is then more stable. The two methods have different fields of application. Parameters according to Ziegler and Nichols are easier to determine and a faster controller is obtained. However, this requires a robust system which is not damaged by oscillation or overshoots. With the Lambda settings, on the other hand, overshoot can be avoided. However, the determination procedure is more complicated and the controller is slower and more sensitive to disturbances. In general, the determination methods shown are rather the starting points for a manual optimization of the controller parameters for a specific application.

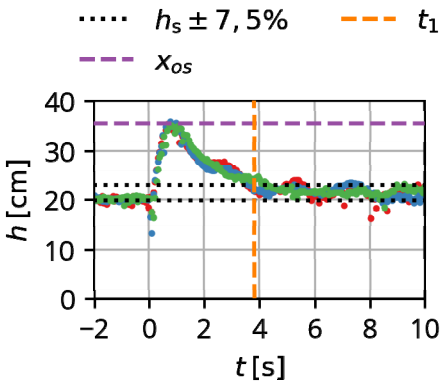

Fig. 18: Temporal progression of three load shedding events and the mean values of the parameters for the lambda setting.

Tab. 7: Evaluation of the load shedding for the lambda setting.	
σ_s	$(3{,}7 \pm 0{,}3)$ cm
x_{os}	$(66{,}3 \pm 1{,}4)$ %
t_1	(3840 ± 670) ms

9. The student implementation

The lab course was carried out in the summer semester of 2021. Findings from this performance as well as findings from the experiment described here were used to revise the instructions and the tasks, whereby differences to our own experiment will be explained in more detail below. The students are in the 6th semester when carrying out the experiment, so that deeper programming knowledge such as the use of program loops cannot be assumed. Instead, the intention is to experiment with the programs provided by manually editing the numerical values and observing their effect on the experimental setup. First experiences with

an Arduino will be acquired in other previous experiments. While with program loops the possible power range of the fan can be fully observed automatically, simply running such programs would not be very interactive and would not lead to much involvement of the participants. By varying the values manually, the characterization of the controlled system has an exploratory character and considerations have to be made about the reasonable distribution of the measurement points to fulfill the task. Thus, in the vicinity of PWM_{min} or PWM_{max} higher measuring point densities may be considered, while a lower density is sufficient for the linear range in between. Due to the time frame of the experiment, only an introduction of a hysteresis was required in the case of the two-point controller, but not the variation of the hysteresis width, as it was done here. As an optional task, however, a further hysteresis width can be tested out. In a group of participants as a sample ($N = 29$) an average of $55\ \%$ of the points of this optional task were achieved. As in the case of the characterization of the controlled system, $K_{P,Krit}$ could be determined by a program loop, but the manual determination trains the estimation of and approximation to values. In addition, no handling of Fourier transforms, as it was exercised here, can be expected, so that instead a keen observation is more important. An obstacle here, however, was the transient process, since this allows an oscillation to be observed, which decays over time. As a result, lower $K_{P,Krit}$ were determined in the student execution in general. After a revision of the instructions, explicit reference is now made to the transient response. Originally, for step response and load shedding a $\pm 5\%$-band was suggested, but it became apparent, especially with the Ziegler-Nichols setting, that this, depending on the choice of $K_{P,Krit}$ is too small of a tolerance band, so that now generally a $\pm 7{,}5\%$-band is suggested for the test. In some cases, Ziegler-Nichols settings showed a very unstable behavior when a too high $K_{P,Krit}$ was used by the students. The evaluation of the data and the creation of diagrams were carried out in the student evaluation with the aid of spreadsheet programs in general and in exceptional cases with Matlab. The optimization of a controller represented a further optional task, while in the sample on average only $25\ \%$ of these points were achieved. However, compared to the other optional task, this task also represents a considerable additional effort. Overall, with $83\ \%$ of the points to be achieved in the sample, the tasks were well fulfilled by the participants, with about $6\ \%$ of these points coming from the optional task parts. The issuing and return of the experimental suite cases took place without major difficulties. Grades were not recorded until the experimental kit was returned in its entirety. About 10 Arduinos had to be replaced, while defects may have already existed at the factory level, since for time reasons not all Arduinos could be tested prior to issuing. On the other hand the plugging of the $12\ \mathrm{V}$ fan power supply to the $5\ \mathrm{V}$ input of the Arduino is another possible cause. In the instructions it is now explicitly pointed out not to do this.

10. The conclusion

With the control loop experiment shown here, an old experiment of the chair was redeveloped. Due to the change of the medium, the experiments can be carried out more quickly. With the exception of the pipe, the experiment is very compact and part of the experimental case of the chair. The special instructions make it possible to set up an equivalent setup with one's own materials and carry out the experiment even without the experimental kit. From a didactic point of view, the students are led from a simple two-point controller via a P-controller to a PID-controller and learn about the characterization and various setting rules of these controllers. As can be seen from the results shown here, very different controllers can be well illustrated with this setup. In the MAT practical course of the summer semester 2021, the experiment was successfully carried out with 400 students, and findings from this implementation were incorporated into a revision of the instructions and task definition. The exact measured values of a setup can vary depending on the fan and the quality of the setup, such as the inclination of the pipe, so that each student group has a setup with individual values.

Acknowledgement

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Literature

[1] S. Odenbach, L. Selzer, and J. Morich, "Internship without presence - is it possible?," Lessons Learned, no. 1, pp. 1-2, 21 07 2021.
[2] B. Beauregard, "Arduino PID Library," [Online]. Available: https://github.com/br3ttb/Arduino-PID-Library.
[3] Photos: K. Kaden and K. Klinkicht. Private correspondence
[4] Ziegler J.G. and Nichols N.B., Optimum settings for automatic controllers, Trans. ASME, pp. 759-768, 1942
[5] Dahlin E.B., Designing and Tuning Digital Controllers, Instr and Cont Syst, 41 (6), 77, 1968.

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Cheating in Higher Education Teaching:

Classification of the current situation at TU Dresden and derived possibilities for action

C. Böhm, A. Jantos*, K. Lauber

ZiLL - Center for Interdisciplinary Learning and Teaching, Technische Universität Dresden

Abstract

Seit dem Sommersemester 2020 werden an der TU Dresden, sowie fast allen deutschen und internationalen Hochschulen, Prüfungen zum wesentlichen Anteil digital durchgeführt. Diese Veränderung in der Prüfungslandschaft, auch an der TU Dresden, hat unweigerlich bereits bekannte, aber auch neue Fragen zur Planung und Durchführung betrugssicherer (digitaler) Prüfungen mit sich gebracht. Diskussionen zu Prävention, Nachweis oder Sanktion von Betrugsversuchen werden mitunter leidenschaftlich geführt, bedürfen allerdings einer evidenzbasierten Grundlage, um die Sachlage angemessen einschätzen und Handlungsmöglichkeiten ableiten zu können. Nachfolgend werden bestehende Erkenntnisse zur aktuellen Situation aus Umfragen an der TU Dresden sowie (inter-)national gebündelt dargestellt, die TUD und eine Fakultät an der TUD unter die Lupe genommen und Handlungsmöglichkeiten abgeleitet sowie einzubeziehende Aspekte der Thematik diskutiert. In diesem Beitrag wird in keiner Weise ein Generalverdacht des Betrugs in digitalen Prüfungen gegenüber Studierenden ausgesprochen. Ziel ist, die Thematik von Betrugsversuchen in digitalen Prüfungen unter einer wissenschaftlichen und didaktischen Brille zu betrachten.

Since the summer semester of 2020, exams at TU Dresden, as well as at almost all German and international universities, have been conducted digitally for the most part. This change in the examination landscape, also at TU Dresden, has inevitably brought with it already known, but also new questions about the planning and implementation of fraud-proof (digital) examinations. Discussions on the prevention, detection, or sanctioning of attempted cheating are sometimes passionate, but require an evidence-based foundation in order to adequately assess the situation and derive possible courses of action. In the following, existing findings on the current situation from surveys at the TU Dresden as well as (inter-)nationally are presented in bundled form, the TUD and one faculty at the TUD are put under the microscope and possibilities for action are derived as well as aspects of the topic to be included are discussed. This article in no way expresses a general suspicion of cheating in digital exams against students. The aim is to look at the issue of attempted cheating in digital exams from a scientific and didactic perspective.

*Corresponding author: anne.jantos@tu-dresden.de

1. Current Situation

The national and international data situation shows an ambiguous picture regarding an increase and decrease or constant numbers of cheating attempts in digital course and exam situations. In this paper, we consider only written exam situations in the higher education context with the target group of students. Cheating is meant as the usage of unauthorized aids or persons to gain an advantage with full knowledge. [adapted from 1 and for higher education context]. Dendir & Maxwell define any form of "academic dishonesty," i.e., any behavior under which one falsely passes off one's academic work as one's own, as cheating [2]. However, Norris cautions that universal definitions are not discoverable, as each institution/faculty/teacher also establishes and communicates their own set of rules [3].

Within the currently expanding data base, the tendency of an increased number of cheating attempts in digital exam settings compared to face-to-face exams becomes apparent: According to a survey of 1608 students at German universities by Janke et al. (2021), 31.7% of the students surveyed report having used unauthorized aids or communicated with other students in face-to-face exams. In online exams, this figure is almost twice as high at 61.4% [4]. It should be noted that no statistics of officially confirmed cheating attempts in face-to-face and digital exams could be found or viewed so far. The following data refers to surveys, comparison of test results, and respondents' self-reports.

Alessio et al. (2017) also show that exam groups that took online exams without proctoring performed significantly better than exam groups with proctoring. The authors concluded that the better test scores of the exam group without proctoring was due to the use of unauthorized aids [5]. King and Case (2014) also find that not only do a higher number of students cheat on online exams, but those who cheat do so with increased regularity (3.3 times per semester) compared to cheating in face-to-face exams within a semester (2.9 times per semester) [6]. The result of increased number of cheating attempts in online exams, compared to face-to-face exams, is also reached by Dendir and Maxwell (2020) [4] or Varble (2014) [7]. At the same time, Weiner and Hurtz (2017) show that there are no significant differences between exam groups working in a PC pool and those taking the exam outside the PC pool - where both groups were under observation with proctoring measures [8]. In contrast to these findings, Ladyshewsky (2015) and Beck (2014) found no differences in test scores between students who wrote proctored face-to-face exams and unproctored online exams [9,10]. However, studies that found no change in test scores included academic cheating in courses overall, not exclusively in exams, as the object of investigation.

2. Factors

Cheating in (digital) exams is studied by Becker et al. (2006) with the help of the "cheating triangle" according to Donald R. Cressey. The following three factors are named as positive predictors for the occurrence of cheating behavior:

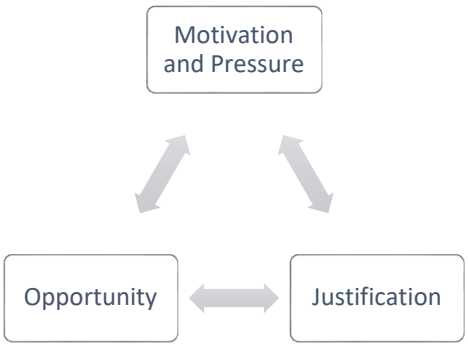

Figure 1: Reasons for cheating in summative exams [11].

The opportunity presents itself if cheating attempts are highly unlikely to be (or cannot be) detected. For example, according to King and Case (2014), 74% of 385 students surveyed reported that it appeared very or relatively easy in their eyes to cheat on online exams [6]. This is especially true in unsupervised exam situations, such as those that necessarily had to be conducted often during spontaneous remote teaching. The factors of motivation, pressure, or necessity may also be invoked in times of pandemic, still unfamiliar teaching and learning situations or restrictions on social contact: For example, it is suggested that students experienced greater difficulty in preparing for

online exams due to changes in family and social circumstances, difficulties with the demands of self-regulated learning, or difficulties with the online exam format, among other factors. The resulting increased pressure can be used as an explanation for a possible increased willingness to cheat, during online exams [4].

Especially at the beginning of the pandemic, the changeover from face-to-face to online teaching was experienced as extraordinarily challenging and exhausting on the part of both teachers and students. This resulted in uncertainty and changed communication patterns [4]. As Arndt et al. (2020) also summarize, many students often felt less prepared for digital exams than for face-to-face exams [12].

Stammen and Ebert (2002) show that there is a possible correlation between uneasiness about insufficient subject exchange in digital teaching-learning settings and the fear of being disadvantaged in digital exams [13]. In contrast, in a survey at the University of Potsdam, instructors were more positive than students about adequate exam preparation through virtual teaching [14]. Justification is given if forms of cheating or cheating per se are compatible with one's own values. If students notice a high degree of cheating among their fellow students, in their course of study, or at the university, a higher tolerance for cheating can arise - or the concern that it is necessary to cheat in exams in order to be able to pass them themselves [15].

In times of pandemic and digital apprenticeship, there may be increased factors that favor the occurrence of fraud attempts. The studies considered in this paper agree with this assumption, with few exceptions. Based on the presented and discussed findings from different surveys, the current situation at the TU Dresden as well as a concrete example from the Faculty of Business and Economics will now be discussed.

3. Situation at the TU Dresden

The Center for Quality Analysis of the TU Dresden conducted a survey among lecturers and students of the TU Dresden on the topic of digital exams in the summer semester 2021 on behalf of the Prorectorate of Education and in cooperation with the Center for Interdisciplinary Learning and Teaching (ZiLL). 62% of the respondents stated that in their estimation digital exam formats lead to cheating (much) more often, 33% estimate that it remained unchanged and 7% have the impression there are fewer cheating attempts. 54% of teachers and students feel, at least in part, that online exams lead to unfair results because of various cheating opportunities.

When fraud was observed, 60% was plagiarism, 10% identity deception, and 54% other methods of deception. For this reason, some auditors decided against digital auditing and even rejected it in general as long as fraud could not be ruled out, because this would make the objectivity of the audit impossible. The main criticism is that the conversion to digital formats, considering the possibility of fraud, would involve a great deal of effort. Under the exception rule in force in the summer semester at the TU Dresden that grades are not binding, this effort is considered too high [16].

4. An example from the Faculty of Business and Economics

A survey at the Faculty of Business and Economics after examinations in the 2020/2021 winter semester revealed that 28% of students gained an advantage in written online examinations with the help of unauthorized aids. The most important motives here were opportunity to cheat, lack of scruples, and the fact that students perceived the exam format as unfair and/or outdated.

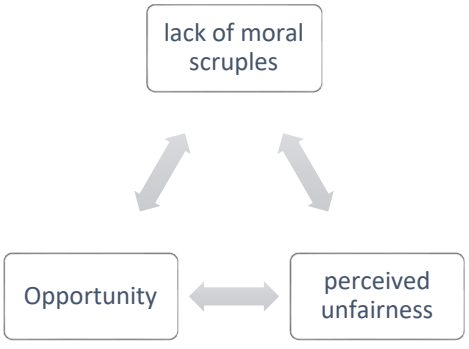

Figure 2: Reasons for cheating in summative exams at the Faculty of Economics of the TUD [17].

More than half of the students who successfully cheated indicated that they were glad they had done so because the exam was perceived as unfair [17].

Faculty members, on the other hand, put in a lot of extra effort to prevent cheating in digital exams. One of the organizational methods to prevent cheating is grouping. This involved examiners putting participants in groups and issuing different versions of an exam to reduce collaborative work. Other common methods included randomizing questions and/or answers in multiple-choice and single-choice questions. The most popular didactic method in economics was raising questions to a higher taxonomy level. Bloom's (1956) six cognitive taxonomy levels help determine different cognitive learning objectives in teaching and testing situations. The taxonomy levels are hierarchical and distinguish different levels of complexity and difficulty [18]. For the most part, fact retrieval was not used. Instead, application and reflection questions were asked. For 7 out of 7 exams, the examiner indicated that there were many opportunities for cheating, especially for unauthorized group work. However, 7 out of 7 examiners also confirmed that the exam could not be passed without good preparation and that both grade point average and failure rate and range of grades were similar to previous years (faculty interviews).

5. Possible courses of action

An effective method to reduce the possibility of cheating in summative online exams is the open-book exam with adaptation of the question taxonomy. In this case, all aids are permitted from the outset and, instead of questions for the reproduction of knowledge, application, transfer, and reflection tasks are set that are based on the course materials and test the students' understanding [18,19,20]. In this context, transparency in the communication of the course and the sequence of tasks is particularly important, because the greatest criticism from students of the Faculty of Business and Economics was the lack of clarity of the exam [21].

A further change in the direction of comprehension testing can be made by having the students create their own tasks according to a certain pattern (e.g. related to a formula that has been discussed). Here, not the memorization of a mnemonic or a formula is required, but the derivation of meaningful tasks related to the same. Furthermore, it is advisable to switch to oral exams, if possible, since this format opens few opportunities for cheating [22].

Changing the examination concept from summative examinations to formative assessment forms promises another sustainable solution, which can also be used in a learner-centered way to enrich teaching [23]. However, this solution usually involves redesigning the entire course and therefore demands increased workload. Whether the effort of such a restructuring is justified, however, must always be examined in detail, since it is highly dependent on framework conditions such as the number of students to be examined, the technical equipment of those involved, the feasibility under the applicable study and examination regulations, time and personnel resources, support possibilities of the teachers, and many more.

6. Discussion

The controllability of online exams is sometimes perceived by teachers as a challenge with regard to online teaching [24]. The term controllability is accompanied by the question of what should be controlled - in the context of online exams, the aspect of equal opportunities for students and their performance is emphasized here [25]. Cheating attempts are therefore in conflict with the desired equality of opportunity for all students under examination conditions.

In addition, the shift towards open source in working and teaching practice must be considered, which manifests itself in the promotion of open educational resources, open access with regard to scientific publications or open content platforms, among other things. The joint development and provision of content that can be reused under certain licensing conditions is moving into the focus of practical working life. A fundamental expression of this change in values is the high value placed on teamwork and cooperative work as soft skills

in work groups and teams. It can be assumed that students must be equipped with these soft skills in the future, i.e. they must have learned and applied them during their studies. If this idea is followed, the question arises as to the competence-oriented design of examination performance - whereby teamwork should come into focus as a competence that is just as serious and fundamental as, for example, professional competence. What would be an attempt at cheating under these circumstances?

The data situation reflects that cheating attempts tend to occur more frequently in unsupervised online examinations and, as shown in the example of the Faculty of Economics, can only be reduced with great effort. Therefore, the question has to be asked which practical definition of cheating in the academic context for measuring the performance of different questions seems to be useful at all with regard to professional practice. However, this will be influenced by various factors such as discipline, subject culture, objectives, subject content, size of the student cohort, etc., and will have to be evaluated in a differentiated manner.

7. Critical View

Finally, we would like to discuss and share some thoughts and conclusions that have emerged for us in the course of dealing with the issue of attempted cheating in digital exams. It is difficult to deal with cheating attempts in online exams without taking a look at cheating attempts in face-to-face exams: Cheating in face-to-face exams has also occurred and continues to occur in varying proportions [4], even if it is made more difficult by proctoring. Presumably, there are also people among the university members who are not (any longer) students who have deposited a cheat sheet in their pencil case, looked at the neighboring table or secretly exchanged information with fellow students during school and/or study times. In some faculties of the TU Dresden it is even allowed to bring along a one-page cheat sheet. It is not the "digital exam" format per se that tempts students to cheat, but rather the context in which exams take place, largely independent of whether they are held in person or digitally. We therefore need a differentiated and open discussion about what kind of examinations or performance measurements will be needed in the future and what the framework conditions for them must look like. We can also ask ourselves how we can move as quickly as possible into types of examinations that develop knowledge, in the examination itself, and thus leave the lower reproductive taxonomy levels of learning.

In times in which questions and problems are becoming increasingly complex, often require interdisciplinary approaches, and the working world increasingly functions digitally and is organized by digital means, it is not so much the ability to replicate as methodological skills, the ability to work in a team, or the understanding of cause-and-effect relationships that appear to be important competencies for later professional activity, but also for assuming social responsibility.

Literature

[1] "Cheating" in Oxford English Dictionary, 3rd ed. Oxford, UK: Oxford Univ. Press, Mar. 2012, def. 2. [Online]. Available: https://www.oed.com. 2021

[2] Dendir, S.; Maxwell, R. S. (2020). Cheating in online courses: evidence from online proctoring. Computers in Human Behaviour Reports, 2. DOI: https://doi.org/10.1016/j.chbr.2020.100033

[3] Norris, M. (2019). University online cheating - how to mitigate the damage. Research in Higher Education Journal Volume 37.

[4] Janke, S.; Rudert, S. C.; Petersen, Ä.; Fritz, T. M.; Daumiller, M. (2021). Cheating in the wake of COVID-19: How dangerous is ad-hoc online testing for academic integrity: Center for Open Science.

[5] Alessio, H. M., Malay, N., Maurer, K., Bailer, A. J., & Rubin, B. (2017). Examining the Effect of Proctoring on Online Test Scores. Online Learning 21 (1), pp. 146-161. https://files.eric.ed.gov/fulltext/EJ1140251.pdf.

[6] King, D.; Case, C. (2014). E-Cheating: incidence and trends among college students. In: Issues in Information Systems 15 (1), 20-27. DOI: 10.48009/1_iis_2014_20-27.

[7] Varble, D. (2014). Reducing cheating opportunities in online testing. In: Atlantic Marketing Journal 3 (3), pp. 131-149. https://digitalcommons.kennesaw.edu/amj/vol3/iss3/9.

[8] Weiner, J. A.; Hurtz, G. (2017). A Comparative Study of Online Remote Proctored versus Onsite Proctored High-Stakes Exams. Journal of Applied Testing Technology, 18 (1), pp. 13-20.

[9] Ladyshewsky, R. K. (2015). Post-graduate student performance in 'supervised in-class' vs. 'unsupervised online' multiple choice tests: implications for

cheating and test security. In: Assessment & Evaluation in Higher Education 40 (7), pp. 883-897. DOI: 10.1080/02602938.2014.956683.

[10] Beck, V. (2014). Testing a model to predict online cheating: Much ado about nothing. Active Learning in Higher Education, 15, pp. 65-75. DOI: 10.1177/1469787413514646.

[11] Becker, D.; Connolly, J.; Lentz, P.; Morrison, J. (2006). Using the business fraud triangle to predict academic dishonesty among business students. In: Academy of Educational Leadership Journal 10 (1), pp. 37-54.

[12] Arndt, C., Ladwig, T., & Knutzen, S. (2020). Between curiosity and uncertainty: internal university surveys of students and faculty in the virtual summer semester 2020: results of a qualitative content analysis. TUHH University Library. DOI: https://doi.org/10.15480/882.3090.

[13] Stammen, K.-H. & Ebert, A. (2020). Still online? Student survey on media technology equipment in the summer semester 2020. Survey period: 29.04 - 17.05.2020. Duisburg: University of Duisburg-Essen. https://panel.uni-due.de/assets_websites/18/StammenEbert_2020_NochOnline_Gesamtbericht.pdf.

[14] Center for Quality Development in Teaching and Learning (2020). Result report on PotsBlitz "Online-Lehre 2020" in SoSe 2020 - General report. Survey period: 04.06. - 21.06.2020. Potsdam: University of Potsdam. https://pep.unipotsdam.de/media/PotsBlitz/Berichte/PotsBlitz_Gesamtbericht.pdf.

[15] Holden, O.; Kuhlmeier, V. A.; Norris, M. (2020). Academic integrity in online testing: a research review: Center for Open Science.

[16] Gaaw, S.; Frohwieser, D.; Lenz, K. (2021). Quick evaluation survey of lecturers and students on digital testing in winter semester 2020/21 - First interim results. Conducted at the Center for Quality Analysis at TU Dresden.

[17] Jantos, A. (2021). Motives for Cheating in Summative E-Assessment in Higher Education - A Quantitative Analysis. 13th International Conference on Education and New Learning Technologies.

[18] Bloom, B. (1956). Taxonomy of Educational Objectives. Handbook 1: Cognitive Domain. London: Longman.

[19] Stollhoff, R.; Jeremias, X.V. (2020). Design and implementation of distance learning examinations at universities. A systematic classification and concrete recommendations motivated by practice.

[20] Anderson, L.W.; Krathwohl, D.R. (2001). A taxonomy for learning, teaching, and assessment. A revision of Bloom's taxonomy of educational outcomes. New York: Longman.

[21] Jantos, A.; Jung, C.; Kohl, A. (2021). Limitations in Written Summative E-Assessment in Higher Education - An Analysis of a Student Survey. In 24th Workshop GeNeMe'2021 Communities New Media.

[22] Jantos, A. (2020). Conducting Oral Interviews Virtually using MS Teams. In 23rd GeNeMe'2020 Communities New Media Workshop. P. 294-298.

[23] Boud, D.; Falchikov, N. (2006). Aligning assessment with long-term learning. Assess. Evaluat. Higher Educat. 31, S. 399-413.

[24] Stifterverband (2020). Survey of lecturers at HTW Berlin on teaching in the online summer semester 2020, survey period: June 2020. Berlin: Berlin University of Applied Sciences, p. 4. https://www.htw-berlin.de/files/Presse/News/Lehrendenbefr gung_Ergebnisbericht_2020.pdf.

[25] Diel, S. et al. (2021). Online exams. Framework, implementation and evaluation., In: U. Dittler; C. Kreidl. How Corona is changing university teaching. Experiences and thoughts from the crisis on the future use of eLearning. Wiesbaden: Springer, pp. 307-337.