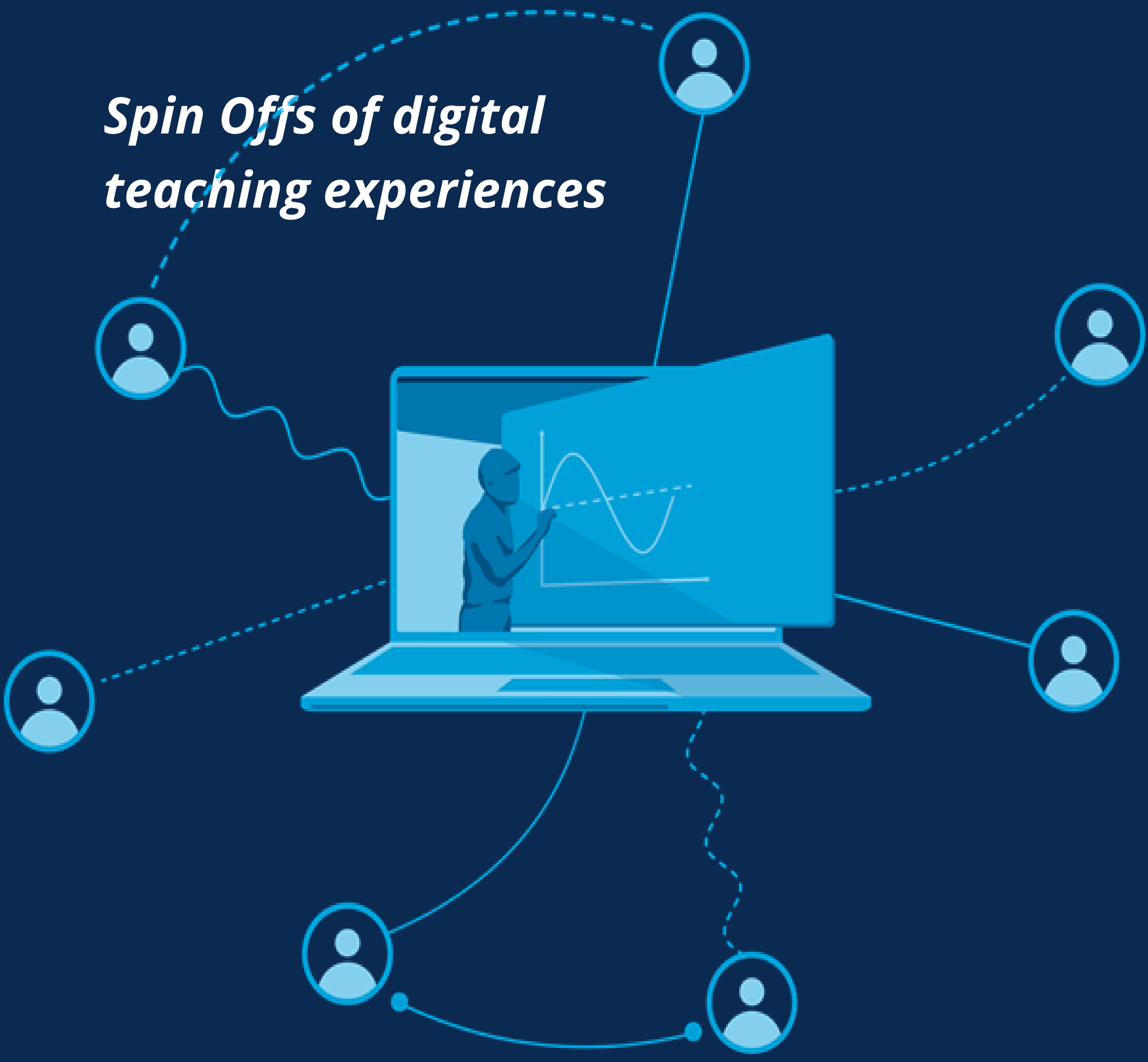
TECHNISCHE UNIVERSITÄT DRESDEN

Lessons Learned

Spin Offs of digital teaching experiences



1&2

Volume 4 | 2024

FAKULTÄT MASCHINENWESEN

About the Journal

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

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

Editorial Board

Imprint

ISSN:

2749-1293 (print); 2749-1307 (online).

Publisher:

Faculty of Mechanical Engineering,
TU Dresden, Dresden

Contact:

Prof. Dr Stefan Odenbach

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

Editorial

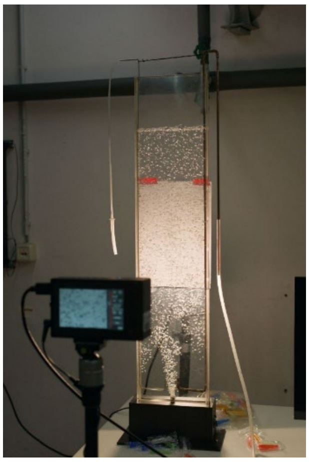
The fourth volume of the ***Lessons Learned Journal*** is arriving late and comes as a not overly thick double issue. Some articles have been on hold for a long time until they were finally published, but the circumstances of the past few months have not been easy and have led to various delays. The extremely high workload in the academic sector is noticeable everywhere – articles are delayed, reviews take longer than expected, and the one-person editorial team of the ***Lessons Learned Journal*** cannot compensate for everything that does not immediately go as planned.

Part of this overload is undoubtedly due to the changing conditions in teaching. The effects of the COVID-19 pandemic are still being felt. The refusal of in-person attendance, which is noticeable among many students, worries educators just as much as the increasingly common psychological problems that more and more students are struggling with. This is concerning, but at the same time, it drives the development of new teaching concepts, some of which we will introduce in this issue.

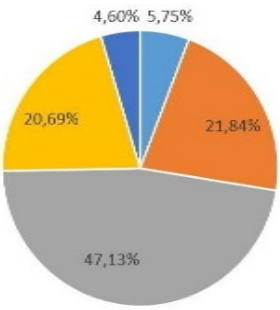
The fifth volume is already in preparation, and it will hopefully include the results of the sixth ***Lessons Learned Conference***. Moreover, since the progress in teaching continues, I can already invite you to the seventh ***Lessons Learned Conference***, which will take place in the summer of 2025. We hope it will – like the previous conferences – have a visible impact on the development of academic teaching and the enjoyment that can come with this progress.

Stefan Odenbach

Range of topics



The range of topics in this issue extends from orientation studies to new concepts of competency-based teaching. It covers the students' perspective on all efforts to digitalize teaching, as well as analyses of the effectiveness of digital elements in education.



Lessons Learned 4, 1&2 (2024)
Submitted: 12.04.2024
Accepted: 10.12.2024
DOI: https://doi.org/10.25369/ll.v4i1/2.93
ISSN: 2749-1293 (Print); 2749-1307 (Online)

The Orientation Program at the TUD Dresden – Survey Results on the Concept

M. Heinz[1*], R. Heitz[2], C. Einmahl[1]

[1] *Center for Interdisciplinary Learning and Teaching (ZiLL), Dresden University of Technology*
[2] *Center for Open Digital Innovation and Participation (CODIP), Dresden University of Technology*

The increasing diversification of study programs is one of many challenges when choosing the right degree program. An orientation program enables participants to explore various degree programs over the course of up to two semesters and to take a closer look at their individual interests and abilities. The orientation program at the TUD Dresden University of Technology acts as a preparatory program prior to regular studies and offers a wide range of events as well as mentoring and coaching support to facilitate an informed and motivated study decision. Before the start of the first cohort, 2043 people were asked about the current status of the concept by means of an online survey. The results were used to further develop the concept and to research the reasons and backgrounds for interest in an orientation program. Around 90 per cent of participants consider it to be a useful offer and agree or tend to agree with the statement that the orientation program can be helpful in deciding for or against a degree course. The article picks up on these and other results after introducing the concept of the orientation program.

The increasing diversification of study programs is one of many challenges when choosing the right degree program. An orientation program enables participants to explore various degree programs over the course of up to two semesters and to take a closer look at their individual interests and abilities. The orientation program at the TUD Dresden University of Technology acts as a preparatory program prior to regular studies and offers a wide range of events as well as mentoring and coaching support to facilitate an informed and motivated study decision. Before the start of the first cohort, 2043 people were asked about the current status of the concept by means of an online survey. The results were used to further develop the concept and to research the reasons and backgrounds for interest in an orientation program. Around 90 per cent of participants consider it to be a useful offer and agree or tend to agree with the statement that the orientation program can be helpful in deciding for or against a degree course. The article picks up on these and other results after introducing the concept of the orientation program.

*Corresponding author: matthias.heinz@tu-dresden.de

1. The situation of prospective students

The number of courses on offer is constantly increasing [1]. Prospective students today also encounter an almost unmanageable abundance of study programs with sometimes misleading designations, which makes it difficult to choose the right degree program and often leads to wrong study decisions [2]. This situation is accompanied by increasing heterogeneity among prospective students, which creates difficulties for universities and first-year students alike [3]. Social background, migration background, age (a larger proportion younger than 19 years and older than 25 years) and educational background prior to admission play a role here. As a result, the motivations of students also diversify [3]. The greatest problems and difficulties when it comes to choosing what to do after leaving school are a difficult to manage number of options and a lack of clarity about their own interests, aptitude and abilities [4]. This lack of self-knowledge and study orientation, misconceptions about studying, subject content and career paths as well as the various motivations and deficits in study preparation are current challenges for prospective students and therefore reasons for an orientation program (german abbreviation OSM for Orientierungsstudium).

Studying involves much more than simply acquiring complex subject content. It requires a redefinition of one's own everyday life, the continuous development of learning techniques, an understanding of the normative foundations of the respective subject and the exploration of new forms of self-organization. At the same time, it means gradually immersing yourself in the multifaceted campus life. However, the promotion of study skills and an understanding of the structures and culture of the university often remain in the background. Successful integration into everyday student life plays a decisive role in student satisfaction and ultimately success. The ability to study as an overarching competence for successful study also includes familiarity with the processes, structures and traditions of the university as well as the perception of the campus as a familiar place. There is undoubtedly a wide range of support services for students in various life situations, sometimes even in precarious situations. However, the question arises as to whether students are aware of these services at the beginning of their studies so that they can access them if necessary. The OSM consists of analog and digital modules that include or refer to the services described from the outset and in some cases provide them as mandatory elements. It is a study success project of TUD Dresden University of Technology (TUD) that integrates previous offers of various study success projects, such as the digital study assistance system gOPAL for the onboarding of first-year students [5].

2. The orientation program

The OSM is one of around 50 OSM programs nationwide, which are constantly growing in number and are mostly located in the fields of mathematics, computer science, natural sciences and technology (STEM).

What should I study? Which degree course really suits me? Do I want to study at all? The OSM of the TUD aims to provide answers to these questions that prospective students ask themselves. The OSM gives prospective students the opportunity to get a taste of various degree courses at TUD for up to two semesters. They can attend lectures, take part in workshops and excursions, take exams, go to the canteen and get to know student life. In the course of the OSM, the participants take a close look at their own ideas, abilities and goals so that they can make an informed and motivated decision for the future. The OSM is an orientation program that can be taken before the regular degree courses at TUD. An extensive range of events helps prospective students to find the right degree program and to start their subsequent studies optimally prepared. Successfully completed examinations can be credited towards a subsequent degree course on application. Furthermore, trying out different courses enables students to immerse themselves in the respective subject cultures and faculty structures. This makes it easier to assess a fit and a sense of belonging, which should not be underestimated in terms of perseverance and also leads to fewer changes and drop-outs in the first semesters and subsequently to a successful degree. In addition, there is the opportunity to get to know student life with all its advantages: the semester ticket, the offers of the university sports center, the student university groups and much more. During the OSM, participants are advised and supported with the help of a mentoring and coaching program.

The OSM at TUD is made up of the following four components:

- Study orientation: support in choosing a course of study, imparting knowledge about university structures, working techniques and subject cultures
- Qualification in natural sciences and engineering: teaching of (possibly missing) technical skills
- Key skills/career exploration: teaching key skills, insights into research and business practice as an orientation aid, language courses
- Project work: teaching interdisciplinary skills, time and project management, teamwork skills

The OSM is designed to enable high school graduates and other prospective students A) to make an informed choice of study program and B) to successfully start a STEM degree program at TUD.

The target groups of the OSM are as follows:

- Prospective students who know that they want to study STEM, but do not yet know exactly which STEM degree program
- Prospective students who want to find out whether a degree course is for them and if so, which one
- Prospective students with knowledge gaps
- Prospective students from non-academic families
- female prospective students
- International prospective students
- Student dropouts/changers
- Professionally qualified persons

Prospective students have the following advantages from OSM:

- They know whether they want to study.
- They know WHAT they want to study.
- They know WHY they want to study

The feedback from the survey will be used to better address the needs of future participants.

3. Survey and results

Before the start of the first cohort, 2043 people were asked about the current status of the OSM concept in an online survey in the second half of 2022. The results were used to further develop the concept and to research the reasons and background for interest in an OSM. Several status groups were distinguished, which were quantitatively distributed as follows: 129 pupils (SuS) (6.3 percent), 1230 students (60.2 percent), 602 employees of TUD (29.5 percent), 41 employees outside TUD (2 percent) as well as 25 responses that indicated the answer "other" (1.2 percent) and 16 times no answer (0.8 percent).

The need for an OSM at TUD is predominantly assessed as high or very high (62.8 percent). Only 6.2 percent rated the need as low or very low. There were no relevant differences in the assessment between the status groups (n = 1927).

Only around 7 percent of students (n = 96) could not imagine participating in the OSM themselves, while 92.7 percent said the exact opposite. 62.5 percent of students answered yes to the desire to participate in the OSM and a further 30.2 percent answered yes if the offer were also available for other departments. Even among current students, there is an approval rate of around 74% (see Fig. 1).

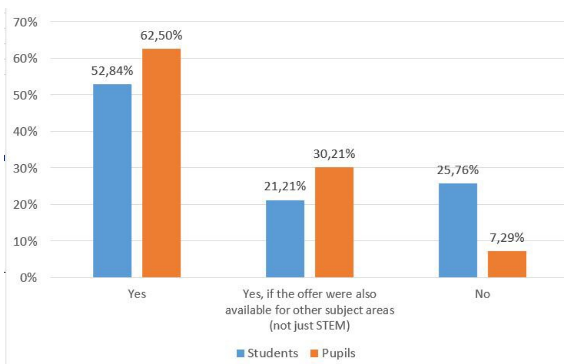


Fig. 1: Could you imagine participating in the OSM? (Status groups: pupils and students, n = 132).

The question of whether students (n = 87) felt well informed about their options after leaving school revealed a mixed picture (Fig. 2). Around 47% answered partly, 25% good to very good and around 27% bad to very bad.

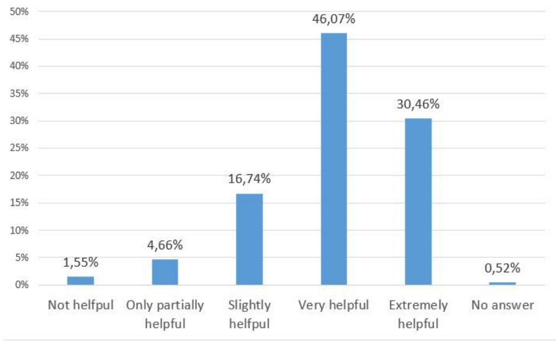


Fig. 3: How helpful do you find the individual modules? - Study orientation? (Status groups: All, n = 1159)

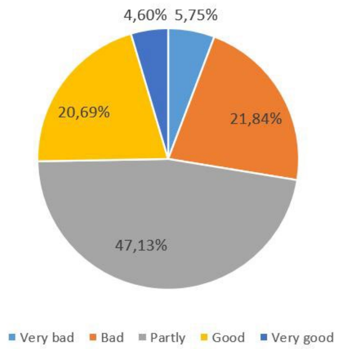


Fig. 2: How well informed do you feel about your options after leaving school? (Status group: pupils, n = 87).

Over 64 percent of pupils (n = 87) want to start a degree course after leaving school, almost 61 percent (n = 56) in the STEM field, while around 21 percent do not yet know.

Almost 60 percent of students (n = 87) have stomach pains when planning their future after leaving school, in particular due to the following points (responses with over 50 percent agreement):

- The difficulty of assessing which qualifications and skills will be important (77 percent).
- Lack of clarity about their own aptitude/skills (73 percent).
- Unsatisfactory preparation for university by the school (64 percent).
- The difficulty of obtaining helpful information (63 percent).
- The difficult-to-manage number of options (54 percent).
- Lack of clarity about their own interests (52 percent).

There are hardly any differences between the status groups in terms of how helpful the individual OSM modules are perceived to be. Over 75 percent rate the study orientation module as very helpful or extremely helpful, around 70 percent the natural sciences and engineering qualification module, around 69 percent the key skills/career exploration module and around 54 percent the project work module.

At around 88 percent, a high proportion agree or agree with the statement that the OSM could be helpful in deciding whether or not to study (n = 1533). Around 89 percent consider it to be a useful service.

The responses to the qualitative question as to which other aspects of content should be included in the OSM were divided into six clusters. These clusters are listed below according to the number of responses with some examples.

- *Meta and practical skills* (n = 169), e.g. social skills, scientific work
- *Outlook in industry/practice* (n = 139) (also profession of the researchers), e.g. getting a taste of it in the form of internships, as these often play a major role in STEM degree programs, cooperation with companies for e.g. construction sites/plant experience
- *Integrate general information about the main study program, provide insights into the study* program, *comparison between departments/study programs* (n = 105), e.g. show study schedules to make students aware of courses to be completed, taster courses in various module subjects e.g. technical mechanics, electrical engineering, thermodynamics
- *Experience and contact with existing students* (n = 75), e.g. talks with/lectures by graduates to get to know future prospects, 1:1 coaching/meetings between prospective

students and working graduates of the degree program (possibly with a questionnaire to help)
- *University* issues *and student life* (n = 69), e.g. student financing, university structure
- *Special content requests* (n = 67), e.g. mostly basic courses or preparatory courses: practical work in the laboratory, programming
- Other unclustered multiple mentions also include: women in STEM studies, psychological counseling program, highlighting differences between school and university, networking between OSM participants, discussing the social relevance of degree programs, sports

The answers to the qualitative question as to which other offers (for study orientation) should be integrated into the OSM could also be divided into the six clusters. These clusters are also listed below according to the number of responses with some examples.

- *Special content requests (mostly foundation courses or preparatory courses)* (n = 53), e.g. preparatory courses in natural sciences, course in chemistry/biology
- *University matters and student life* (n = 25), e.g. campus life, university groups
- *Meta and practical skills* (n = 22), e.g. language courses, self-analysis ability
- *Integrate general information about the main* study *program, provide insights into the study program, comparison between departments/study programs* (n = 19), e.g. mobility and stays abroad, internship week in desired subject areas at TUD, during the vacations
- *Experience and contact with existing students* (n = 17), e.g. discussions with students from the respective study institutions, personal counseling/conversation/coaching offers, as these are best suited to reflect on individual learning and development processes. if necessary, additional reflection tools such as portfolios, podcasts or similar.
- *Prospects in industry/practice (also profession of the researchers)* (n = 17), e.g. present contact points for internships, not only get a taste of study programs, but also contact with everyday working life (research, company visits, lectures)
- Other unclustered multiple mentions include: consultation with Erasmus, lecture series and colloquia of the faculties, research support and psychological counseling program

4. Implications

It is clear that the concerns of the prospective students surveyed coincide with those in the literature. The OSM targets some of these concerns and tries to address and counteract them with the combined modular offers. For example, the following OSM offers address the reasons for the students' concerns about planning their future: The difficulty in assessing their own qualifications and skills as well as the lack of clarity about their own abilities is countered by the OSM with offers to teach key skills, support in choosing a course of study by attending regular lectures and the teaching of subject-specific skills. The OSM responds to the students' statement that they have difficulties obtaining helpful information by offering a wide range of services. It can also be stated that there is interest beyond the STEM field and that the concept, originally planned as a STEM orientation program, has opened up to an orientation program covering all subjects. This interest is also reflected in the results of the participants who come from subject areas other than STEM disciplines.

Literature

[1] Dudek, K.; Ohly, M. & Tauch, C. (2021). Statistische Daten zu Studienangeboten an Hochschulen in Deutschland. Studiengänge, Studierende, Absolventinnen und Absolventen. Wintersemester 2021/2022. Statistiken zur Hochschulpolitik 1/2021. Berlin: HRK.

[2] Berthold, C.; Jorzik, B. & Meyer-Guckel, V. (2015, Hrsg.): Handbuch Studienerfolg. Edition Stifterverband, Essen.

[3] Heublein, U. (2020). Studienorientierung als Voraussetzung für den Studienerfolg (Keynote). Symposium „Studienerfolg durch Orientierung", Frankfurt am Main: Goethe-Universität Frankfurt am Main.

[4] Schneider, H.; Franke, B.; Woisch, A. & Spangenberg, H. (2017). Erwerb der Hochschulreife und nachschulische Übergänge von Studienberechtigten. Studienberechtigte 2015 ein halbes Jahr vor und ein halbes Jahr nach Schulabschluss. Forum Hochschule 4/2017.

[5] Heinz, M.; Heitz, R.; Fischer, H.; Breitenstein, B. & Köhler, T. (2020). Das Studienassistenzsystem gOPAL - Unterstützung Studierender in der Studieneingangsphase. In: Schulze-Stocker, F. (Hrsg.); Schäfer-Hock, C. (Hrsg.); Greulich, H. (Hrsg.). Wege zum Studienerfolg. Analysen, Maßnahmen und Perspektiven an der Technischen Universität Dresden 2016 - 2020. Dresden: TUDpress. https://tud.qucosa.de/api/qucosa%3A74305/attachment/ATT-0/?L=1

Lessons Learned 4, 1&2 (2024)
Submitted: 31.03.2024
Accepted: 02.07.2024
DOI: https://doi.org/10.25369/ll.v4i1/2.92
ISSN: 2749-1293 (Print); 2749-1307 (Online)

Student perspective on digitization

T. Klotz[1], C. Ohlrogge[1], R. Güner[1], J. Brühl[2], C. Fleischer[2], J. Schaarschmidt[2], C. Czichy[3]

[1] *Students at the University of Bremen*
[2] *Students at the TU Dresden*
[3] *Chair of Magnetofluid Dynamics, Measurement and Automation Technology, Institute of Mechatronic Mechanical Engineering, Faculty of Mechanical Engineering, TU Dresden*

In the workshop "Student View of Digitization", students and lecturers discussed both fundamental and specific content related to teaching courses. The aspects and possibilities of digitization were considered, and which different teaching approaches are currently available. Thereupon, ideal concepts for lectures, tutorials and practical courses for the present and the future were developed. During the discussions the problems of the lecturers as well as the wishes of the students for the lecturers were collected and integrated in the developed concepts.

Im Workshop „Studentische Sicht auf Digitalisierung“ wurde zwischen Studierenden und Lehrbeauftragten sowohl über grundlegende als auch spezifische Inhalte bezogen auf Lehrveranstaltungen diskutiert. Es wurde über die Aspekte und Möglichkeiten der Digitalisierung gesprochen und darüber welche unterschiedlichen Lehransätze es aktuell gibt. Daraufhin wurden ideale Konzepte für Vorlesungen, Tutorien und Praktika für die Gegenwart und die Zukunft entwickelt. Während der Diskussionen wurden die Probleme der Lehrbeauftragten sowie die Wünsche der Studierenden gesammelt und in die entwickelten Konzepte eingebracht. Die Erkenntnisse aus diesem Workshop werden im Folgenden dargelegt.

*Corresponding author: timklotz@uni-bremen.de

1. Introduction

Digitalization continues to advance. From a student perspective, it is a complex and fascinating matter. As students, we belong to a generation that has grown up with digital technologies. Attending courses plays a large part in this.

In recent years, it has become apparent that the challenge of digitizing teaching has been implemented with varying degrees of success by lecturers. Students have experienced a variety of different digital teaching concepts and are therefore able to classify them qualitatively. Although a large number of courses are now taking place in person again, some hybrid teaching concepts have also been retained.

Overall, digitalization has the potential to enrich and improve student life. However, it is up to us, together with the teaching staff, to seize the opportunities and overcome the challenges of digitalization.

Three students each from the University of Bremen and the Technical University of Dresden jointly organized a workshop at the Lessons Learned Conference in July 2023. With around 15 participants who are active in teaching, various aspects were discussed together with the six students for four hours and the results were recorded in the form of mind maps. The aim of this workshop was to develop concepts for lectures, tutorials and practical courses that can be applied both in the present and in the future.

2. Opportunities through digitalization in teaching

Digitalization in teaching refers to the integration of digital technologies and media into the educational process, particularly in teaching and learning processes [1]. The aim is to improve and modernize educational offerings and optimize the learning environment.

The most important aspects of digitalization in teaching are listed below:

1. accessibility:

Digital teaching materials enable simple, flexible and fast access to educational content, regardless of location. This is one of the most important advantages of current technology, as it can lead to the individualized acquisition of knowledge and make it easier to catch up on missed learning materials [2, 3].

2. individualization:

Digital tools and platforms offer the opportunity to adapt the course more closely to individual needs. Students can progress at their own pace and access personalized resources [4].

3. interactivity:

By using interactive elements such as videos, simulations, quizzes and discussion forums, lecturers can make the lecture more appealing and create new stimuli. As a possible result, students' understanding increases [3, 4].

4. collaboration:

Digital technologies promote collaboration and the exchange of knowledge between students. Collaboration tools allow group members to work on the same project at the same time. Meetings can also be coordinated and adhered to more easily, as there is no need to walk long distances, for example [4].

5. feedback and evaluation:

Digital platforms offer opportunities for automated assessment and faster feedback on tasks. For example, e-tests during the semester, where only multiple-choice questions or exact amounts need to be typed in, are a good option. This helps students to consolidate their knowledge. Individual feedback is also provided on which subject areas are still causing students problems without overloading the lecturers [4, 5].

6. distance learning:

Digitalization has proven to be particularly important during the COVID-19 pandemic in order to maintain teaching operations even in times when face-to-face teaching is not permitted. In addition, for degree programs with a particularly high number of international students, it enables them to attend the first lectures, even if attendance is not possible due to delays in the visa procedure, for example [4, 6].

7. asynchronous teaching:

Asynchronous teaching makes it possible to consume course content at any time and from any location. Students can access teaching material via third-party providers such as StudyDrive or other paid partners. Alternatively, wikis can also help in this regard. The advantage of asynchronous teaching is that it promotes flexibility and individual learning [6, 7].

In addition to all these positive aspects, it should also be noted that not every form of digitalization is useful. For example, asynchronous teaching can also limit social interaction and spontaneous exchange between lecturers and students or between students and other students, which in some cases can lead to a feeling of isolation [8]. It can be generalized that teaching without a fixed lecture date encourages students to take more initiative, which does not benefit every type of student. Digitalization in teaching offers a lot of potential to improve the educational experience and increase student learning outcomes, but also requires careful planning, training of teaching assistants and consideration of possible challenges.

3. Current spectrum of teaching

The current spectrum of existing teaching approaches offered by the workshop participants is shown below. The spectrum was compiled with the help of the study regulations for the mechanical engineering degree program at the TUD (§ 5) [9], the general part of the Bachelor's examination regulations at the University of Bremen (AT PBO § 6) [10] and with the help of a discussion between all workshop participants.

1. traditional lectures:

These include lectures and presentations in which lecturers impart knowledge to students through face-to-face teaching.

2. seminars and workshops:

These are interactive sessions in which students actively participate in discussions, group work and practical exercises.

3. project-based learning:

Here students work on specific projects or case studies to develop practical and problem-solving skills.

4. e-learning and online courses:

Online platforms and learning management systems are used to provide teaching materials, assignments and tests.

5. blended learning:

Blended learning refers to teaching concepts that combine traditional classroom teaching and online learning in order to utilize the advantages of both approaches.

6. flipped classroom:

Students prepare for course content before class, while class time can be used for discussions and interactive activities.

7. gamification:

Gamification refers to the integration of playful elements and video game formats to increase student motivation and engagement.

8. online platforms for collaboration:

This corresponds to the use of tools such as wikis, blogs and social media to promote collaborative learning and discussion.

9. simulation and laboratory courses:

Virtual or physical laboratory environments are created in which students can gain practical experience.

10. internships and field work:

This provides direct application of the acquired knowledge in real working environments.

With all these teaching approaches, it should be noted that the boundary conditions must always be taken into account. For example, it is probably not possible to implement a particularly meaningful flipped classroom course with 300 students.

4. Concept development Lecture

This and the next two chapters contain evaluations of the concepts developed by the workshop participants, i.e. students and lecturers, in order to develop an optimized lecture, exercise and laboratory course. The concepts relate to the present, whereby wishes or visionary hopes for the future are named. The following are ideas developed in small groups for an optimized course under the listed boundary conditions. These differ for each module course in terms of content, location/rooms, student cohort, type of examination and others.

1st lecture with a high number of participants:

For a basic course, which is attended in one of the first semesters and comprises around 300-400 students, frontal teaching with tablets is a good option. The content is recorded on the tablets in a similar way to how it would otherwise be done on the blackboard. The written content can be projected onto the wall by the lecturer using a projector or similar. The advantage of writing on a tablet/laptop is that the written notes can be easily uploaded, making it easier for lecturers to present animations or similar. It is also a good idea to hold a quiz in the middle of the lecture, for example via Kahoot, to consolidate the content and increase the attention of the audience. The lecture is also recorded and uploaded to a platform, such as YouTube. Ideally, small experiments/laboratories can also be incorporated so that the students get a practical reference and retain the content better, as they can also visualize the content visually/haptically.

Looking to the future, it is hoped that the technical infrastructure at the universities will meet all needs. This means that the necessary equipment is available in the rooms and sufficient bandwidth is provided. In addition, there are no longer any problems with data protection. Furthermore, AIs can provide direct support. The AIs are able to correctly reproduce specific content. Figure 1 shows a mind map that was created by the workshop participants on the topic of "Concept for a lecture". Such mind maps were created for all topics and discussions.

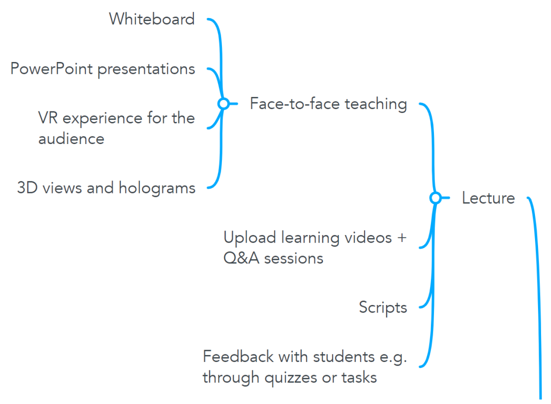


Figure 1: Concept for a lecture, created by workshop participants

2. lecture with practical relevance

If it is a course in the higher semester, the following has been developed: Half of the lecture period consists of a lecture on the specific topic. In the second half, students are asked to start and analyze simulations, ideally with the help of a research assistant or doctoral student. The advantage of this is that technical skills are learned in addition to the content of the lecture.

One example is an event on quantum mechanics. Here, simulations could be made with QuantumESPRESSO [11]. In addition to this software, students could also work with UNIX systems, VIM, VESTA [12] and Xcrysden [13]. To motivate the students, they would be free to choose their specific topic. Xcrysden could be used to create GIFs that reflect the movements of atoms. With this extreme example, it should be noted that not every course can look like this, as this would place an additional burden on students and academic staff.

5. Concept development exercise/tutorial

The exercises and tutorials are designed to reinforce understanding of the lecture content. Accordingly, the tasks are competence-based and there is no calculating ad absurdum.

1. expectations

The supervisor is expected to have sufficient presentation skills and to encourage group work. In addition, the tasks and materials must be available to the students at an early stage so that they can look at the tasks before the exercise.

In principle, not all tasks should be calculated and every intermediate step to reach the solution should be uploaded. Instead, only the final solutions and any intermediate results should be made available somewhere so that students can look up whether they have solved the task correctly while calculating or ask questions if necessary. With this approach, what has been learned sticks much better, and students also get a sense of achievement when they find the correct solution. Learning from their own mistakes is a large part of learning success. This is the opinion of both the students and the participating lecturers.

2. teaching structure

During the tutorial, the tasks are to be solved in small groups. Students can support each other and explain their calculations. If appropriate, the tutor can repeat the necessary content from the lecture for the tutorial in the first 10 - 15 minutes.

In the future, video clips could serve as preparation for the tutorial. These could be used to visualize the content more easily. AIs could also be helpful in the tutorial, for example to quickly point out mistakes to students.

3. problem definition and future vision

The biggest problem with AI is that it is not yet fully developed and it will take some time until this is the case. The use of e-tutors could also be helpful in the future. These could be used as reminder bots or chatbots for questions.

6. Concept development labs

Overall, labs provide a more comprehensive and hands-on educational experience alongside lectures, preparing students for a wide range of professional challenges and enhancing their academic development. In addition, critical thinking skills are encouraged. Lab work often requires critical thinking, problem solving and decision making. Students learn to analyze complex problems, develop hypotheses, and design experimental approaches to find solutions. Teamwork and communication between students is also encouraged.

In the future, digital tools can also be introduced into the laboratories, for example VR tools for assembly technology or reactor technology. Gamification is to be introduced, for example in the sandbox system, in order to gain a full understanding of the system shown. Such a sandbox system is an isolated test environment that makes it possible to safely execute and test programs, codes or software without endangering the rest of the system or the production environment. It should be noted that there are already simulation games that are understandable and user-friendly, although their functions must be checked for usefulness beforehand.

7. Problems identified by the lecturers

While the digitalization of teaching brings many benefits, it also poses a number of challenges and problems for lecturers. The following is a list of some of the most common problems that lecturers may face when integrating digital technologies into the teaching process:

1. technical challenges: Not all rooms at higher education institutions are equipped with the necessary technical infrastructure to use digital tools and platforms effectively. Dealing with new software applications or learning management systems can be difficult.

2. time required: The creation of digital teaching materials, the maintenance of online platforms and technical support for students require additional time. This can lead to an overload for lecturers, especially if the preparation and implementation of online courses takes place in addition to regular teaching commitments. In addition, such enormous additional work is not always compensated for, for example financially or in terms of time, although this would be absolutely necessary.

3. interaction and engagement: In a digital learning environment, it can be more difficult to keep students' attention and encourage active interaction. The challenge is to find ways to stimulate online interaction and discussion.

4. inequality of technological equipment: not all students have access to high quality technology or a stable internet connection. This can lead to unequal participation and lecturers need to find alternative solutions to ensure that everyone can participate in both exams and classes.

5. Data protection and security: The handling of students' personal data in digital platforms requires careful compliance with data protection regulations and security guidelines. These make the digitalization of teaching units considerably more difficult.

8. Summary of the students' wishes

This section lists the students' wishes that could have a positive influence on teaching.

1. students would like to acquire skills that are independent of the course content, in addition to learning the basics of the course content:

- Use of digital tools (e.g. Vim, Microsoft Office, LateX, Obsidian or module-specific software such as Inventor)
- Soft skills (e.g. through group work and presentations)

2. another wish is that there should be the option of hybrid teaching (if possible). The majority of students still prefer face-to-face teaching, but there are always problems that can arise from time to time, which is why students are unable to attend class. This could be due to illness or other appointments, for example. In the best case scenario, lectures can be recorded and made available to students until after the exam. Students want seamless access to all content.

3. centralization/standardization of the courses within the corresponding portal (OPAL, Stud.IP etc.) would prevent many organizational problems for both students and lecturers. Furthermore, it was noticeable that many lecturers use different tools. Teams, Zoom, BigBlueButton, Discord etc. were used as examples for online lectures. Students would like to see the same tools used at least within the department/faculty.

4. if appropriate, interactions can be incorporated in the middle of the lecture, e.g. a quiz, kahoot or similar. These apply the knowledge learned in the lecture and ensure better consolidation of the content. In addition, the inserted phase provides variety and renewed concentration for the subsequent lecture section. Interactions can also be practically linked to digital experiences.

9. Conclusion

The "Student perspective on digitalization" workshop offered an in-depth discussion on the future of teaching in the digital age. The participants developed visions that go beyond current possibilities and are intended to create an optimized learning environment for students. The discussions revealed that digitalization can improve accessibility, individualization, interactivity and collaboration in education. Nevertheless, lecturers face technical, time and social challenges. Students would like to see a balanced integration of digital tools, hybrid teaching formats and a standardization of teaching platforms. Overall, the workshop shows the importance of close collaboration between students and lecturers in order to shape teaching in a future-oriented way.

With regard to lectures, an increased integration of digital technologies was discussed that goes beyond the mere recording of lectures. Future lecture concepts could include the use of artificial intelligence (AI) to convey teaching content more precisely and dynamically. The idea of a technically mature infrastructure in lecture halls and direct support from AI may seem utopian, but it is still a goal worth striving for.

For exercises and tutorials, the idea of digital assistants, such as e-tutors or chatbots, was discussed as potential support for students and lecturers. These could not only help with questions, but also serve as reminder bots or to support the preparation and follow-up of teaching content.

In the area of labs, the integration of virtual reality (VR) and gamification were discussed as forward-looking approaches. VR tools could allow students to experience realistic laboratory environments, while gamification elements could increase engagement and motivation.

These ideas for the future illustrate the potential of digitalization to make teaching even more effective and appealing. However, they also show that the successful implementation of these ideas requires continuous development of the technological infrastructure and close cooperation between all those involved.

10. Acknowledgments

We would like to express our sincere gratitude to all participants of the workshop "Student perspective on digitalization". This workshop was only possible thanks to the active participation and dedicated contribution of all participants. Many thanks for the input, the interesting discussions and the insightful answers.

Thanks go to all the students who planned and conducted this workshop and for the great cooperation. A big thank you also goes to the organizers and supporters for the opportunity to host this workshop and for the smooth running. We would especially like to thank Prof. Odenbach for the invitation and support for the workshop. We would also like to thank the TUD funding.

Literature

[1] Rampelt, F., & Wagner, B. (2020). Digitalisierung in Studium und Lehre als strategische Chance für Hochschulen. Zukunft Lernwelt Hochschule. Perspektiven und Optionen für eine Neuausrichtung, 105-120.

[2] Albrecht, S., & Revermann, C. (2016). Technik folgenabschätzung (TA). Digitale Medien in der Bildung (Bericht des Ausschusses für Bildung, Forschung und Technikfolgenabschätzung (18. Ausschuss) gemäß §56a der Geschäftsordnung Nr. 18/9606; S. 177). German Bundestag - 18th electoral term

[3] Federal Ministry of Education and Research (BMBF). (2016). Bildungsoffensive für die digitale Wissensgesellschaft. Strategie des Bundesministeriums für Bildung und Forschung. Berlin.

[4] Gloerfeld, C. (2020). Auswirkungen von Digitalisierung auf Lehr-und Lernprozesse. Wiesbaden.

[5] Vladova, G., Ullrich, A., & Bender, B. (2021). Chancen und Grenzen digitaler Lehre an Hochschulen aus Studierendenperspektive: Empirische Befunde und Gestaltungshinweise. HMD Practice of Information Systems, 58(6), 1313.

[6] Stoppe, V., & Knaus, T. (2022). Hybrid-Lehre: Klar! Aber wie? Konzeption und technische Umsetzung interaktiver Hybrid-Lehre am Beispiel eines synchronen Tutoriums. Ludwigsburger Beiträge Zur Medienpädagogik, 22, 1-12.

[7] Becker, M., Leßke, F., Liedtke, E., Hausteiner, E., Heidbrink, C., Horneber, J., ... & Wessel, P. (2020). Rückblick auf das erste „Corona-Semester ". Ergebnisse einer semesterbegleitenden Untersuchung der Task Force Digitale Lehre des Instituts für Politische Wissenschaft und Soziologie der Universität Bonn. Journal of Political Science, 30, 681-696.

[8] Fuchs, T., & Matzinger, D. (2021). Lost in Pandemic. Zur Frage von adoleszenten Bildungsprozessen und Übergängen in Zeiten des Social Distancing (pp. 33-47).

[9] Dresden University of Technology Faculty of Mechanical Engineering (2019). Studienordnung für den Diplomstudiengang Maschinenbau (https://www.verw.tu-dresden.de/Amtbek/PDF-Dateien/2019-10/01_13soDM17.05.2019.pdf)

[10] University of Bremen (2021). s Allgemeinen Teils der Bachelorprüfungsordnungen der Universität Bremen (https://www.uni-bremen.de/fileadmin/study-data/DBS/Dokumente/Ordnungen/Pruefungsordnung/AT-BPO-02-21_Lesefassung_gesamt.pdf)

[11] Giannozzi, P., et al, (2009). J. Phys.:Condens. Matter 21 395502 (https://www.quantum-espresso.org)

[12] Momma, K., & Izumi, F. (2008). VESTA: A three-dimensional visualization system for electronic and structural analysis. Journal of Applied Crystallography, 41(3), 653-658.

[13] Kokalj, A., J. Mol. Graphics Modeling (1999), 17, 176--179.(http://www.xcrysden.org/)

Lessons Learned 4, 1 (2024)
Submitted: 26.04.2023
Accepted: 16.02.2024
DOI: https://doi.org/10.25369/ll.v4i1/2.77
ISSN: 2749-1293 (Print); 2749-1307 (Online)

An analysis of participation in a hybrid and asynchronous course

L. Degenhardt[1] , M. Bodirsky[2]

[1] *Digital Teaching Team, Department of Mathematics and Natural Sciences, TU Dresden*
[2] *Professorship of Algebra and Discrete Structures,* Institute *of Algebra, Mathematics, TU Dresden*

Abstract

Time- and location-independent teaching helps students to complete their studies independently of external circumstances, such as private ones. Among other things, the use of hybrid and asynchronous teaching scenarios is suitable for this, which is therefore a highly topical but controversial subject in university didactics (even after the coronavirus pandemic). How hybrid teaching can be designed to be effective for learning and systematically developed further has still not been clarified. In the pilot project "TEORy - Try, Explore, Observe and Review hybrid Teaching", a technically and didactically trained person, the so-called e-scout, regularly supports and accompanies a hybrid course. This offers the opportunity to evaluate each individual course in a lecture series and thus provide the lecturer with continuous feedback on the course. In order to address the concerns expressed by lecturers about declining participation in hybrid courses with concrete figures, the development of participation figures on site and online over the semester is examined on the basis of the e-scout protocols. Initial factors influencing the type of participation (online or on-site) in a hybrid teaching scenario are identified. Based on the observations and feedback, it is assumed that the implementation of hybrid and asynchronous courses makes sense under certain conditions and that lecturers should continue to be motivated to offer these teaching formats.

Zeit- und ortsungebundene Lehre unterstützt Studierende dabei, das Studium unabhängig von äußeren, beispielsweise privaten Umständen, zu bewältigen. Hierfür eignet sich u.a. der Einsatz von hybriden und asynchronen Lehrszenarien, welcher dementsprechend (auch nach der Corona-Pandemie) ein hochaktuelles, aber kontrovers diskutiertes Thema in der Hochschuldidaktik ist. Wie hybride Lehre lernwirksam gestaltet und systematisch weiterentwickelt werden kann, ist noch immer nicht geklärt. Im Pilotprojekt „TEORy – Try, Explore, Observe and Review hybrid Teaching“ unterstützt und begleitet daher eine technisch und didaktisch geschulte Person, der sogenannte E-Scout, regelmäßig eine hybride Lehrveranstaltung. Dies bietet die Möglichkeit, jede einzelne Veranstaltung einer Vorlesungsreihe zu evaluieren und so dem Lehrenden ein kontinuierliches Feedback zur Lehrveranstaltung zu geben. Um den von Lehrenden geäußerten Bedenken hinsichtlich einer sinkenden Teilnahme an hybriden Lehrveranstaltungen mit konkreten Zahlen zu begegnen, wird auf Basis der Protokolle des E-Scout die Entwicklung der Teilnahmezahlen vor Ort und online über das Semester hinweg betrachtet. Dabei werden erste Einflussfaktoren auf die Art der Teilnahme (online oder vor Ort) an einem hybriden Lehrszenario herausgearbeitet. Es wird vermutet, dass auf Grundlage der Beobachtungen und Rückmeldungen die Durchführung hybrider und asynchroner Lehrveranstaltungen unter bestimmten Randbedingungen sinnvoll ist und die Lehrenden weiterhin motiviert werden sollten diese Lehrformate anzubieten.

*Corresponding author: laura.degenhardt@tu-dresden.de

1. Background

A needs analysis on digital teaching at the Department of Mathematics and Natural Sciences (MN)[1] at TU Dresden revealed that teachers and students consider the possibility of time- and location-independent learning to be the most important goal in connection with the use of digital elements in teaching. The implementation of hybrid and asynchronous teaching scenarios is particularly suitable for achieving this goal [1]. As the term "hybrid" is not clearly defined in teaching [2]we define it below:

Hybrid teaching is a synchronous teaching scenario in which people participate and interact simultaneously on site and virtually.

This type of course poses great challenges for teachers, not only technically but also didactically, as a classroom and online auditorium must be actively involved in the course at the same time. For this reason, in addition to the necessary technical requirements, teachers usually want personnel support in the preparation, implementation and follow-up of hybrid courses [3]. In the literature, for example, the appointment of "student co-moderators and technical assistants" is used [4]who voluntarily take on tasks such as moderating questions from the chat. This approach was viewed rather critically by some lecturers in the MN area, especially from the mathematics and physics faculties: due to the complexity and abundance of the material covered, students with additional tasks could find it difficult to follow the content. An external person would therefore have to take on these supporting tasks. This is where the "TEORy" pilot project comes in and provides additional staff support for a hybrid course.

The results presented in this text are based on the lecture of the module "Discrete Structures" in the winter semester (WiSe) 2022/23, an export course of the Faculty of Mathematics for the 1st Bachelor semester of Computer Science. The lectures took place twice a week in a hybrid and asynchronous format. This means that, in addition to the introduced definition of hybrid teaching, the lecture was recorded and then made available to students on the video platform Videocampus Sachsen. This course was supported and accompanied by an e-scout (cf. Fig. 1). The term "e-scout" originates from the "Digital Teaching Hand in Hand" project of CODIP and ZiLL at TU Dresden. It refers to a student assistant (SHK) who is trained in media didactics and technology and then works to support digital teaching at various chairs [5]. From the surveys marked in green of the Fig. 1 marked in green show that the e-scout, in addition to his

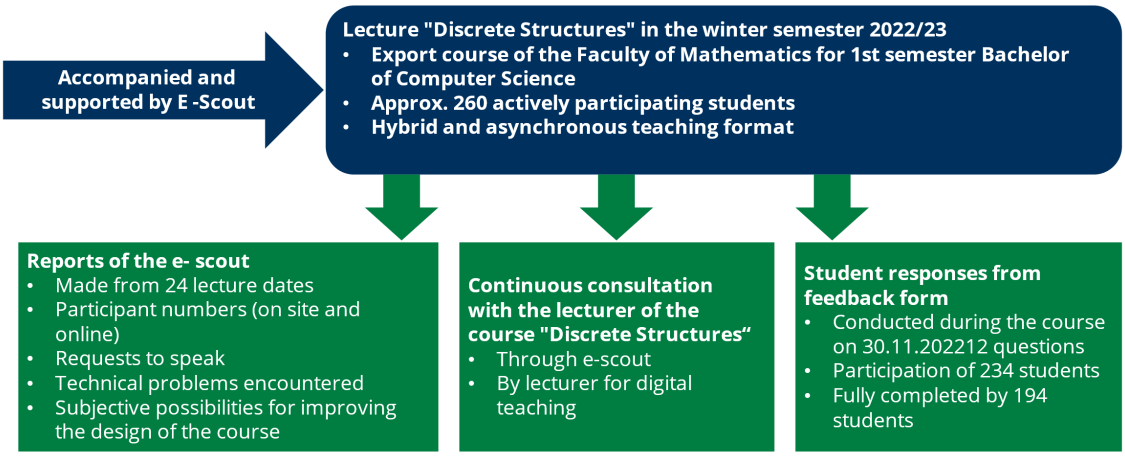


Fig. 1 : Overview of data collection

[1] At TU Dresden, faculties are assigned to a department. The MN area includes the faculties of Mathematics, Physics, Biology, Chemistry and Food Chemistry, as well as Psychology.

supporting activities in the course, also recorded participant numbers, requests to speak, problems encountered during implementation in the hybrid format and subjective opportunities for improvement. In addition

In addition, a student survey was conducted in the form of a feedback form during a course in the middle of the semester (course on 30.11.2022). Of the approximately 260 students actively participating in the course, 234 took part in the survey. All 12 questions from the feedback form were completed by 194 students (green box on the right in Fig. 1). Overall, the response rate of approx. 75% for fully completed feedback forms is very satisfactory for the authors. The lecturer's perspective was obtained by means of continuous discussions with the e-scout or the lecturer for digital teaching in the MN department throughout the semester (green in Fig. 1). These surveys (protocols of the e-scout, information from students in the feedback form, discussions with lecturers) form the data basis for the results presented here.

2. Problem definition

Although the combination of hybrid and asynchronous teaching formats enables students to learn independently of time and place [1]the return to unrestricted face-to-face teaching from winter semester

2022/23 at TU Dresden as a whole, especially in the MN department, meant that fewer lectures were offered in hybrid formats or lecture recordings were made available. This can be seen from a comparison of the data on TU Dresden's course offerings from the winter semester 2021/22 with the winter semester 2022/23 and the current planning status 2023/24.[2] In addition to various technical and didactic challenges, the lecturers in the MN department at TU Dresden expressed concerns that the number of in-person participants would drop sharply over the course of the semester in a hybrid lecture course (cf. [6] and [7]). In the underlying surveys and interviews, only subjective perceptions and estimates of lecturers with regard to participation in hybrid courses have been recorded to date. Accordingly, the numbers of participants documented on site and online in the course of the pilot project are evaluated below and initial factors influencing the type of participation in hybrid courses are highlighted.

The analysis of the number of participants and the data presented in section 1 can be used to derive arguments that support the thesis that the implementation of hybrid and asynchronous courses makes sense under certain conditions and that teachers should continue to be motivated to offer these teaching formats.

3. Type of participation in hybrid courses

In the following section, the number of participants in a hybrid course is analyzed over the course of the semester and initial factors influencing the type of participation are identified on this basis.

Total number of participants over the course of the semester

As described in section 1 the e-scout recorded the number of participants on site and online over the course of the semester. The documented values are shown in Fig. 2 shown. It can be seen that the total number of participants decreased by around 150 students over the semester. This decline should not be attributed to the hybrid, asynchronous format of the course. Studies show that the amount of time students spend attending a course depends on numerous factors, such as compulsory attendance, course size or the type and scope of examinations ([8, p. 38]). With approximately 260 participating students, the underlying course is comparatively large. Empirical findings support the thesis that "anonymity in large lectures encourages students to stay away" [8, p. 39]. It should also be noted that when considering a first-semester course in computer science, influencing factors such as course changes and dropout rates can have a negative impact on the total number of participants over the course of the semester

[2] Last system access on 14.07.2023

(cf. dropout rates in [9], cf. change of degree program in [10]).

Development by type of participation over the course of the semester

The in Fig. 2 shows the development of the number of participants by type of participation over the course of the semester and shows that, with two exceptions, more students took part in the courses in person than online. Over the course of the semester, the numbers of on-site and online participants converge, with the number of students participating online fluctuating constantly around 50. The numbers of on-site and total participants tend to develop similarly over the course of the semester.

There was a real slump in the number of participants in December. This is the course before the mid-term exam. The week before the midterm exam (corresponding to the 2nd and 3rd course in December) has two special features: Firstly, it was the first course in which more students participated online than in the lecture hall; and it was the course with the lowest total number of participants (directly before the midterm exam). It may be a coincidence, but it is remarkable that this phenomenon is repeated in the last two lectures before the examination period. The question arises as to whether students focus on self-study and repetition when preparing for exams instead of using the opportunity of the course to clarify any existing questions or gaps in understanding in an active exchange with the lecturer. However, this is not the question to be answered in this paper.

Tab. 1Evaluation of participant numbers

	Regardless of the day		
	Presence	Online	Total
Mean value	135	49	184
Percentage share Mean value	73%	27%	100%
Median	130	43	176
	Wednesday		
	Presence	Online	Total
Mean value	125	71	196
Percentage share Mean value	64%	36%	100%
Median	110	71	181
	Friday		
	Presence	Online	Total
Mean value	143	30	173
Percentage share Mean value	83%	17%	100%
Median	140	31	171

Analysis of the number of participants by day

A closer look at the number of online participants in Fig. 3 it is noticeable that it

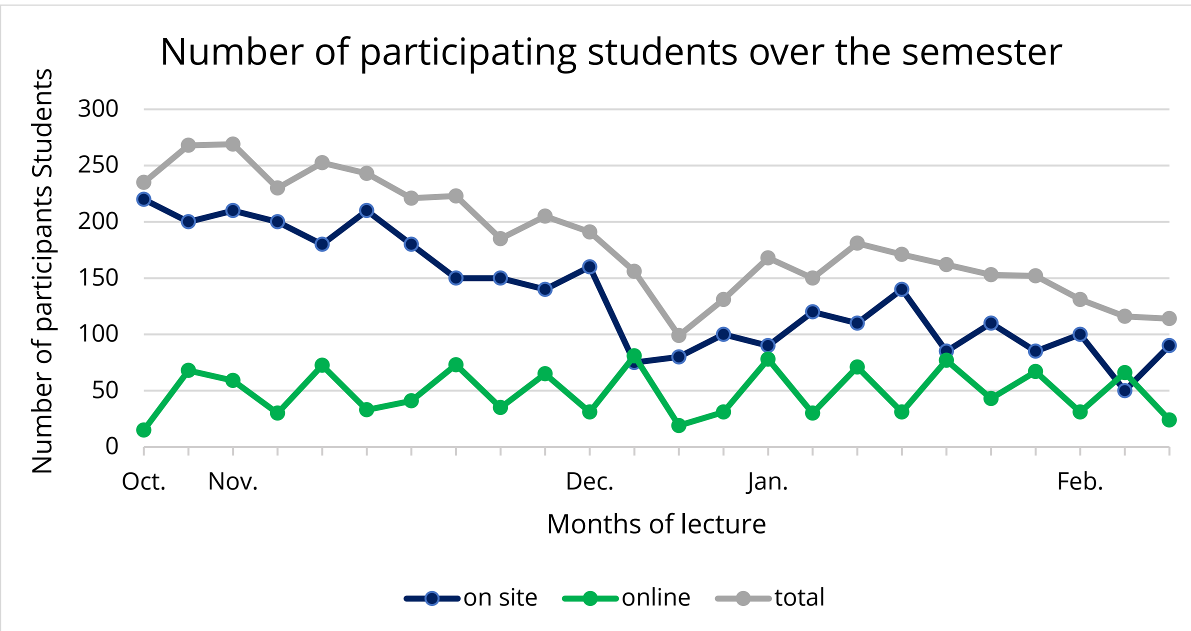


Fig. 2 : Recorded number of participants in the Discrete Structures lecture in winter semester 2022/23

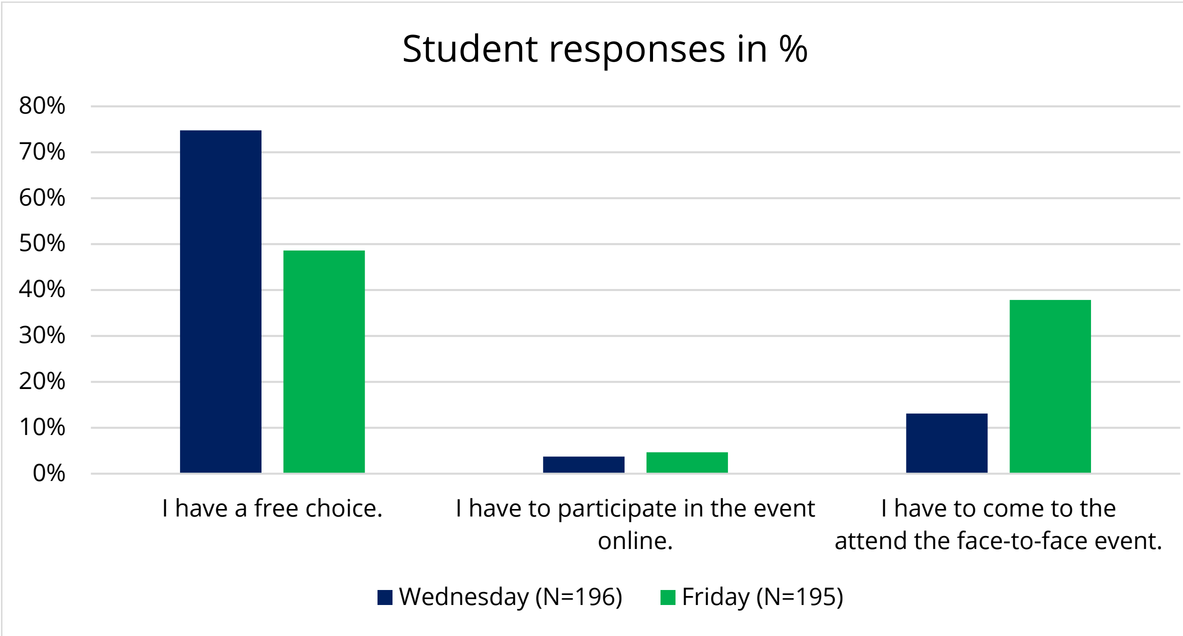


Fig. 4 : Student responses in the feedback form to the question "Do you have to attend the lecture online/live due to a course before/after?"

oscillates between two values at a relatively constant rate throughout the semester. Lectures with fewer than 50 online participants are often followed by lectures with between 50 and 100 online participants. To take a closer look at this phenomenon Tab. 1 shows the mean and median values of the number of participants by day and type of participation, so that readers can better interpret the mean value in relation to outliers. The values from Tab. 1 show that not only the average total number of participants varies depending on the day (on average 20 fewer students on Friday than on Wednesday). The proportion of students participating on site also changes depending on the day of the course. For example, an average of 64% of participating students are present on site on Wednesday and 83% on Friday. The median and mean value of online participants on Wednesday and Friday are (almost) identical. This leads to the conclusion that the number of students participating online is symmetrically distributed over the semester on both days of the week, while the distribution of attendance on Wednesdays is skewed to the right.

Identification of initial factors influencing the type of participation

In the needs analysis for digital teaching in the MN department [7] some of the students surveyed stated in the free text field that attendance in hybrid formats depends on the semester timetable, among other things. For example, the fact that courses may overlap, that it is not possible to change locations during breaks and that other courses are offered exclusively online or as face-to-face events on the same day all play a role. Based on the results of the needs analysis, the students were asked to provide feedback on the Discrete Structures course in the feedback form (see green box on the right in Fig. 1): *"Do you have to attend the lecture online/live on Wednesday/Friday due to an event before/after?"* For this question, depending on the day, it was possible to indicate whether the lecture had to be attended in person or online or whether the students were free to decide how to attend the lecture. The answers of the students surveyed are shown in Fig. 3 shown. In addition, a free text field was available in the feedback form for this question, in which the answers given could be commented on or justified.

Looking at the data shown in Fig. 3 it is noticeable that the proportion of students who have to attend the lecture on site due to an event before/after is higher on both days than the proportion of students who have to attend online as a result. On Wednesday, the proportion of students who are free to choose which format they attend is significantly higher than the proportion of students who have to choose a lecture format due to other (private or university) events in order to be able to attend the course at all. On Fridays, this ratio is relatively balanced. Furthermore, the data set shows that 48% of students are free to choose whether to attend the course online or in person on both Wednesday and Friday. Only two people (approx. 1%) stated that they had to attend the lecture online on both days. According to the information provided, 24 (approx. 11%) of the students were required to attend the course on site on both days. In addition, three comments were made in the free text field, the content of which is reproduced here[3] :

- I only take part online on Wednesdays because I have a part-time job.
- On Wednesday, I would have to drive to the university for the lecture, which is why I use the online alternative. It's perfect for me.
- Although I have the choice of how I attend the event, I would always prefer the on-site event. I am simply more attentive and stay on the ball. The videos available help me to look at certain things again afterwards.

The comments show initial influencing factors, such as timetable and having a part-time job, on the type of participation in hybrid courses. Unfortunately, the responses to the feedback form are not suitable for showing a broader spectrum of influencing factors. In future surveys, a selection of predefined influencing factors would be useful instead of a free comment field.

The information in the feedback form is consistent with the figures collected by the e-scout from the courses. Since, according to the feedback form, 75% of the students surveyed had a free choice between online and face-to-face participation on Wednesdays, it could be concluded from the e-scout's surveys that around half of the students prefer the face-to-face event to the online event. Conversely, however, it is also clear that a not insignificant proportion of students need or prefer the online option.

The comments suggest another factor influencing the type of participation in hybrid courses - personal (learning) preference.

Conclusions

In summary, the results show that a hybrid and asynchronous teaching format does not

Tab. 2Statistical evaluation of access to the lecture recordings

	before audit period (until 03.02.2023)	**in the audit period** (03.02.2023-03.03.2023)	**Total** (until 03.03.2023)
Total **number of views**	290	542	832
Mean value (views per lecture)	11	20	31
Percentage of the mean value	35%	65%	100%
Median (views per lecture)	8	17	23
Variance	64,51	104,61	275,31
Standard deviation	8,03	10,23	16,59
Min. number of accesses (of a lecture recording)	0	8	12
Max. Number of accesses (of a lecture recording)	31	44	69

[3] A qualitative content analysis according to Mayring is only recommended for 10 or more statements. Accordingly, all comments were reformulated at this point, but their content was not changed.

automatically lead to an empty lecture hall. On average, around 70% of students took part in the course on site. The type of participation is influenced by external factors such as timetable and part-time job. As attendance is not compulsory for students in this module, studies have shown that a decline in the number of participants over the course of the semester can also be expected in purely face-to-face courses (cf. [11], [8], [12]). In connection with the ZeitLast study and the project of the same name, which deals with "Studyability in Bachelor's and Master's degree courses, particularly with regard to the organization of time, learning culture and the use of modern technologies" [12, p. 4] various influencing factors (e.g. having a part-time job) on participation in face-to-face courses have already been identified (cf. [11], [8]). This raises the question of whether and in what form these influencing factors can be transferred to hybrid formats. If, for example, doing a part-time job in purely face-to-face formats leads to students staying away from the course altogether, while in hybrid formats they have the opportunity to take part in the course online, this could, contrary to the assumption made in section 2 a hybrid teaching format could have a positive effect on the total number of participants. The observations raise the question of whether in a hybrid course, compared to a pure face-to-face course, the face-to-face participants switch to the online format or whether an additional group of students is reached through the online offer. In other words, the question arises as to whether the total number of participants in hybrid courses is higher due to the online offering. However, this requires comprehensive studies.

4. Influencing factor lecture notes

As described in section 1 the lectures were recorded and made available online. The following section looks at the views of the lecture recordings and answers the question of whether these correlate with participant numbers. The aim is to investigate the hypothesis that lecture recordings of courses with a lower number of participants record more views for follow-up and exam preparation than lecture recordings of courses with a higher number of participants. The authors therefore expect a negative linear relationship between the variables.

In Tab. 2 shows a statistical evaluation of access to the lecture recordings. Among other things, the average views of the lecture recordings are shown. The values from Tab. 2 show that almost two thirds of the views are recorded after the lecture period. This is in line with the students' statements in the needs analysis and the associated focus group discussions, in which it was stated that the lecture recordings are primarily used to prepare for exams [7]. It can also be seen that the lecture recordings were used comparatively rarely by the students (approx. 260 participants and an average of 31 views per lecture). As the videos were made available on Videocampus Sachsen, it is unfortunately not possible to make any statements about how long the students watched the individual lecture recordings (e.g. continuously or at certain times). Other video platforms, such as YouTube, are suitable for such evaluations. This data could be used to investigate whether the consumption behavior of students changes before and during the examination period, for example whether the videos are preferably watched continuously during the lecture period and whether they actively skip to certain explanations/topics during the examination period. However, this is not the focus of the present study.

The Pearson correlation coefficient was determined in order to check whether there is a correlation between the number of participants and the number of accesses to the lecture recordings. At $r=0.227$, this indicates a positive, weak linear correlation, which is not statistically significant with a p-value of 0.308.

The high variance and standard deviation of accesses from Tab. 2 indicate a wide spread of accesses, i.e. there are lecture recordings that were clicked on very frequently and others that were rarely clicked on (cf. min. and max. from Tab. 2). A closer look at the lecture with the most accesses before the examination period (lecture from 04.11.2022; 31 accesses until 03.02.2023) confirms the weak positive correlation effect, as 230 students took part in this course, 200 of them on site and 30 online. This lecture was also accessed comparatively frequently (35 times) during the examination period. These figures indicate that students use lecture recordings primarily for topic-specific follow-up/exam preparation of the material taught.

Contrary to expectations and the initially formulated thesis, there is a weak positive correlation between the views of the lecture recordings and the number of participants. In addition, the numbers of views match the students' statements in the needs analysis and focus group discussions (cf. [7]), which state that

- Lecture recordings are mainly used for exam preparation
- Lecture recordings help to explain "difficult to understand topics" again.

5. Effect on the examination performance

In the following section, the examination performance in winter semester 2022/23 will be briefly discussed and the observation will be put up for discussion.

It should be noted that this is the first time that this course has been offered in a hybrid and asynchronous teaching format. Before the corona pandemic, the course "Discrete Structures" was designed for a purely face-to-face format and was switched to a purely online format due to the circumstances of the pandemic.

In Tab. 3 lists the failure rates for the final exams of the first semester course "Discrete Structures" in the Bachelor of Computer Science from winter semester 2016/17. The figures contained therein come from the responsible examination office. The results of the exams in the Corona semesters are not taken into account, as these took place online and therefore in a non-comparable setting.

Tab. 3Examination statistics of the final exam in the course Discrete Structures

winter semeste r Year	Average points	Failure rate
2016/17	49	44,73%
2017/18	51	40,35%
2018/19	42	56,98%
2019/20	40	47,47%

It is noticeable that the average number of points achieved in the exam in winter semester 2022/23 is higher than in previous years. The failure rate also decreased in the semester that was offered hybrid and asynchronously compared to the purely face-to-face semesters.

Of course, this one-off observation may be purely coincidental and independent of the teaching format offered. However, the results positively surprised the lecturer of the course and encouraged him to offer the lecture in hybrid and asynchronous format in the coming winter semester 2023/24.

It is important to continue to monitor the development of failure rates in the Discrete Structures course and to discuss whether a hybrid and asynchronous course offering in this course (with comparatively large numbers of participants and a heterogeneous student body) helps to reduce failure rates while maintaining the same level of examination demands.

6. Summary

The recorded attendance figures show that more students took part in the course on site than online. The type of participation is influenced by various factors, such as timetable, part-time job or personal learning preferences. Some of the students stated in the feedback form that they had to take part in the course online. It is assumed that hybrid teaching formats can contribute to higher overall participant numbers on average than pure face-to-face courses. This should be investigated in more detail in the future.

Accordingly, the analysis shows that the additional online offer of the hybrid course is used or preferred by a not insignificant proportion of students.

Furthermore, contrary to expectations, the number of views of the lecture recordings and the number of participants in a lecture indicate a weak positive linear correlation. From the click behavior and student surveys, it can be assumed that lecture recordings are primarily used for lecture follow-up and exam preparation.

In connection with the examination results achieved in winter semester 2022/23, the conversion of the course to a hybrid and asynchronous format is rated positively by the lecturer (and, as can be seen from the feedback form, also by the students) and encourages the lecturer to offer the course hybrid and asynchronous in the coming winter semester as well.

In summary, it can be said that the analysis presented here has highlighted arguments that confirm the thesis that the implementation of hybrid and asynchronous courses makes sense under certain conditions and that teachers should continue to be motivated to offer these teaching formats.

7. Literature

[1] German Science And Humanities Council, "Empfehlungen zur Digitalisierung in Lehre und Studium," 2022.

[2] G. Reinmann, "Hybrid teaching - A term and its future for research and practice," IMPACT FREE 35, 2021.

[3] S. Herrmann and R. Freudenreich, "The "Blackboard" Challenge - Hybrid Teaching in the Technical Thermodynamics Module at Zittau/Görlitz University of Applied Sciences," Perspectives on Teaching. Journal for Higher Education and Academic Development, March 2023.

[4] M. Magdowski, "Why hybrid teaching has not worked (so well) so far and what we (still) need to change," Perspectives on Teaching. Journal for Higher Education and Academic Development, March 2023.

[5] C. Böhm, "Digital teaching hand in hand," [Online]. Available: https://tu-dresden.de/zill/studienerfolg/digitale-lehre-hand-in-hand. [Accessed 25. 04. 2023].

[6] C. Albrecht, A. Jantos and C. Böhm, "Hybrid courses - the tension between technical practicability and didactic demands," Perspectives on Teaching. Journal for Higher Education and Academic Development, March 2023.

[7] L. Degenhardt and C. Albrecht, "Bedarfsanalyse zur digital gestützen Lehre im Bereich MN der TU Dresden," [Unpublished manuscript], 2022.

[8] D. Großmann, C. Engel, J. Junkermann and T. Wolbring, Studentischer Workload: Definition, measurement and influences, Springer Fachmedien Wiesbaden, 2020.

[9] U. Heublein, C. Hutzsch and R. Schmelzer, "DZHW-Brief 05|2022 - The development of dropout rates in Germany," 2022.

[10] Federal Statistical Office, "Study progression statistics 2021," 2022.

[11] R. Schulmeister and C. Metzger, Die Workload im Bachelor: Zeitbudget und Studierverhalten: An empirical study, Waxmann Verlag GmbH, 2011.

[12] L. Groß, M.-A. Boger, S. Harmann and M. Wedjelek, "ZEITLast research report - Mainz site," 2012.

Lessons Learned 4, 1&2 (2024)
Submitted: 17.10.2023
Accepted: 26.03.2024
DOI: https://doi.org/10.25369/ll.v4i1/2.87
ISSN: 2749-1293 (Print); 2749-1307 (Online)

Conceptual approach to problem-oriented teaching in the subject sciences

F. Düwel[1] , M. Niethammer[1]

[1] Professorship for Construction Technology, Wood Technology, Color Technology and Interior Design/Vocational Didactics and BFR Laboratory and Process Technology/Didactics of Chemistry, Institute for Vocational Education and Vocational Didactics, Faculty of Education, TU Dresden

Abstract

In order to increase the coherence between the specialist sciences and the relevant vocational didactics, this article presents the first cycle of a design-based research approach in which a lecture series on building physics was conceptually reorganized in such a way that the relevance of the lecture content becomes clearer to students. A key aspect of this is problem orientation, in which the phases of the problem-solving process are made transparent to students and the content to be considered is categorized and made explicit. The analyses of the lecture materials show that the cognitive activation potential was significantly increased by the problem orientation. However, the increased number of slides is problematic. It is therefore necessary to decide which lecture content can be dispensed with or made accessible to students in another form.

Zur Erhöhung der Kohärenz zwischen den Fachwissenschaften und den einschlägigen Berufsdidaktiken wird im vorliegenden Beitrag der erste Zyklus eines Design-based Research-Ansatzes vorgestellt, bei dem eine Vorlesungsreihe zur Bauphysik konzeptionell so umgestellt wurde, dass Studierenden die Relevanz der Vorlesungsinhalte deutlicher wird. Ein wesentlicher Aspekt ist dabei die Problemorientierung, bei der Studierenden die Phasen des Problemlöseprozesses transparent und die dabei zu durchdenkenden Inhalte eingeordnet und expliziert werden. Die Analysen der Vorlesungsmaterialien zeigen, dass das kognitive Aktivierungspotenzial durch den Problembezug deutlich erhöht wurde. Problematisch ist allerdings die erhöhte Anzahl der Folien. Daher ist zu entscheiden, welche Vorlesungsinhalte verzichtbar bzw. in anderer Form Studierenden zugänglich gemacht werden können.

*Corresponding author: frauke.düwel@tu-dresden.de or manuela.niethammer @tu-dresden.de

1. Problem background

In many engineering degree programs and vocational and general education teacher training programs, students are faced with the challenge of having to deal with abstract technical and scientific contexts. The fact that this content is often taught in undergraduate courses without any reference to later professional activity makes it difficult for students to deal with the content [1]. For teacher training students, there is also little or no coherence between the engineering and natural sciences and the educational sciences. This inhibits the development and use of specialist knowledge. The lack of reference to later professional activities is seen as a reason for students dropping out in the first semesters [2].

As part of the Quality Campaign for Teacher Education (QLB), sub-project 3 of the TUD-SYLBER BBS project, approaches are therefore being developed to analyze and improve the coherence of content between subject-specific sciences and subject-specific didactics. These approaches are based on the assumption that problem-oriented teaching makes the links between the content clear both within a course and across disciplines and courses [3]. In terms of research methodology, the design-based research approach (see Fig. 1) is followed.

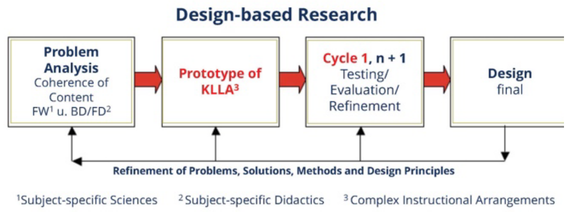


Fig. 1: Design-based research approach for the development and evaluation of complex instructional arrangements (KLLA); own illustration based on Reeves (2006) [4].

To this end, lectures in building physics and physical chemistry were observed and analyzed according to the chosen structure of the content. The results of the current state analysis showed that the lectures and the associated scripts tend to follow a subject-systematic sorting of the content, whose significance for the world of work and life is often subordinated [5]. However, teaching approaches are more cognitively activating if they place the problem at the beginning and derive learning steps logically from this in order to motivate students and set goals [6]. The less problem-oriented the content is in subject-specific courses, the more challenging it is for students to gain an in-depth understanding of the issues addressed in the course. A stronger practical orientation may also increase students' motivation to learn.

The question is to what extent it is possible for the subject sciences to restructure their content for a more problem-oriented teaching approach.

2. First cycle of problem-oriented teaching of building physics

The aim is to make the courses in the specialist sciences more problem-oriented. To this end, lectures in building physics were observed in two consecutive winter semesters (2021/22 and 2022/23) and regularly evaluated with the lecturer. In addition, working meetings were held at which professional and didactic approaches for a stronger problem orientation were presented. On this basis, the lecture content in building physics was restructured for winter semester 2022/23. For this purpose, a renovation project of a villa was placed at the center, which was suitable for sorting the lecture content along the renovation requirements of the villa.

Fig. 2 shows the number of slides that refer to the villa for the respective topics in building physics. A central problem in the renovation of the villa is the formation of mold on the walls, which must be remedied. To this end, the causes must be identified in order to derive appropriate measures for remedying the damage. Fig. 3 shows the relationships to be discussed in abbreviated form in a concept map.

One factor that promotes mold growth is moisture on the surface of the building component. This in turn is caused by condensation water, which forms on the surface of the building component when the temperature falls below the limit temperature. On the construction side, falling below the limit temperature can be prevented by thermal insulation measures. In order to select suitable measures, the conditions of the outdoor and indoor climate must be taken into account.

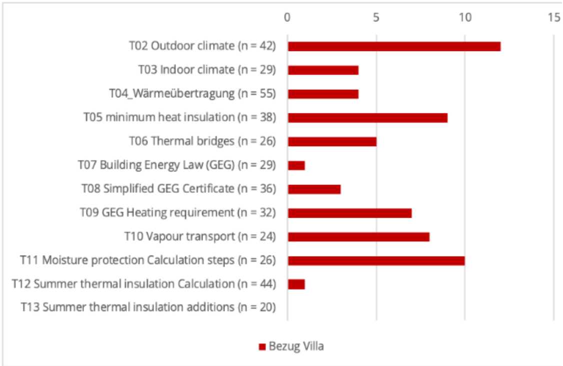


Fig. 2: Number of lecture slides with problem reference Villa in winter semester 2022/23 [2]

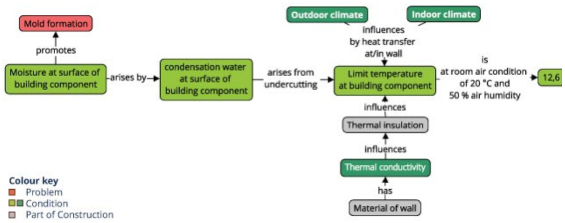
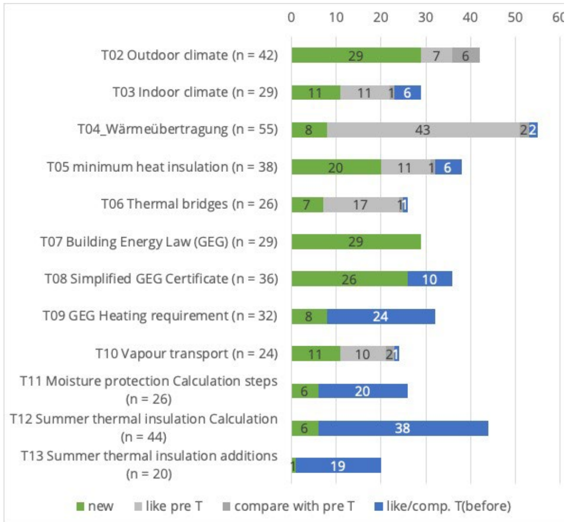


Fig. 3: Concept map of the logical relationships of mold growth in buildings [3]

3. First results of the evaluation

A total of 718 lecture slides were analyzed in the pre-post comparison of the winter semesters mentioned (n(pre) = 317; n(post) = 401). The problem reference to the villa led to the creation of new slides (n = 162), all other slides from winter semester 2022/23 (n = 239) were taken from the previous semester (*as pre T*), partly adapted (*cf. m. pre T*, see Fig. 4). Even if slides from winter semester 2021/22 were not adopted, the total number of slides in winter semester 2022/23 increased significantly (n = 84). It is noticeable that as the topics progress, reference is made to slides from previous topics (*like/comp. T(before)*; see Fig. 4).

In the newly designed slides, aspects relating to the villa in particular have been illustrated. In the revised slides (*cf. with pre T* and *T(previously)*, see Fig. 4), headings were optimized and formulas were supplemented with corresponding illustrations. In some cases, logical breaks were identified in the sequence of the sub-goals associated with the problem.



Legend: T = Topic

Fig. 4: Number of unmodified to slightly modified slides for the building physics lecture in a pre-post comparison [3]

4. Conclusion and outlook

The contents to be worked on in the lecture were well contextualized by the problem reference to the villa. In connection with this, subgoals for solving the problem were formulated (mostly in the form of questions). In winter semester 2022/23, significantly more reference was made to the content of previous lectures than in winter semester 2021/22, so that the lecture topics were better related to each other. Qualitative correlations were better illustrated with figures.

From these findings, it can be concluded that the cognitive activation potential of the lecture topics was significantly increased by the reference to the problem. The increased number of slides that could not be fully covered in the respective lectures is problematic. Therefore, for the second cycle, revision proposals are to be developed as to which lecture content can be dispensed with or made accessible to students in a different form. The contents of the lecture are to be analyzed according to the given subobjectives/learning tasks, the (non-) recurring aspects and routine aspects in order to derive which changes to the sequence of sub-objectives/learning tasks are necessary and which forms of learning support are suitable and possible for the respective sub-objectives/learning tasks. The basis for this revision is the 4C/ID model. This model describes an instructional design that consists of four components: learning tasks, supporting information, procedural information and exercises [7].

- Learning tasks are derived from the subgoals.
- Supporting information refers to the non-recurring aspects of a learning task so that it can be successfully completed by explaining to learners how a *domain* is structured and how to approach the problem solving of a domain. In this way, the process of schema formation is supported so that students can process the new information/learning content more deeply.
- Procedural information specifies how routine aspects of the learning task are to be implemented, preferably in the form of direct, step-by-step instructions.
- Exercises are used to automate recurring aspects of a learning task.

Sorting lecture content according to these four aspects also has implications for the way content is provided in digital formats, which have become particularly important during and after the pandemic. The decisive factor is how sub-objectives/learning tasks are linked to the information required (for processing). With the current version of the lecture slides and the accompanying script, the necessary material basis for a conversion of the content according to the 4C/ID model has already been created.

Acknowledgments

The project on which this abstract is based is funded by the Federal Ministry of Education and Research under the funding code 01JA2022 as part of the joint "Quality Offensive Teacher Training" of the Federal Government and the Länder.

Literature

[1] Leuders, Tim (2020): Coherence and professional orientation in university teacher education. University didactic impulses through the 4C/ID model, in: Jessica Kreutz/Timo Leuders/Katharina Hellmann (eds.), Professionsorientierung in der Lehrerbildung. Competence-oriented teaching according to the 4-component instructional design model, Wiesbaden: Springer VS, pp. 7-24.

[2] Rach, Stephanie (2019): Student teachers in mathematics. How does the analysis of learning prerequisites help us to achieve coherent teacher education, in: K. Hellmann et al. (eds.), Kohärenz in der Lehrerbildung, Wiesbaden: Springer Fachmedien Wiesbaden, pp. 69-84.

[3] Düwel, Frauke/Niethammer, Manuela (in print): Entwicklung eines didaktisch induzierten Ansatzes zur Erfassung der inhaltlichen Kohärenz von Fachwissenschaft und Fachdidaktik, in: Antje Wehner/Nicole Masanek/Katharina Hellmann/Finja Grospietsch et al. (eds.), Vernetzung von Wissen bei Lehramtsstudierenden. A black box for professionalization research, Klinkhardt.

[4] Reeves, Thomas C. (2006): Design research from a technology perspective, in: Jan van den Akker/Koeno Gravemeijer/Susan McKenney/Nienke Nieveen (eds.), Educational design research, Routledge, pp. 64-78.

[5] Kühne, Tino/Hillegeist, Annika/Ott, Marko/Fürstenau, Bärbel et al. (2022): Komplexe Lehr-Lern-Arrangements als gemeinsame Aufgabe von Fachwissenschaft und Fachdidaktik, in: Sebastian Anselmann/Uwe Faßbauer/Hannes Nepper/Lars Windelband (eds.), Berufliche Arbeit und Berufsbildung zwischen Kontinuität und Innovation. Conference proceedings of the 21st Conference of Industrial-Technical Sciences and their Didactics (GTW), Bielefeld: wbv, pp. 91-104.

[6] Baumert, Jürgen/Kunter, Mareike (2011): Teachers' mathematics-specific knowledge, cognitive activation in the classroom and pupils' learning progress, in: Mareike Kunter/Jürgen Baumert/Werner Blum/Uta Klusmann et al. (eds.), Professionelle Kompetenz von Lehrkräften. Results of the COACTIV research program, Münster [et al:] Waxmann, pp. 163-192.

[7] van Merriënboer, Jeroen J. G./Kester, Liesbeth (2014): The Four-Component Instructional Design Model: Multimedia Principles in Environments for Complex Learning, in: Richard E. Mayer (ed.), The Cambridge Handbook of Multimedia Learning, pp. 104-148.

Further literature

[8] Düwel, Frauke (2018): Using concept maps as a supplementary learning strategy in subject-related English lessons, in: Bärbel Fürstenau (ed.), Concept Mapping. Training and instruction examples, Dresden: TU Dresden, pp. 37-54.

[9] Düwel, Frauke (2019): Analysis and assessment of textbook texts from a didactic perspective, in: Berufsbildung. Journal for Theory-Practice-Dialogue, Vol. 73, No. 177, pp. 23-26.

[10] Düwel, Frauke (2020): Lines of argumentation in teaching-learning contexts. Potenziale englischer Fachtexte zur Chromatografie und deren hochschuldidaktische Einbindung, Dissertation, Dresden: Technische Universität Dresden.

[11] Düwel, Frauke/Eichhorn, Sigrun/Niethammer, Manuela (2019): Development of vocational didactic skills. Conceptual approach to linking disciplinary knowledge and vocational didactic knowledge, bwp(at) No. 37, [online] http://www.bwpat.de/ausgabe37/duewel_etal_bwpat37.pdf [18.12.2019].

[12] Düwel, Frauke/Eichhorn, Sigrun/Niethammer, Manuela (in print): Fachdidaktische Einsatzfelder von Concept Maps im Bereich Chemie, in: Bärbel Fürstenau/Jeannine Ryssel (eds.), Concept Mapping als Lern- und Lehrstrategie einsetzen. Theoretische Grundlagen und Anwendungsbeispiele, Leverkusen: Budrich.

[13] Düwel, Frauke/Hillegeist, Annika/Niethammer, Manuela (2022): Quality of vocational learning tasks. Implications for the subject-specific and vocational/didactic professionalization of teachers, in: Sebastian Anselmann/Uwe Faßbauer/Hannes Nepper/Lars Windelband (eds.), Berufliche Arbeit und Berufsbildung zwischen Kontinuität und Innovation. Conference proceedings of the 21st Conference of Industrial-Technical Sciences and their Didactics (GTW), Bielefeld: wbv, pp. 75-92.

[14] Düwel, Frauke/Niethammer, Manuela (2023): Güte von Argumentationslinien in Unterrichtskonzepten im Fach Chemie, in: Helena Van Vorst (ed.), Lernen, Lehren und Forschen in einer digital geprägten Welt, Aachen: pp. 222-225.

Lessons Learned 4, 1&2 (2024)
Submitted: 29.09.2023
Accepted: 16.02.2024
DOI: https://doi.org/10.25369/ll.v4i1/2.83
ISSN: 2749-1293 (Print); 2749-1307 (Online)

Results you can touch: The interdisciplinary aerospace engineering design project

F. Biertümpfel, J. Frey*, S. Schubert, H. Pfifer

[1] *Flight Mechanics and Flight Control, Aerospace Engineering, Mechanical Engineering, TU Dresden*

Abstract: Results you can touch: The interdisciplinary aerospace engineering design project

Within the Interdisciplinary Design Project in Aerospace Engineering, students design unmanned aerial systems for search and rescue tasks. This includes the preliminary design (e.g. aerodynamic design), detailed design (e.g. structural design) and, so far, implementation in a simulation environment. In the current semester, the design is to be brought from the computer into the air. The Chair of Flight Mechanics and Flight Control is providing the electronic and mechanical components (motors, flight computer, etc.) for this purpose. The aircraft structure is to be manufactured by the students themselves. A state-of-the-art laser cutter is available to them for this purpose, which the Chair was able to procure as part of the tender for teaching/learning projects of the Faculty of Mechanical Engineering. This allows the structural parts to be cut quickly and efficiently in wood. The self-built flight system is being evaluated in the wind tunnel and flight tests.

Im Rahmen des Interdisziplinären Entwurfsprojektes Luft- und Raumfahrttechnik entwerfen Studierende unbemannte Flugsysteme für Such- und Rettungsaufgaben. Dies umfasst den Vorentwurf (z.B. Aerodynamische Auslegung), Detailentwurf (z.B. Strukturauslegung) und, bisher, die Implementation in eine Simulationsumgebung. Im laufenden Semester soll der Entwurf vom Computer in die Luft gebracht werden. Hierfür stellt die Professur für Flugmechanik und Flugregelung die elektronischen und mechanischen Komponenten (Motoren, Flugrechner, etc.) zur Verfügung. Die Flugzeugstruktur soll von den Studierenden selbst gefertigt werden. Hierfür steht ihnen ein hochmodernes Laserschneidgerät zur Verfügung, das die Professur im Rahmen der Ausschreibung für Lehr-/Lernprojekte der Fakultät Maschinenwesen beschaffen konnte. Dieses erlaubt den schnellen und effizienten Zuschnitt der Strukturteile in Holzbauweise. Das selbstgebaute Flugsystem wird im Windkanal und Flugversuch evaluiert.

*Corresponding author: juergen.frey@tu-dresden.de

1. Introduction

In the summer semester 2023, the Chair of Flight Mechanics and Flight Control hosted the course "Interdisciplinary Design Project Aerospace Engineering" for the second time. In this project, groups of four to five students design and test a small unmanned aerial system (sUAS) specifically for search and rescue missions. sUAS are virtually predestined for this field of application and their market is therefore growing rapidly [1]. The operation of autonomous aircraft under changing wind and weather conditions is also a central field of research at the Chair of Flight Mechanics and Flight Control [2].

In the course of the semester, participants go through the typical phases of any development project: preliminary design, detailed design including constructive implementation and the implementation and verification of the concept. The latter also takes place practically for the first time in the current year. Students receive standardized commercial-off-the-shelf (COTS) components and construction materials from the chair for implementation. With the help of the laser cutter sponsored by the faculty, the structural components can be produced from the design documents in a short space of time. The assembly is carried out by the students themselves. Similar to large aircraft construction, a wind tunnel test precedes the final flight test.

Such a project requires a high degree of cooperation, self-organization and interdisciplinary thinking from those involved in order to effectively process the various subtasks and bring them together into a meaningful whole. This is all the more important as the task now also includes practical implementation. A large number of detailed solutions must be developed, checked for technical feasibility and ultimately implemented in practice. At the same time, the computational verification remains in the simulation environment, but is reduced in scope compared to the first iteration in favour of the design and practical implementation [3]. A realistic implementation of the overall project is also an essential concern of the course, even beyond the practical implementation. This includes realistic requirements, the development of specifications, reviews, progress meetings and the presentation of milestones in combination with deliverables. These are subjected to strict reviews in the form of presentations.

By working in small groups and regularly checking progress, intensive interaction with each other and with teachers is strongly encouraged and promoted. This trains crucial skills in dealing with each other. In addition, the learning progress of individual participants can be closely monitored and specific problems can be addressed. This allows students to be better supported and challenged individually.

2. Concept of the module and procedure in the first year

The practical implementation of the project in an airworthy model was part of the concept from the very beginning, but could not be put into practice in the first year due to the lack of available production capacities. Instead, the project initially took place exclusively on paper or on the computer [3]. The theoretical tasks were correspondingly more extensive: A separate fuselage was part of the design, a wider range of propulsion options were available for selection, and the simulation was to be carried out more extensively. These sub-areas were later restricted in consideration of the workload.

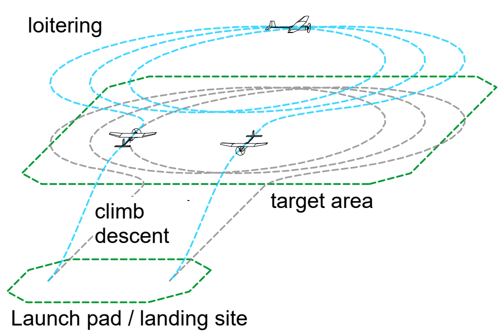


Fig. 1: Illustration of the flight path on a typical search-and-rescue mission.

The project starts with the specification of a apparently realistic operational situation for a small unmanned aerial system: missing persons are to be searched for and found in a target area that is difficult to access (Fig. 1). To do this, the UAV must carry a small camera with the necessary data transmission system as a payload and be able to cover a certain distance to the location. At the beginning, it is launched by hand and climbs independently to its operational altitude. It must operate in the target area for a specified time and search for the missing persons. After returning to the starting point, it lands in a safety net. Sufficient speed and range reserves must be provided in order to complete the mission even in adverse wind conditions. The specifications differ slightly between the groups. This variation is intended to promote the diversity of the designs and the independent work of the groups.

Based on the requirements, which are summarized in a specification sheet, a preliminary design must be developed at that meets these requirements. The aerodynamics are central to this phase; essentially, a suitable wing airfoil must be selected and the necessary lifting surface determined. XFOIL [4], an easy-to-master calculation program based on a 2D panel method with superimposed boundary layer calculation (Fig. 2), serves as a tool for this.

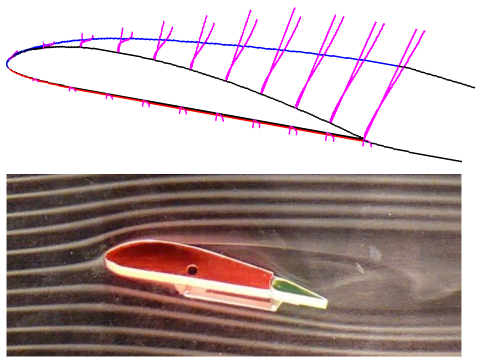


Fig. 2: XFOIL calculation of the flow around an airfoil at a very low Reynolds number (Clark Y, Re=5·10⁴, α=10°, top) compared to the flow visualization (bottom).

Using simple approaches to induced drag and empirical methods for estimating the wall friction on the remaining surfaces [5], an initial polar diagram is created (Fig. 3). This is the starting point for the preselection of drive and battery from a given portfolio.

In the next phase, the detailed design, the actual wing geometry is created with the tip, dihedral and ailerons. The tail unit with elevator and rudder must also be dimensioned. The program Athena Vortex Lattice (AVL) [6], which is based on a vortex lattice method, provides the flight mechanical derivatives (Fig. 4).

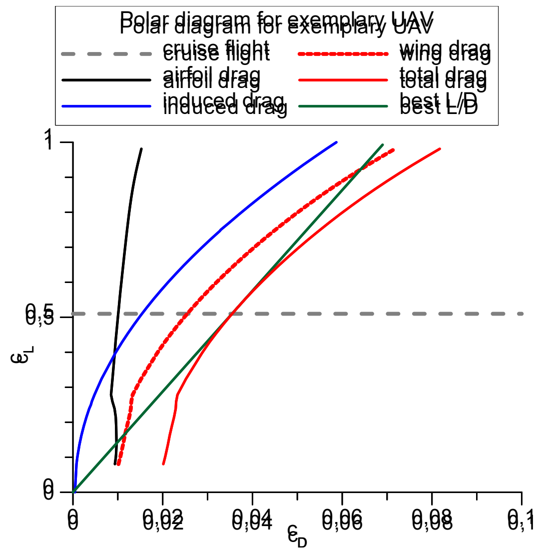


Fig. 3: Representation of an initial polar curve estimated using simple methods (lift and drag in the form of nondimensional coefficients)

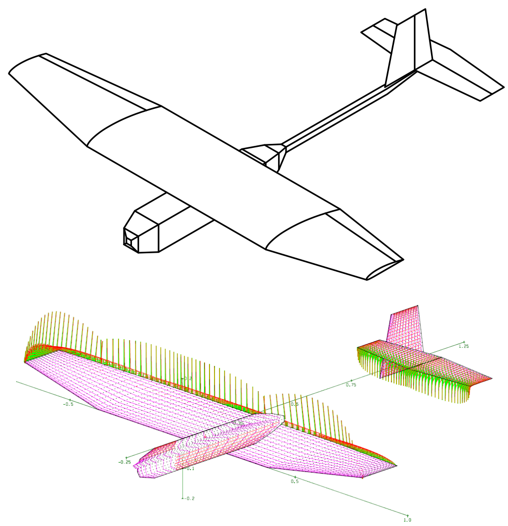


Fig. 4: Geometry of 2023's exemplary design (top) and implementation as a vortex lattice model in AVL (bottom).

Of particular interest is the neutral point position, which determines the permissible center of gravity range in which the aircraft remains stable and controllable. This center of gravity range must be calculated by the students on the basis of the relevant moment equilibria. On the basis of this, the students must position all system components necessary for flight operations (battery, telemetry, Pixhawk flight computer, GPS, etc.) in the fuselage.

A simple structural estimation is also part of the task, both with regard to the final mass and the strength.

The aerodynamic and flight mechanics parameters obtained up to this point are used for implementation in the simulation environment developed in-house, which has been a central component of the course to date.

All calculations with the data from XFOIL and AVL must be carried out in Matlab [7], which makes the solution paths traceable and errors easier to find. In addition, a clean implementation in Matlab allows the students to carry out the necessary iterations in the design process more quickly. The simulation is carried out in the Matlab environment Simulink.

3. Innovations in the summer semester 2023

The main and central innovation is the practical implementation of the design. The funded laser cutter and self-financed components are used for this purpose. This realizes a fundamental component of the methodological-didactic concept of the module: there is a motivating goal with a tangible result. Furthermore, the participants learn about the many small obstacles in the practical implementation of a design, how to deal with them and how to overcome them.

As a result, the focus of the work packages is shifting more towards the actual design. A reference-sUAS (Fig. 4, 7, 8) was designed, constructed and built at the chair in advance. This allowed the lecturers to better estimate the effort required for the individual process steps and to provide the students with more targeted support.

During the design and construction of the UAV, a large number of detailed solutions must be developed and implemented. While the global structure of the wing in spar-rib design with covering is still relatively straightforward, the complexity increases considerably when it comes to the recesses for the control surfaces, the positioning of the actuators and push rods or the removable connection of the wing to the fuselage, including the intersections and cable feedthroughs.

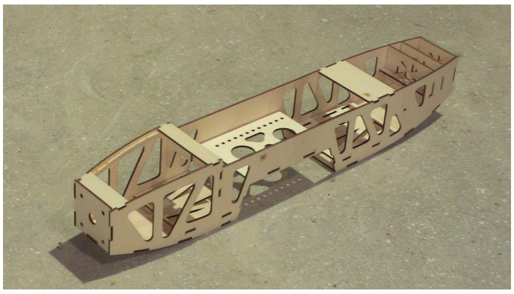


Fig. 5: Standardized box fuselage in the shell construction, still without covering.

A certain simplification and thus reduction of the workload is achieved by tightening the specifications for the available components. The standardized box hull is prefabricated by the chair (Fig. 5).

The tail boom is a simple carbon fiber tube, which allows an uncomplicated variation of the tail unit lever arm. The choice of motors and batteries has also been restricted (Fig. 6). The propeller to be used is predefined.

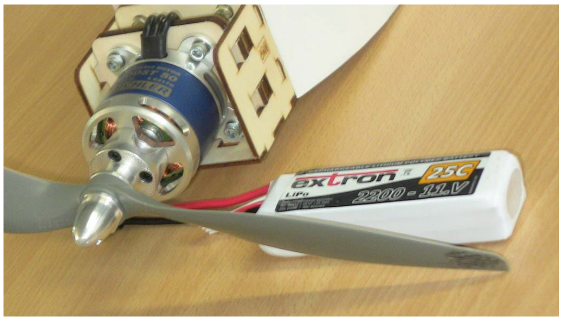


Fig. 6: Motor, propeller and flight battery from the upmarket range of model-making accessories

The wings and tail unit are to be designed and constructed by the students, using the classic spar-rib construction method. It is to be made of aircraft plywood in accordance with the available technology. The laser cutter enables fast and efficient production of the many individual parts as well as simple positioning devices for assembly. The groups assemble the parts themselves under the guidance and supervision of the teaching and workshop staff.

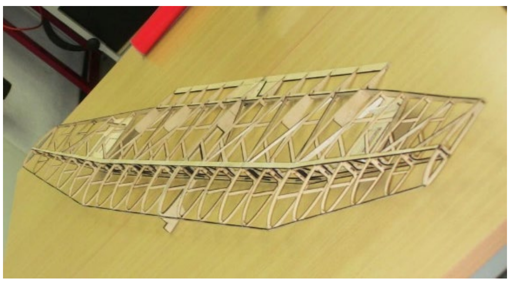


Fig. 7: Spar rib structure of the wing for the reference SUAS.

The finished wing frame (Fig. 7) is then covered with modelling film to create a smooth, closed surface (Fig. 8). For fine adjustment of the center of gravity, the positions of the individual system components in the fuselage can still be moved. In addition, the installation height and angle of the electric motor can be adjusted. The thrust vector should run through the center of gravity as far as possible in order to minimize the thrust-induced pitching moment.

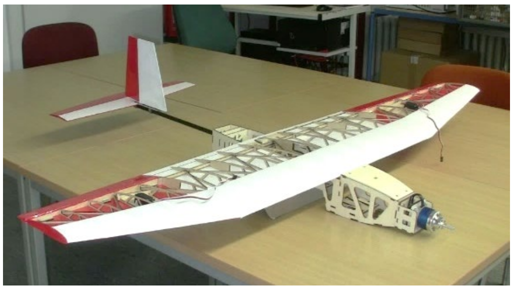


Fig. 8: First estimation of the actual center of gravity on a prism.

Flight control is performed centrally via a Pix hawk autopilot [8]. The Pixhawk flight computer is programmed using QGroundControl [9] on the basis of the flight dynamic properties and controller designs obtained in the simulation. The combination of QGroundControl and Pixhawk makes it easier for students to program autopilots and mission planning (flight routes etc.). QGroundControl also functions also acts as a ground station for the operation of the sUAS.

The interaction of the electronic and mechanical components must then be tested and optimized.

Up to now, the wind tunnel test is still being carried out with a fairly simple tethering, with which the effect of the control system can be demonstrated and checked.

To compensate for the considerable additional work involved in detailed design and construction, the scope of the simulation has been reduced and only a written report is required at the end of the project. The regular presentations on the progress of work have been retained, thus encouraging everyone to keep up the documentation.

4. Increased experience in the 2nd year

Extensive experience was also gained by the participating teachers themselves, who had previously had very little contact with model aircraft construction. This includes the handling of materials, e.g. laser cutting, the range of properties of the semi-finished products supplied, the time required for post-processing and assembly. The concept of the spar-rib composite with interlocking plug-in connections, which are finally fixed with adhesive, proved to be fundamentally suitable. The limitation of the laser cut to flat contours of largely constant thickness makes manual reworking necessary for diagonal stiffeners in particular, which are needed to ensure sufficient torsional stiffness. The center of gravity of the reference model came as a surprise: it was initially significantly more tail-heavy than assumed in the design.

It turned out that, not unexpectedly, the devil is in the details: a solution must actually be found for every little problem. This is particularly true for moving connections and linkages/actuators. A concrete example of another detail is the measurement of the dynamic pressure and thus the airspeed, a key parameter for determining the current flight attitude.

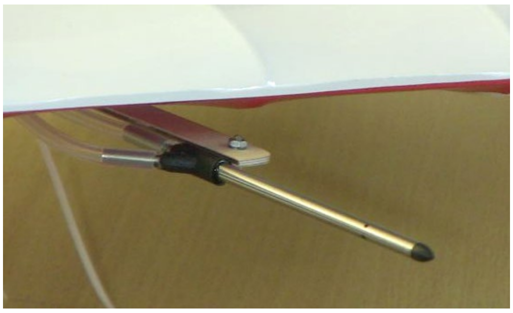


Fig. 9: Pitot-static tube from the model making supplies for taking static and total pressure in front of the wing leading edge

The points at which the total and static pressure are measured for this purpose are always influenced by the flow around the aircraft itself, which in turn depends on the flight attitude. The variable deviation must therefore be estimated and a suitable correction introduced (Fig. 9, 10).

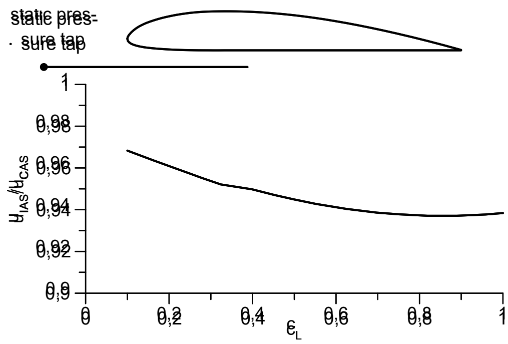


Fig. 10: Error to be expected in the displayed airspeed due to the effect of the pressure field of the wing airfoil on the measurement position (XFOIL calculation)

When the students worked together on site, very specific group dynamics could be observed, which can vary greatly from one group to another. Basically, as in the previous year, the working methods of all groups were characterized by a high level of motivation and great ingenuity and a strong willingness to experiment.

The placement of the course in the timetable (Fr., 1st and 4th lesson) proved to be even less favourable than in the previous year, which meant, for example, that there was not enough time to prepare meaningful questions for the subsequent consultation after the tasks had been handed out. In addition, there were overlaps with other courses with compulsory participation (excursions). The additional dates offered for independent but supervised work were used extensively.

On-going construction work in the wind tunnel building caused some considerable restrictions. This situation posed an additional challenge, but one that could be overcome through mutual understanding among those involved.

The final step was a simplified wind tunnel test with the completed models in a tethered suspension (Fig. 11). This proved that the designs were stable in the airflow in the required speed range.

5. Outlook

In the future, more detailed wind tunnel measurements are planned, which will allow the calculated characteristics to be checked on the real object and thus establish a continuous connection between the predictions of the design and the actual flight characteristics. Student research projects or final theses for a balance with a suitable measuring range are being advertised.

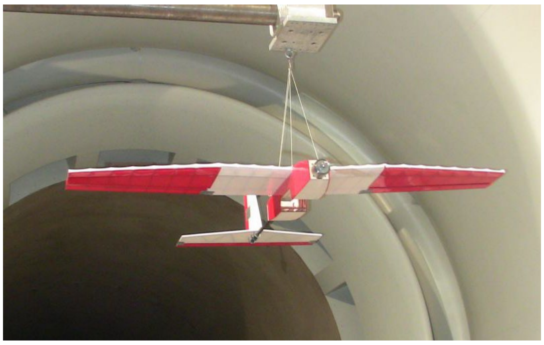


Fig. 11: Model in the wind tunnel on a simple restraint with blocked control surfaces

As part of an ongoing diploma thesis, the characteristic field of a typical propeller was measured in the wind tunnel. This enables a more precise estimation of the performance data, particularly with regard to range and flight duration. A comparison of the actual characteristics with predictions from XROTOR [10] then allows extrapolation to the performance data to be expected in reality for any configuration.

On the material side, the use of thinner plywood and even rigid cardboard is also being considered. On the one hand, this enables the production of lighter structures with a more favourable center of gravity, and on the other hand, it also makes it possible to achieve planked curved surfaces that are characterized by a higher aerodynamic quality. It also makes it easier to produce closed profiles with higher torsional stiffness (nose box) so that diagonal stiffeners can be largely dispensed with.

Fig. 12: Group 1 in front of their design "SN-23 Penguin"

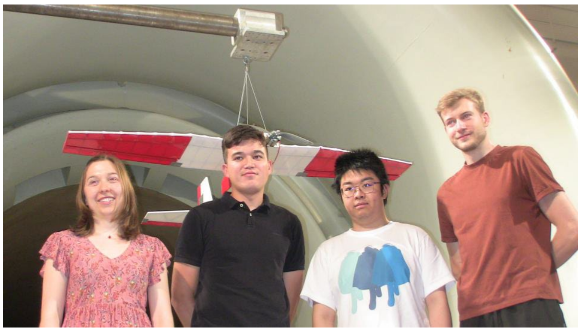


Fig. 13: Group 2 in front of their "FeuerFalke" design

Acknowledgments

The authors would like to thank the Faculty of Mechanical Engineering at TU Dresden for funding the laser cutter as part of the "Call for Teaching/Learning Projects of the Faculty of Mechanical Engineering".

Literature

[1] M. Garvens, Analysis of the German drone market, Unmanned Aviation Association, Berlin, 2021

[2] H. Rienecker, V. Hildebrand, H. Pfifer, Energy optimal flight path planning for unmanned aerial vehicle in urban environments, Proceedings of the 2022 CEAS EuroGNC conference, CEAS, Berlin, Germany, 2022. CEAS-GNC-2022-031

[3] F. Biertümpfel, J. Frey, H. Pfifer, From the computer to the air - The interdisciplinary aerospace engineering design project, Lessons Learned 3, 1 (2023), DOI: 10.25369/ll.v3i1.59

[4] M. Drela, XFOIL: An Analysis and Design System for Low Reynolds Number Airfoils, In: Mueller, T.J. (eds) Low Reynolds Number Aerodynamics. Lecture Notes in Engineering, vol 54, pp. 1-12, 1989

[5] C.-C. Rossow, K. Wolf, P. Horst, Handbuch der Luftfahrzeugtechnik, Carl Hanser Verlag, 2014, ISBN: 9783446436046

[6] M. Drela, H. Youngren, MIT, AVL User Primer - AVL 3.40, 2020, http://web.mit.edu/drela/Public/web/avl/avl_doc.txt (retrieved on 29.09.2023)

[7] The Mathworks, Inc. MATLAB. Version 2021b, 2021

[8] Homepage - Pixhawk, https://pixhawk.org/ (retrieved on 27.09.2023)

[9] QGC - QGroundControl - Drone Control, http://qgroundcontrol.com/ (retrieved on 27.09.2023)

[10] M. Drela, H. Youngren, MIT, XROTOR User Guide, 2003, http://web.mit.edu/drela/Public/web/xrotor/xrotor_doc.txt (retrieved on 29.09.2023)

Lessons Learned 4, 1 (2024)
Submitted: 04.10.2023
Accepted: 22.05.2024
DOI: https://doi.org/10.25369/ll.v4i1/2.86
ISSN: 2749-1293 (Print); 2749-1307 (Online)

The Shanvi project - Discovery-based learning in fluid mechanics

L. C. Haenel, F. Rüdiger, J. Fröhlich*

Chair of Fluid Mechanics, Institute of Fluid Mechanics, Faculty of Mechanical Science and Engineering, TU Dresden

Abstract:

The article provides an initial assessment of the Shanvi learning project (german for Strömungen hautnah, nicht virtuel) It was designed to offer students independent experiential opportunities in fluid mechanics that go beyond regular university operations. Examples are a student project in a company, demonstrations for the general public, small self-steered experiments during lectures and exercises as well as during excursions. In addition to direct exposure to physical phenomena and the autonomous structuring of experiments, another aspect of the project is the promotion of teamwork, which is often lacking in university life. After one year, very positive results are evident, but they also require a corresponding commitment from the faculty.

Der Beitrag zieht eine erste Bilanz des Lernprojekts Shanvi (Strömungen hautnah, nicht virtuell). Es wurde konzipiert, um Studierenden eigenständige Erfahrungsmöglichkeiten in der Strömungsmechanik zu bieten, die über den normalen Universitätsbetrieb hinausgehen. Beispiele sind ein studentisches Projekt in einem Unternehmen, Demonstrationsversuche bei Veranstaltungen für das breite Publikum, sowie kleine, selbständige Versuche in Vorlesungen und Übungen und bei Exkursionen. Neben der direkten Erfahrung zu physikalischen Phänomenen und der eigenverantwortlichen Strukturierung von Versuchen ist ein weiterer Aspekt des Projektes die Förderung der Teamfähigkeit, die im Universitätsalltag oft zu kurz kommt. Nach einem Jahr zeigen sich sehr positive Resultate, doch erfordern diese auch entsprechenden Einsatz des Lehrstuhlpersonals.

* corresponding author jochen.froehlich@tu-dresden.de

1. Motivation

The idea for the project was born in 2022 from the experiences of the coronavirus pandemic and aims to bring students de out of the virtual world and back into the real world through direct contact with flow phenomena. The approach is to encourage students to take their own creative action by providing mobile measurement technology and expert support. Students' interest in self-directed design of learning content and learning methods is to be encouraged in the spirit of discovery learning [1]. Specialist knowledge is practically applied, consolidated and expanded. In addition, general engineering skills (e.g. design of experiment, measurement electronics, and scientific communication) are promoted.

Even before the pandemic situation, there was a tendency for practical aspects of education, and in particular independent learning by students , to play a smaller and smaller role in the learning process - despite the knowledge of its importance. "Independent" here means: set in motion by own motivation, pursued by the inner drive of the joy of discovery and, if necessary, the exchange with peers, as well as the independent formulation of an insight. The pandemic situation has once again massively highlighted the need for such forms of teaching.

Independent learning, even if it is predominantly self-directed, requires expert guidance and supervision, which in our case will take place in the laboratories of the chair. Additionally, the project creates opportunities for interaction with other institutions, e.g. with companies and schools in the region, which broadens students' horizons in the real world.

These issues were discussed among the authors leading to the project objectives formulated in Fig. 1.

Fig. 1: Aims of the project

2. Status of implementation

The learning project is based on mobile measurement technology sets configured in a targeted manner, which make flow phenomena directly tangible through time-averaging methods and visualization of instantaneous flow. Two cases with measurement technology were procured for this purpose, one for measurements in water and one for measurements in air. In addition, a mobile high-speed camera was purchased for observing the processes that are often too fast for the human eye *(Fig. 2)*.

Fig. 2: Measurement technology procured as part of the Shanvi project. Top: AHLBORN measuring device case [2] for measuring the mean flow in air, bottom: CHRONOS 1.4 high-speed camera [3]

The data loggers included in the measurement technology sets enable the connection of additional sensors with voltage output and thus allow students to produce and use their own measuring instruments and probes for their specific application.

Activities planned as part of the project include

- Support for students' own projects,
- Student projects in cooperation with companies in the region,
- thematic excursions,
- student contributions to exercises,
- Lecture experiments and demonstration experiments and
- internships of high-school students.

In the first year since the start of the project, the following activities were supported:

- Excursion of an 11th grade class from Schwerin to Dresden with a visit to the Chair of Fluid Mechanics in June 2022
- Internships of pupils in spring 2022 (10 participants) and spring 2023 (6 participants), see Fig. 4
- Practical course on experimental fluid mechanics in summer semester 2022 and summer semester 2023
- Demonstration experiments for the courses "Technical Fluid Dynamics" and "Gas Dynamics"
- Long Night of the Sciences (LNdW) 2022 and 2023, see Fig. 3
- Excursions with staff and students of the chair to the Rabenauer Grund (July 2022) and the Dresden Heath (July 2023)
- Measurements in a test setup for the production of paper fleece in the Bärenstein paper mill (Fig. 5)
- Use of the high-speed camera to demonstrate everyday effects such as the coalescence of soap bubbles (Fig. 7)
-

3. Experience in the individual projects

Demonstrations LNdW

During the Long Night of Science, the high-speed camera was used to observe the rise of bubbles in a water column (Fig. 3). The camera was set up in such a way that recordings can be made, saved and played back directly from the camera without a computer. Visitors were thus able to get a vivid picture of the rise of bubbles of different sizes and related form instability, which is a subject of the chair's current research work. Thanks to the availability of the measurement technology, it was possible to independently determine ascent speeds and bubble sizes by reading the time and position from the camera image and thus carry out observations using the diagram provided. The clear presentation offered many opportunities to build on the various previous knowledge and to impart knowledge and methods in dialog. The new measurement technology thus opened up new opportunities for communication, both with the general public and with the students present during the LNdW.

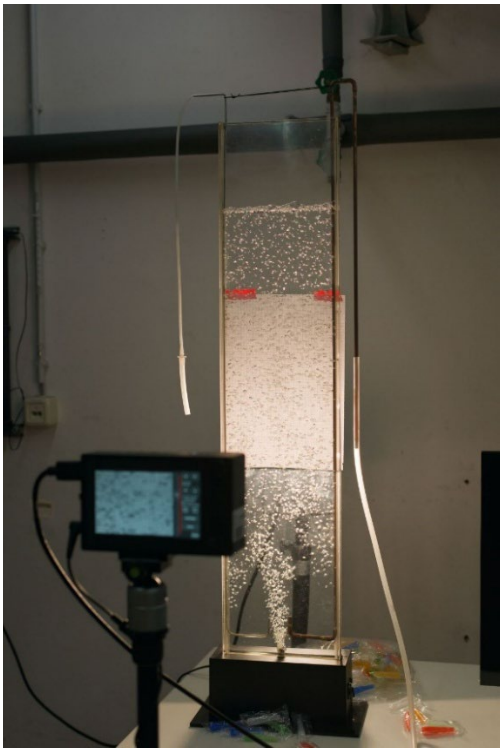


Fig. 3: Use of the high-speed camera on the bubble column for the Long Night of Science 2022

Student internships:

Various previously initiated internships of high-school students were carried out as part of the project. The main focus was on awakening interest in science, particularly in fluid mechanics. Instead of just frontal teaching, the pupils were encouraged to deal with the subject matter independently by carrying out experiments in which the setup, implementation and evaluation were discussed among themselves with the support of a supervisor. This enabled the pupils to actively experience science and thus gain their first child-friendly insights into research.

Fig. 4: Measuring a free beam during the 2023 student internship

Project: Flow-induced inhomogeneities in non-woven deposition

As part of an investigation to improve a test stand for dry web separation (Fig. 5 and 6), different flow velocities were measured at various points in front of the screen for collecting the fibers using mobile measurement technology. The different velocities indicate an inhomogeneous flow, which explains the irregular surface of the nonwoven as shown in Fig. 6. Based on the measured values, a simulation to improve the flow conditions could be validated allowing measures for improving the test stand at a later stage.

These investigations were used to establish contacts with two companies in Saxony. Furthermore, the student involved, through his on-site measurement campaign, also gained an insight into paper production and into the engineering work in a paper mill, i.e. the day-to-day work of a professional engineer in industry. For the chair, these investigations open up opportunities for further research activities and cooperation.

Fig. 5: Experimental setup for the production of paper fleece

Fig. 6: Non-woven layer after completion of the deposition process

Coalescence of soap bubbles

The high-speed camera offers the possibility of imaging exciting everyday effects, such as the coalescence of soap bubbles. In a research project at the Institute of Fluid Mechanics, it was possible to show how the soap bubbles merge and form a single bubble. Due to the high number of images that can be recorded per second, it is possible to depict the individual phases of this effect step by step and thus make visible what would otherwise remain hidden to the human eye.

Fig. 7: Presentation of everyday effects, such as the merging of soap bubbles and the associated change in shape and size, as part of a 2023 diploma defence. Recorded with the high-speed camera.

Student's self-proposed projects

In the lectures of the chair, students were encouraged to come forward with their own research questions that they would like to investigate under supervision using the measurement technology procured. Unfortunately, despite several calls, there were no reports of this kind. The authors attribute this to the fact that no credit points can be acquired with such an independent project, but "only" knowledge and the joy of implementing one's own ideas. In the current study situation, with pressure on grades and little time, this approach has unfortunately not yet been possible. Nevertheless, the opportunity to carry out independent projects will continue to be offered and advertised. This includes that students carry out studies on their own topics and have them recognized as coursework. Particularly for distance learning students, this opens up opportunities to work not only theoretically or numerically but also experimentally.

Options for expansion

It was found that the range of possible investigations can be significantly enlarged by using apps for cell phones, among others. Here, for example, phyphox was used to measure various physical parameters (RWTH Aachen), as well as SmartPIV, an application for measuring velocity fields (TU Ilmenau). This potential is to be further explored in the future and will be used to increase the attractiveness of studying fluid mechanics phenomena.

4. Summary and outlook

In all the activities carried out so far as part of the project, the participants have gained a better understanding of the flow phenomena they have investigated themselves or demonstrated in experiments. The personal experience of the flow situation and the experience of carrying out self-steered measurements - especially learning from the mistakes made - have contributed to the enthusiasm for the topic. The use cases designed in the first year will be expanded in the future. In particular the high-school students internships can promote interest in STEM subjects and thus counteract the decline in the number of university students.

5. Acknowledgements

The authors would like to thank the Faculty of Mechanical Science and Engineering for funding the measurement technology required for realizing this learning project.

Literature

[1] In discovery learning, the focus is on learning stimuli or learning arrangements that are intended to motivate self-active learning [Wikipedia]

[2] https://www.ahl-born.com/de_DE/produkte/messgeraetekoffer (19.06.2022)

[3] https://www.krontech.ca/product/chronos-1-4-high-speed-camera (19.06.2022)

Lessons Learned 4, 1 (2024)
Submitted: 21.11.2023
Accepted: 21.12.2023
DOI: https://doi.org/10.25369/ll.v4i1/2.89
ISSN: 2749-1293 (Print); 2749-1307 (Online)

The effects of peer observation on the quality of a tutorial: A case study

M. Ludwig[1], P. Thamm[2]

[1] Center for Interdisciplinary Learning and Teaching, TU Dresden
[2] Professorship for Vocational Education and Professorship for Health and Care/Vocational Didactics, Institute for Vocational Education and Vocational Didactics, Faculty of Education, TU Dresden

This article uses a case study to illustrate the structured approach to (peer) observation. First, it shows how peer lead observation can support specialist teaching. Subsequently, the general effects of peer observation and possible observation aspects are presented. This form of quality assurance in tutorial teaching enables an exchange at eye level in the form of collegial observation at peer level. This allows "blind spots" in one's own teaching activities to be addressed transparently in the feedback discussion. The possible discrepancy between self-perception and external perception (of teaching activities) is also broken through the change of perspective. Specific observations and assistance are presented in the case study.
With the help of observation and a subsequent feedback discussion, these didactic adjustments can be uncovered and one's own teaching style can be changed for the better by applying the adjustments. At the same time, didactically well-executed teaching at peer level has a motivating effect that encourages students to attend courses in person again.

Dieser Artikel veranschaulicht mit einem Fallbeispiel das konkrete und strukturierte Vorgehen bei einer (Peer-) Hospitation. Zunächst wird dargestellt, wie Peer-Angebote die fachliche Lehre unterstützen können. Anschließend werden generelle Effekte einer Hospitation und mögliche Beobachtungsaspekte vorgestellt. Diese Form der Qualitätssicherung der tutoriellen Lehre ermöglicht in Form kollegialer Hospitation auf Peer-Ebene einen Austausch auf Augenhöhe. Hierdurch können „Blinde Flecke“ der eigenen Lehrtätigkeit transparent im Feedbackgespräch thematisiert werden. Auch die mögliche Diskrepanz zwischen Selbst- und Fremdwahrnehmung (der Lehrtätigkeit) wird durch den Perspektivwechsel durchbrochen. Es werden im Fallbeispiel konkrete Beobachtungen und Hilfestellungen dargestellt.
Mit Hilfe einer Hospitation und einem anschließenden Feedbackgespräch lassen sich diese didaktischen Stellschrauben aufdecken und der eigene Lehrstil kann durch Anwendung der Stellschrauben zum Positiven verändert werden. Zeitgleich wirkt eine didaktisch gut durchgeführte Lehre auf Peer-Ebene motivierend, um wieder in Präsenz an Veranstaltungen teilzunehmen.

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

1. Finding your way out of "presence fatigue" with peer offers

The COVID-19 pandemic has resulted in lower participation rates in university courses and a prevailing "online fatigue" [1], which is currently turning into "presence fatigue" and a lack of commitment to participation. What is needed is commitment and motivation, which is conveyed via peer offerings, among other things. Well-trained peers who act as teachers in tutorials (tutors) "build a bridge here" [2].

2. Understanding a tutorial

In this context, a tutorial is understood as a teaching unit or a learning group that is led by a student tutor. In a tutorial, students come together at a learning location to practise subject-specific content in depth, discuss certain topics, clarify questions or receive additional support as equals in a peer-to-peer setting. In this abstract, tutorials also refer to exercises that are led by a tutor. In principle, tutorials are offered in university teaching to supplement or accompany lectures or seminars.

3. Understanding observation

Observation in a tutorial refers to a setting in which one observes and participates in such a tutorial [3]. During an observation, the observing person has the task of recording previously defined observation focal points:

- the structure and sequence of the content – clarity in goals of practice (e.g. are the individual phases logically linked and are they oriented towards learning objectives or competencies?)
- the methodological and didactic design of the tutorial (e.g. the choice of work and social forms, as well as the appropriate integration of selected media and materials such as worksheets, presentations, other learning objects for illustration)
- the social interaction between the participants and the tutor as well as the collection of feedback (e.g. the way of communication and the learning atmosphere in the group)
- the ability of students to engage in self-directed learning (e.g. understandable and comprehensible explanations of existing problems or exercises and encouragement to develop independent solution strategies)
- the presentation style of the tutor (e.g. the use of facial expressions, gestures, language and expression)
- the tutor's leadership function (e.g. first appearance in front of the students and role awareness)
- participants‘ feedback to lesson

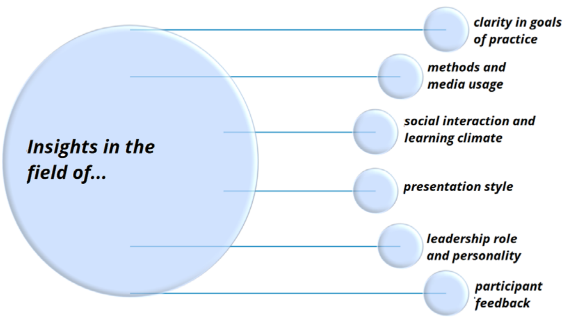


Fig. 1: Observation dimensions of the hospitation ***[created by M. Ludwig]***

4. Effects of observation

This provides insights into the tutor's teaching activities and offers the opportunity to identify proven teaching strategies, reflect on pedagogical approaches and suggest possible improvements or adjustments.

Furthermore, peer observation promotes a change of perspective on the part of the tutor, as the tutor's own perspective and that of others are perceived. This procedure therefore makes it possible to discover the "blind spot" [4] in one's own teaching activities. In addition, the defined observation focus provides new insights and impulses and can therefore make a professional contribution to university teaching.

The observation can also serve to promote the exchange of best practices, strengthen the pedagogical skills of the tutor and improve the overall effectiveness of the learning process within the tutorial.

5. The prototypical course of an observation program at the Technical University of Dresden

At the beginning, the tutor voluntarily contacts the TUTORING hybrid team and expresses the wish to take advantage of a peer observation.

After an appointment has been made, the so-called preliminary interview and a short survey on the observation focus follow. The following points are discussed in this interview:

- Content of the tutorial
- Aim of the tutorial
- Number of participants
- Format (in presence or online)
- Suitable internship date
- Experience of the tutor (previous experience, prior knowledge, professional expertise)
- Feedback requests from the tutor
- Problems and challenges encountered in past tutorials
- Clarification of the procedure on the day of the peer observation (transparency about the observation etc.)
- Agreement on confidentiality and the protected framework at peer level
- Arrangement of a feedback appointment

The criteria-based observation then takes place. Right at the beginning, the tutor explains the new context and the observation situation to the group and then starts with the content of the lesson. The observer chooses a place in the room that allows all participants to be seen from behind. In addition, the entire room and the prepared materials should be visible. Meanwhile, the observer makes notes on the desired feedback aspects in a previously created observation protocol and notes down interesting facets of the teaching activity and skills in a resource-oriented manner. During the ongoing tutorial, no intervention is made and no comments are made. Only the observation process takes place.

In the feedback discussion that follows immediately or takes place later, the tutor is first asked about their own assessment, the so-called self-perspective. This is a form of self-reflection. Which aspects did the person themselves notice, which were they not aware of? Where were obstacles encountered and what went really well? What didactic questions or adjustments arose after the tutorial? Wisniewski and Zierer (2018) describe professionalism in relation to the teaching profession as "reflexivity in relation to one's own professional actions" [5]. In order to "act professionally as a teacher, one's own routines must be constantly questioned. Among other things, self-reflection can serve this purpose. However, this should be supplemented by "external data." [6].

Depending on the agreed observation focus, the questions for self-reflection can vary, for example, more specific feedback on one's own leadership function and group dynamics can be focused on.

Here too, the observer makes notes and then responds to the questions or perceptions. In addition, all thematic blocks of the observation protocol are discussed and feedback is formulated in a constructive and appreciative manner. This relates primarily to the desired aspects (e.g. presentation style, methodological and didactic process, etc.). If there are no more open questions, the feedback session ends and the tutor is then sent the observation protocol by email to secure their own results.

Templates already exist for all of the steps mentioned, which are currently being revised and standardized in order to achieve a consistently high quality of observation and feedback.

It should be noted here that the confrontation of the observed person with the "blind spot" can lead to an emotional situation with unpleasant feelings. It is therefore important to emphasize that no subjective evaluation process takes place, but rather an objective observation according to previously defined criteria, in order to transparently illustrate any defensive or unconscious aspects of the teaching function and to derive various offers of support for the tutor from this.

Each individual step described requires expertise, which is provided by trained or appropriately trained observers. If the observation is implemented as "collegial observation" by peers, the commitment of the person being observed is also increased.

6. A case study

The following case provides insights into the teaching reality of a tutor in the engineering sciences department at the Technical University of Dresden and at the same time shows what important adjustments are needed in the didactic training of tutors.

In the summer semester 2023, an exercise was observed at the Faculty of Mechanical Engineering. In the preliminary discussion, the wish was expressed to get ideas for more interaction between the students and the tutor. Students would often not speak up, even if they actually had questions. It would therefore be interesting to shape the relationship in order to examine the openness, cooperation and barriers of the participants more closely.

Right at the beginning of the tutorial, the tutor pointed out the observation as agreed and the tutorial started. There were around 35 students present and it was the second and, according to the tutor's assessment, "louder" tutorial of the afternoon. After a review of the content and a classification of the topic, an outlook on the lesson was given. Meanwhile, the doors and windows of the large seminar room remained open - students came and went. The further back, the louder the side conversations were.

The tutor used a tablet as a work object to illustrate his content using a projector presentation. He always made it clear on the tablet what he was talking about with markings that remained for a short time and then disappeared again. This led to the effect that he primarily looked at the tablet and hardly made direct eye contact with the students. There were short question-and-answer dialogs that took place between him and students in the front row of seats. The dialogs could no longer be understood due to the restless working atmosphere at the back of the room. The tutor did not repeat any questions or answers and there was no demand from the students in this regard. There were also numerous spelling mistakes in the presentation documents.

When asked, it turned out that the tutor had used documents from his predecessors and had not noticed the mistakes. No one in the audience drew his attention to this either.

After a half-hour introduction to the topic, the students were given an exercise unit in which they were to work independently on the steps just shown in the exercise booklet. There were no didactic instructions as to how this should be done or which working or social forms should be used (individual work, partner work or group work). The tutor walked between the rows and answered questions quietly.

Afterwards, the overall content of the training session was summarized once again and an outlook on the next content was given.

7. Evaluation

In the feedback discussion that immediately followed, the tutor himself recognized a few of the disruptive factors mentioned (for example, restlessness in the room and little interaction). In the end, it was possible to jointly identify important parameters for more peace and quiet in the room as a basis and quality aspect for "good teaching":

1. Clearly communicate the start and end of the tutorial and signal important content sequences via body-space presence: Clearly close the door and stand at the front, look at the participants and wish them a good day in a friendly and determined manner to start.
2. Establish clear rules: Please arrive on time and let me know if you have to leave early. Cancellations in the event of illness are also relevant in order to provide more planning security.
3. Show presence in the form of facial expressions and gestures throughout the room: Walking around while telling the story involves participants sitting at the back and tries to create an active interaction.
4. Repeat participants' questions if they were quiet. Students sitting at the back ask

whether the questions are understandable and include feedback from participants.

5. Actively involve participants through an appealing methodical design. For example, by including questions ("Do any of you already know the answer?") to build on previous knowledge.
6. Instruction of group work forms: encourage group work, give concrete small-step instructions, thus establishing active and passive shorter learning phases in the tutorial and supporting learning processes in peer format.

It was suggested that the tutor should set himself the goal of implementing exactly one new aspect for his next tutorial (e.g. signaling more presence in the room during the storytelling). In the next sessions, further aspects could then be taken up and implemented in the tutorial. For example, formulating questions in such a way that they remain open: "What thoughts do you have on this topic?" instead of "Do you have any questions?").

8. Conclusion

In retrospect, it is clear that peer observation enables an exchange at eye level. This allows "blind spots" in one's own teaching activities to be addressed transparently in the feedback discussion. The possible discrepancy between self-perception and external perception (of teaching activities) is also broken through the change of perspective. With this approach, didactic levers can be uncovered in the future and one's own teaching style can be changed for the better by applying the levers. At the same time, didactically well-executed teaching has a motivating effect at peer level to participate in courses in presence again.

Literature

[1] Sälzle, S. et al (2021): Development paths for higher education and teaching after the corona pandemic. 1st ed. Baden-Baden: Tectum.

[2] Krappmann, L. & Oswald, H. 1995. Invisible through visibility: The participant observer in the classroom. In: Imke Behnken and Olga (eds.) Childhood and School. Weinheim: Beltz, 39-50.

[3] Koenen, S., 2019, Peer observation in the classroom. GRIN Verlag, https://www.grin.com/document/497887 (23.06.2023)

[4] Luft, J. & Ingham, H.: The Johari window, a graphic model of interpersonal awareness. In: Proceedings of the western training laboratory in group development, Los Angeles: UCLA, 1955.

[5] Wisniewski & Zierer. 2018. Visible Feedback A guide to successful teaching feedback. Schneider publishing house.

[6] University of Osnabrück: How is peer observation carried out? In: https://www.uni-osnabrueck.de/studium/im-studium/professionalisierung/tutoren-und-multiplikatorenprogramm/angebote-fuer-tutorinnen/#c14890 [23.06.2023]