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Student perspective on digitization

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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.

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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.

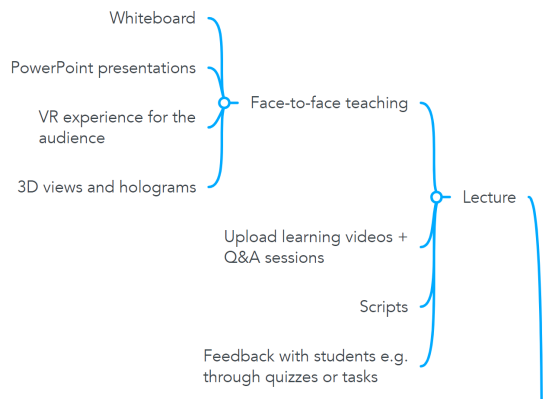

Figure 1: Concept for a lecture, created by workshop participants

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.

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