Lessons Learned 2, 1 (2022)
Submitted: 19.04.2022
Accepted: 24.06.2022
DOI: https://doi.org/10.25369/ll.v2i1.34
ISSN: 2749-1293 (print); 2749-1307 (online).

Study 2.0 - Presence, Digital or Hybrid?

M. Fiedler*, J. Kaliske, M. Kästner

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

Abstract

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

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

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

1. Introduction

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

2. definition presence, digital and hybrid

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

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

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

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

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

3. current state of the art in teaching operation

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5. application example subject technical mechanics for industrial engineers

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

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

Presence teaching (before 2020)

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

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

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

The negative effects, however, were:

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

Digital teaching (from 2020)

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

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

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

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

The negative effects, however, were:

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

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

Hybrid teaching (since WiSe 21/22)

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

6. possibilities of hybrid studies at the TU Dresden

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

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

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

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

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

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

Szenario 1: Blockweise Campus-Wechsel

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

Szenario 2: Täglicher Campus-Wechsel

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

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

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

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

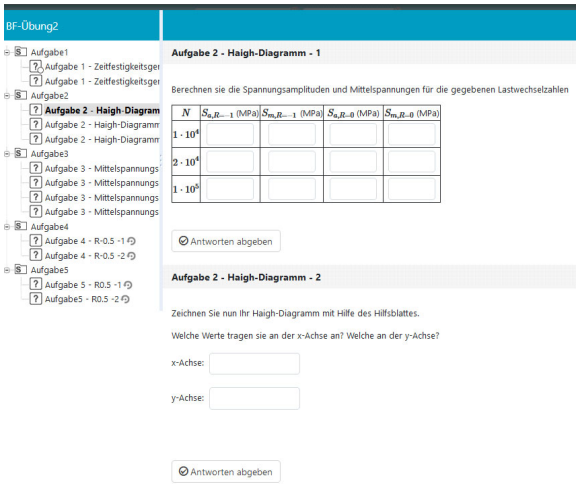

Figure 2: Self-learning scenario for checking the intermediate solutions of the classroom tasks

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

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

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

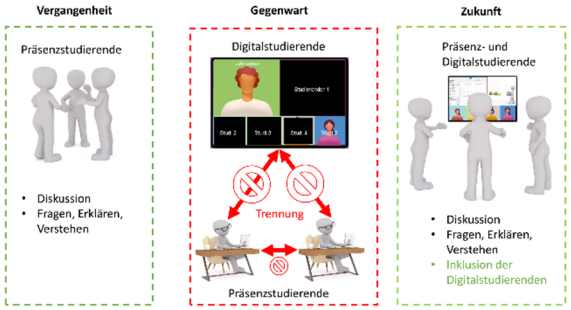

Figure 3: Inclusion of digital students in face-to-face courses

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

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

7. Summary

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

Table 1: Comparison of the variants of the hybrid gauge

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

Literature

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

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

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

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

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

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

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