



Presentation and student evaluation of digital learning formats in two methodological basic subjects of mechanics

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Die pandemiebedingte Umstellung der Präsenzlehre auf digitale Lernformate brachte vor allem für die Studierenden große Herausforderungen mit sich. Die beiden vorgestellten, methodischen Grundlagenfächer der Mechanik wurden vollständig digital angeboten. Zur Stoffvermittlung wurden aufgezeichnete Lehrvideos und zur Fragenbeantwortung vor allem Übungsforen eingesetzt. Mithilfe von Umfragen unter allen Prüfungsteilnehmenden wurden die eingesetzten Lernformate evaluiert. Es zeigt sich dabei, dass aufgezeichnete Vorlesungsvideos gegenüber Präsenzvorlesungen von den Studierenden als hilfreicher wahrgenommen werden. Als Vorteil wird dabei die Möglichkeit zum Anhalten und Wiederholen der Vorlesungsvideos genannt. Das Übungsforum wird zwar als eher hilfreich bewertet, jedoch nicht als adäquater Ersatz zur Präsenzübung eingeschätzt. Laut den studentischen Kommentaren spielt die direkte und unmittelbare Kommunikation in der Präsenzübung eine wichtige Rolle, die in einem Forum nicht erreicht werden kann. Die beste Bewertung unter den Lernformen erzielten kurze Einführungsvideos in die Thematik und Aufgaben der Übungen.

The pandemic-induced migration of classroom teaching to digital learning formats brought great challenges, especially for the students. The two presented methodical subjects in basic mechanics were offered completely digitally. Recorded teaching videos were used to convey the course content and mainly exercise forums were used to answer questions. The learning formats used were evaluated with the help of surveys among all examination participants. The results show that the students prefer recorded lecture videos over classroom lectures. The possibility of pausing and repeating the lecture videos was named as an advantage. The exercise forum is rated as helpful, but not as an adequate substitute for the classroom exercise. According to the student comments, direct and immediate communication plays an important role in the classroom exercise, which cannot be achieved in a forum. The best rating among the teaching formats was achieved by short introduction videos on the topic and tasks of the exercises.

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1. Introduction

The shift in university teaching from the classroom to the digital space over several semesters due to the Corona pandemic has brought great challenges, especially for students. Especially in calculation-intensive subjects such as technical mechanics, teaching basic methods in classroom exercises is an essential part of the usual course programme. This article deals with the realization of digital teaching in two subjects of the Chair of Dynamics and Mechanism Design at TU Dresden in the summer semester 2020 and the evaluation of the implemented learning formats by all students who participated in the corresponding written examination.

2. Presentation of the courses

The course *Technical Mechanics Kinematics and Kinetics* (TMKK) is a compulsory course with 3 credit hours per week (CHW) lecture and 2 CHW exercise in the diploma and bachelor degree programme Mechanical Engineering in the 4th semester. In attendance semesters, the exercises take place in groups of 20 to 60 students. The audience of the English-language course *Kinematics and Kinetics of Multi-body Systems* (MBS) consists mainly of students of the degree programmes Mechanical Engineering in the specialisation Simulation Methods in Mechanical Engineering (MB-SIM), Mechatronics (MT) and Computational Modelling and Simulation (CMS). The students regularly attend 2 CHW lecture and 2 CHW exercise. In addition, students of the mechanical engineering specialisation in Processing and Textile Mechanical Engineering (MB-VTMB) regularly attend half the course content with 1 CHW lecture and exercise each. For the diploma degree programmes (MB-SIM, MB-VTMB, MT), this is a elective course in the main study period.

3. Digital learning formats in TMKK

In the course TMKK, lecture recordings were available that were recorded by the AG Fernstudium (correspondence course team) of the Faculty of Mechanical Engineering at the TU Dresden in 2015 during the regular lecture.

The respective lecture videos were released in the corresponding semester week on the saxon learning platform OPAL using the video server MAGMA. The lecture content is mainly taught using hand written notes on a tablet computer (see Figure 1).

For the respective exercises, detailed introduction slides, instructions for solving the single tasks and detailed sample solutions were provided. In addition, the first two exercise introductions were recorded on video. This video production was not continued for the further exercise introductions due to capacity reasons of the teaching staff. Questions about the exercises and for exam preparation could be asked in an OPAL forum. A separate forum was set up for each exercise. Online consultations were offered approximately every fortnight, although this offer was only used by an average of 5 students.

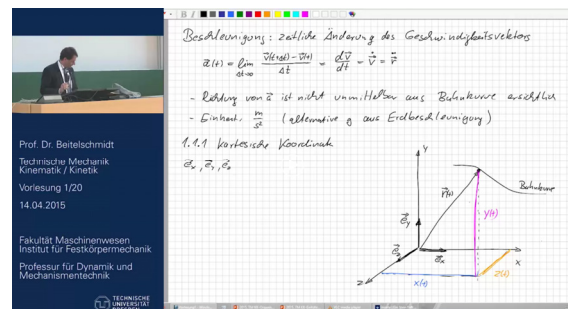


Fig. 1: Lecture TMKK, recording of the AG Fernstudium of the Faculty of Mechanical Engineering at TU Dresden.

4. Digital learning formats in MBS

The lectures of the MBS course are designed as a combination of slide presentation and handwritten tablet lecture. The lecture videos (see Figure 2) were recorded during the semester. The actual video duration is shorter than the usual lecture time of 90 minutes due to a lack of questions and spontaneous additional explanations.

While changing the course language from German to English one year before, slide-based introduction videos (intro videos) of approx. ten minutes were produced for all exercises (see Figure 3). As in TMKK, the OPAL forum was used to answer questions about the exercises and sample exams.

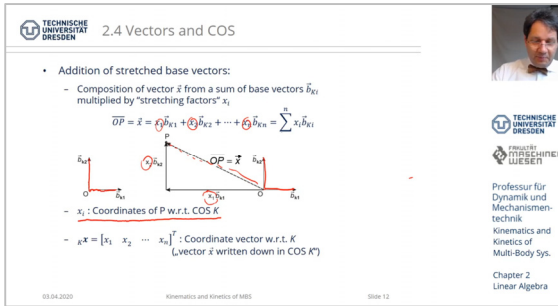


Fig. 2: Lecture MBS, slide with handwritten comments, recorded using OBS Studio.

The final course element is a complex exercise. In the digital semester, it took place partly in presence, but with low participation. The aim of the complex exercise is to program a multi-body simulation in the commercial software MATLAB. For examination preparation, one online and one classroom consultation took place.

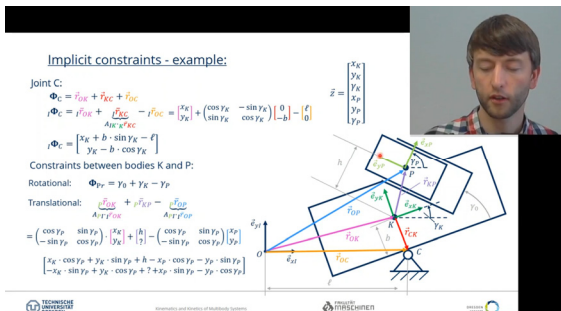


Fig. 3: Exercise introduction MBS, example calculation on PowerPoint slide, recorded using OBS Studio

5. Evaluation of the courses

In order to allow a comprehensive teaching evaluation, an anonymous survey with approx. 20 questions and comment fields was conducted among all examination participants at the end of the respective written classroom examination. Thus, 338 filled surveys are available for the TMKK course and 70 for MBS. Further 52 completed surveys with partly identical questions are available for the MBS course of the previous year. This allows a comparison between the digital and the classroom semester.

In the diagrams for the TMKK course, the proportion of students who have repeated the examination and have thus already attended the

course for the first time in a regular classroom semester is marked in orange. This applies to 16% of the base students who took the examination. In the course MBS, a distinction is made between the student groups Mechanical Engineering-SIM/Mechatronics (blue), CMS (orange) and Mechanical Engineering-VTMB (yellow). Due to negligible failure rates, the proportion of students repeating the exam plays a subordinate role here.

Prüfungsversuch:	<input type="radio"/> Erstversuch	<input type="radio"/> Zweit- oder Drittversuch				
Muttersprache:	<input type="radio"/> Deutsch	<input type="radio"/> Andere				
Aussage (Bitte bewerten Sie nur Aussagen, zu denen Sie aussagefähig sind)	Trifft voll zu	Trifft zu	Teils/Teils	Trifft kaum zu	Trifft nicht zu	Keine Aussage möglich
Ich konnte der Vorlesung inhaltlich sehr gut folgen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich konnte den Video-Vorlesungen besser folgen, als „normalen“ Vorlesungen in Präsenz.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich habe die Videos zur Vorlesung in der jeweils vorgesehenen Woche angeschaut.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich hatte technische Probleme, die Videos anzuschauen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Die Einführungen und Lösungen zu den Übungen waren sehr hilfreich für mich.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich habe die Übungsaufgaben in der jeweils vorgesehenen Woche bearbeitet.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich habe mich regelmäßig mit Kommilitonen über Vorlesung bzw. Übung ausgetauscht.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Das Übungsforum war für mich sehr hilfreich zur Bearbeitung der Übungsaufgaben.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich hatte technische Probleme bei der Teilnahme an den Online-Konsultationen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Das Prüfungsforum hat mir in der Prüfungsvorbereitung sehr geholfen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vor der Prüfung habe ich mich sehr gut vorbereitet gefühlt.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bei der Prüfung habe ich gemerkt, dass ich sehr gut vorbereitet war.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Die Möglichkeit, das Prüfungsergebnis im Nachgang zu annullieren, beeinflusste meine Prüfungsvorbereitung.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Es fiel mir in diesem Semester schwer, mich für die Bearbeitung der Kursinhalte zu motivieren.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Fig. 4: Front page of the survey in the TMKK course

As shown in Figure 4, most of the survey questions offered 5 response options ranging from "1: Fully true" (left) to "3: Partly true" (middle) to "5: Not true" (right). Deviating answer options are marked in the respective diagrams.

6. Comparison of face-to-face and online semesters

The comparison between classroom and online semester reveals a differentiated picture. Figure 5 shows the TMKK students' rating of the statement whether they were able to follow the online lecture better than normal classroom lectures. With an average rating of 2.55, the students stated that they were able to follow an online lecture better. The statement whether they were able to follow the online lecture very well was rated with 2.41 on average.

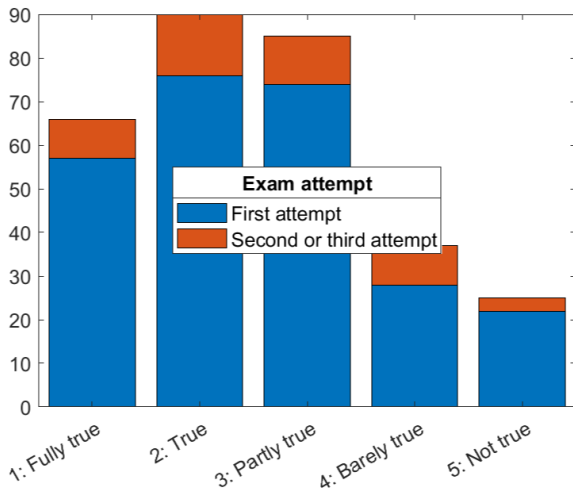


Fig. 5: "I was able to follow the video lectures better than normal classroom lectures". (TMKK)

This is also supported by the direct comparison of the MBS lecture between the summer semesters 2019 and 2020 in Figure 6. The question about the benefit of the respective lecture was answered with an average rating of 2.44 for the video lecture and 2.74 for the classroom lecture of the previous year.

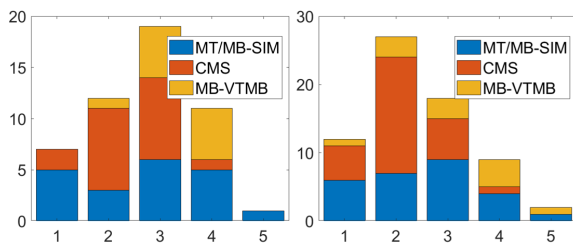


Fig. 6: "The lecture was very helpful for me" (FMD). Left: Presence 2019; Right: Digital 2020

One possible reason for the better rating of the online lecture can be found in the handwritten comments in the survey. Here, the possibility of pausing and repeating the video lecture was named positive several times. One student concretized it saying that listening and writing can be done separately by using the pause function. Another named the repeatability of "difficult parts" in the video lecture.

It should be pointed out that the regarding lectures content contains many complex derivations and calculation methods. The individual learning speed of each student can only be addressed very limited in the classroom lecture.

The fact that approximately half of the students in TMKK watched more than 75% of the lectures (see Figure 7) is consistent with the

lecture attendance in classroom semesters of the course.

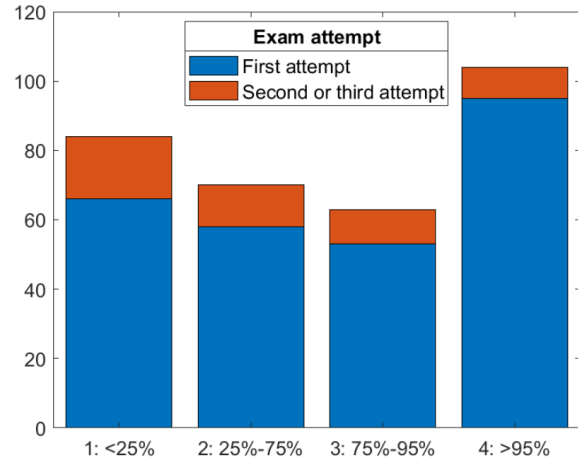


Fig. 7: Viewed lecture videos. (TMKK)

However, the entire MBS course consisting of lecture and tutorial performs worse in the online semester than in the classroom semester, as shown in Figure 8. The statement whether the course content is much harder to understand in the online semester than in the regular semester is rated with an average of 2.77 in MBS.

The positive evaluation of the digital lecture in contrast to the entire course indicates that the quality of exercises in presence is not reached by the online substitute.

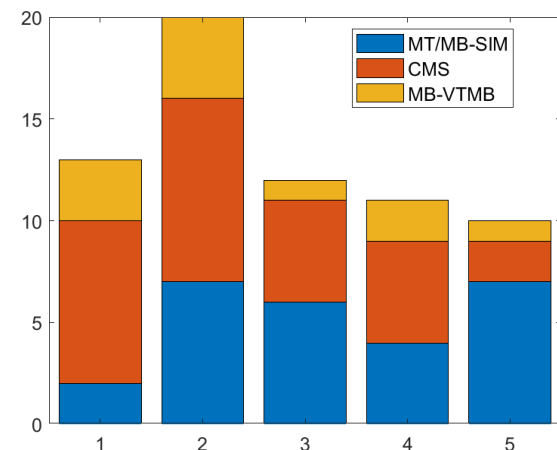


Fig. 8: "The course content is much harder to understand in an online semester than in a regular one". (FMD)

A large proportion of the students states that they had at least partial motivation problems to study the course content (see Figure 9). The

statement whether it was difficult for the students to motivate themselves to work on the course content is rated with an average of 2.61 in TMKK.

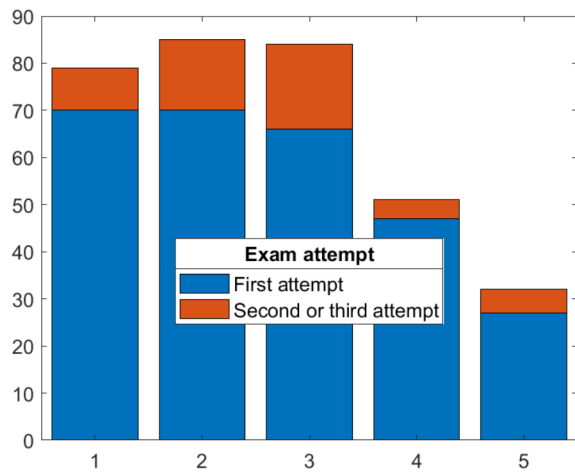


Fig. 9: "It was difficult to motivate myself to work on the course content this semester." (TMKK)

As shown in Figure 10, this is supported in the fact that the larger proportion of TMKK students spent less than the weekly planned attendance time on the course during the semester. A similar result is obtained from the survey in MBS.

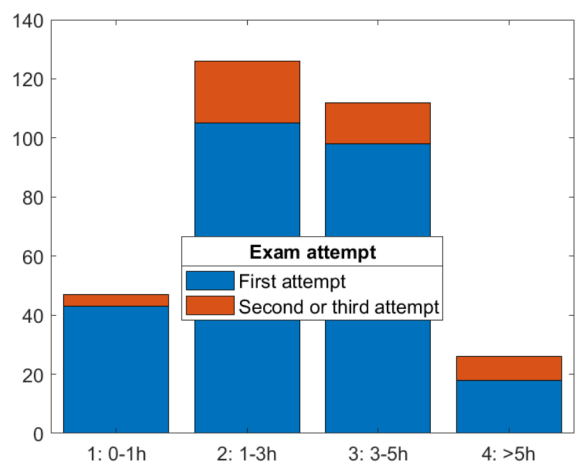


Fig. 10: Weekly time spent on the course. (TMKK, weekly presence time would have been 3.75 h)

In MBS, the statement whether the students had problems keeping up with the course content is rated with an average of 3.10. TMKK students rated the statement with an average of 3.28 whether the exercises were completed within the scheduled semester week. In other words, the majority of the students had at least partial problems following the given schedule

in the online semester. Since no comparative data is available from a classroom semester, no solid comparison can be made here between online and classroom semesters.

The low number of participants in the complex exercise in MBS in the online semester is a further indication of delay in the course schedule by the students. To successfully participate in the complex exercise, it is necessary to complete all the exercises beforehand.

In TMKK, a comment field was used to ask for reasons for lagging behind in course content. "Motivation, stress, understanding problems" were given as example answers. The lack of motivation, understanding problems and the lack of separation between studies and free time were frequently named by the students. The sample answers presumably play a role in the frequency of the first two answers.

It can be concluded from Figure 11 that the smaller proportion of students had regular, content-related communication with fellow students. The statement whether the students regularly communicated with fellow students about the course content was rated with an average of 3.36 in TMKK. The majority of students acquired the course content in self-study, which is in clear contrast to the classroom exercises.

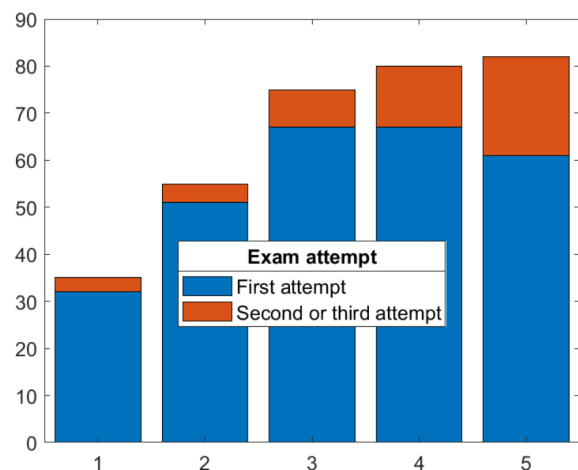


Fig. 11: "I regularly communicated with fellow students about the lecture or exercise". (TMKK)

7. Assessment of the individual forms of learning in the exercise

As already mentioned, largely asynchronous learning formats have been used for the exercises in the courses presented.

Figure 12 shows that the written practice material provided, consisting of introductions and sample solutions, was perceived as helpful in TMKK. The statement whether the corresponding material was very helpful was rated with an average of 2.41.

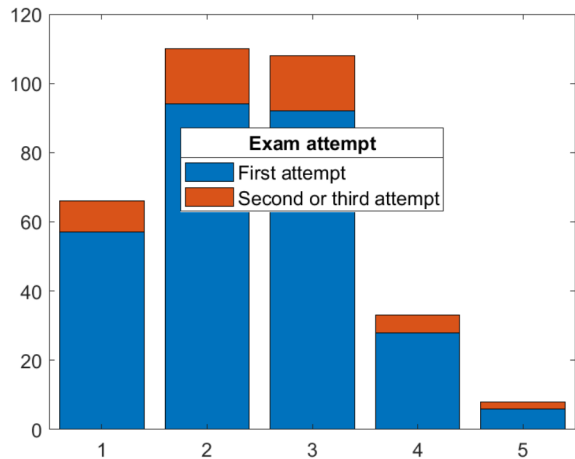


Fig. 12: "The introductions and solutions to the exercises were very helpful". (TMKK)

The exercise forum was rated rather lower, as shown in Figure 13. The statement whether the exercise forum was very helpful was rated with an average of 3.00 in TMKK and with an average of 2.55 in MBS.

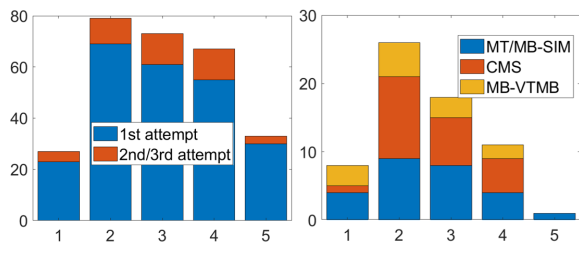


Fig. 13: "The exercise forum was very helpful for me". Left: TMKK; Right: MBS

Accordingly, the comments on the forum in TMKK give a mixed picture. On the one hand, the low clarity and the long waiting time for an answer were criticised several times. On the other hand, it was stated several times that students had only read the forum contributions and had benefited from them without asking questions themselves. A student noted positively that through the forum he came across problems that he had not recognised on his own. It was also noted that the possibility to ask anonymous questions reduced the inhibition to actively use the forum. Very often,

the desire for classroom exercises was stated in the comment fields, since answering questions in the forum could not replace direct communication in a classroom exercise.

As shown in Figure 14, the short intro videos that were used in MBS for exercise introductions achieved by far the best rating. The question whether the intro videos were very helpful for the students was rated with an average of 1.58 in MBS in the 2019 classroom semester and an average rating of 1.64 in the 2020 online semester.

As shown in Figure 15, the short intro videos were watched multiple times by a large proportion of students. The longer lecture videos were watched once by the majority of students.

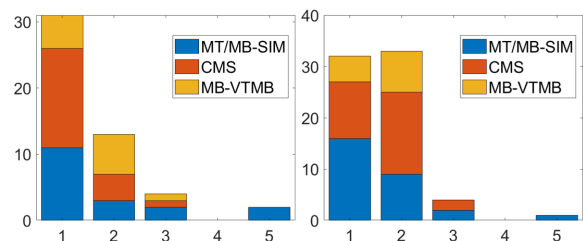


Fig. 14: "The intro videos were very helpful for me." (FMD) Left: 2019; Right: 2020

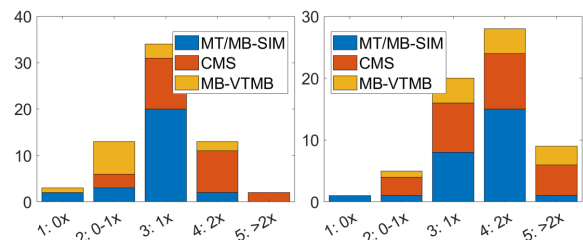


Fig. 15: "How many times did you watch each video on average?" Left: Lecture video; Right: Intro video

The statement whether the students were able to solve the exercises in self-study using the intro videos and the forum was rated with an average of 2.16 in MBS in the online semester 2020. The similar statement whether the students were able to do this (only) using the intro videos was rated with an average of 2.12 in MBS in the 2019 classroom semester.

8. Exam preparation

As shown in Figure 16, the students' felt level of exam preparation in the digital semester is slightly worse than in the classroom semester.

The statement whether the students felt very well prepared for the examination is rated on average with 2.62 in MBS in the 2019 classroom semester and with 2.91 in the 2020 online semester.

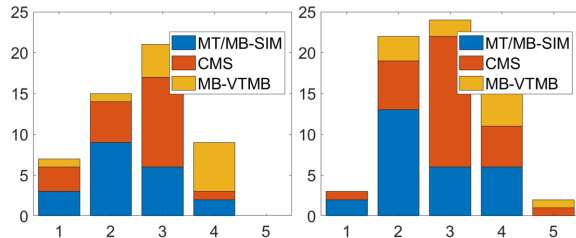


Fig. 16: "Before the examination, I felt very well prepared". (MBS) Left: 2019; Right: 2020

In the summer semester 2020, students at Dresden University of Technology had the option of cancelling examinations without justification. As shown in Figure 17, the majority of students see this option as having little influence on their exam preparation. The statement whether the opportunity to cancel the exam result afterwards influenced their exam preparation was rated by the students in MKS with an average of 3.78 and in TMKK with an average of 3.89.

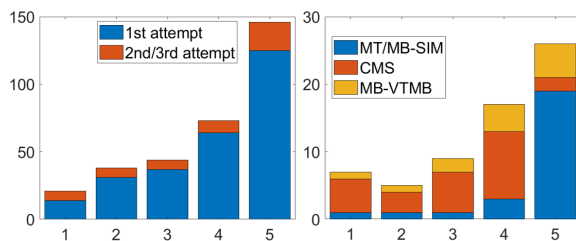


Fig. 17: "The opportunity to cancel the exam result afterwards influenced my exam preparation." Left: TMKK; Right: MKS

9. Summary

A differentiated picture results from the evaluation of the two courses surveyed. For many students, an online lecture seems to have advantages over a classroom lecture. In contrast, no adequate substitute for classroom exercises was used in the digital semester. The offer of online consultations on the exercise was hardly taken up and the exercise forum does not offer an equivalent substitute for direct communication due to the time-delayed communication. Short video exercise introductions are rated as the most helpful course format.

Acknowledgement

A big thanks goes to Anja Jablonski and Falko Berger, who were particularly involved in the evaluation of the surveys.