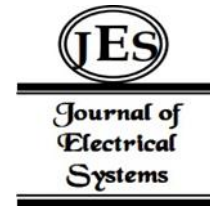


¹ Harald Wahl *² Florian
Eckkrammer³ Alexander Mense⁴ Luis Torres Pereira

Navigating Educational Transformation: The Change of Engineering Pedagogy in the Wake of COVID-19



Abstract: - In response to the COVID-19 pandemic in 2020, the University of Applied Sciences Technikum Wien faced significant challenges in swiftly transitioning its traditionally technical-oriented academic programs to online teaching. With course materials that were not designed for e-learning and both, faculty staff and students, were unfamiliar with remote instruction and collaboration tools, a hybrid approach of self-study and guided teaching became imperative, necessitating innovative didactic strategies. Initially, faculty implemented ad hoc online teaching methods, resulting in a wide spectrum of outcomes. Subsequent surveys conducted in December 2020 and June 2021 provided crucial feedback for ongoing evaluation and adjustment of these approaches. The findings illuminated the constraints of traditional teaching in an online environment, except notably in computer science-related disciplines where pre-existing familiarity with online tools mitigated challenges. This paper describes the methodology and findings of the evaluation process, emphasizing the imperative for adaptable pedagogical approaches in navigating unforeseen disruptions like the COVID-19 pandemic, particularly within the technical education landscape.

Keywords: Academic Education, Corona Situation, Engineering Education, Teaching Methods.

I. INTRODUCTION

When the pandemic suddenly made it necessary in 2020 to switch traditional teaching to online teaching, we were faced with major challenges. On the one hand, in most courses the course materials were not designed for pure e-learning. On the other hand, teachers as well as students were used to presenting and discussing in the presence time of the courses. However, there were no suitable tools for this, and teachers and students were not used to using such tools extensively. Nevertheless, a mixture of self-study combined with guided teaching, i.e., a kind of blended learning must be designed suitably. In addition, the types of lectures need different approaches. So, the far goal was to follow the constructive alignment approach combined with definitions of group sizes and amount of self-study phases.

At the beginning of the pandemic ad hoc approaches for teaching must be implemented. Teachers were encouraged to switch teaching to online. They were allowed to implement all variants that they knew or had experience with, this included using tools they knew and preparing the teaching materials as they saw fit. One can imagine that qualitatively very different results were achieved. Surveys were then quickly conducted for the possibility of evaluating and improving these ad hoc approaches, one in December 2020 and June 2021 (see [1]).

II. RESEARCH APPROACH

In order to be able to evaluate the online teaching approaches, a survey was carried out after one semester of teaching (in December 2020). After reviewing this survey, adjustments and stricter restrictions were specified. Since the lockdown lasted even longer, after another semester of classes, the survey was conducted again (in June 2021) to see the improvements.

Table 1. The questions of the survey.

Question	Possible answers
Please select your course of study	The individual course of study
Please select your semester	The individual semester
How satisfied are you with your current situation at the UAS Technikum Wien?	very satisfied / satisfied / neutral / dissatisfied / very dissatisfied

^{1,2,3} University of Applied Sciences Technikum Wien, Vienna, Austria

⁴ University of Trás-os-Montes e Alto Douro, Vila Real, Portugal

* Corresponding Author Email: wahl@technikum-wien.at

Question	Possible answers
Overall, the UAS Technikum Wien handles online studies well.	applies / rather applies / partially applies / less applicable / does not apply
My questions are answered quickly and reliably.	applies / rather applies / partially applies / less applicable / does not apply
The organizational handling of the online course works well.	applies / rather applies / partially applies / less applicable / does not apply
Due to the online study operation, a considerable additional effort has been incurred to be able to complete the courses.	applies / rather applies / partially applies / less applicable / does not apply
How much do you think you learned this semester?	more than in an average semester / about the same as in an average semester / less than in an average semester
What could the UAS Technikum Wien improve when it comes to online study?	Text

Table 1 shows the questions of the survey and possible answers. The last point with free text answer options is particularly interesting in order to get ideas for improvement from the respondents.

III. RESULTS

A significant number of students took part in the surveys (see Table 2). In December 2020, this meant a response rate of 23%, which increased to 30% in June 2021.

Table 2. The answers of current course programs.

Channels	Number December 2020	Number June 2021
Bachelor's	828	879
Master's	353	356
No answer	4	3
Not finished	214	304

If we look at the general opinion on the implementation of online teaching (see Figure 1), you can see that the quality has improved significantly. For question “Overall, the UAS Technikum Wien handles online studies well”, full agreement was increased by 78.44%, rejection was reduced by 64.65% (see Table 3).

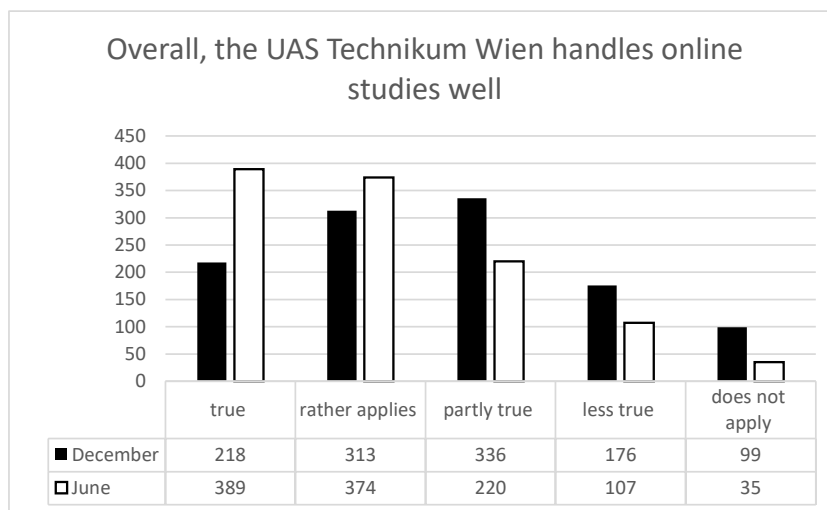


Figure 1. The general impression of students in December 2020 and June 2021.

Table 3. The change of the general impression of students in December 2020 and June 2021.

	Difference in %
true	78,44%
rather applies	19,49%
partly true	-34,52%
less true	-39,20%
does not apply	-64,65%

In response to the question "What could the University of Applied Sciences Technikum Wien improve when it comes to online study?" answered 513 students (36.67%), 545 answered with "no answer" (38.96%). The evaluation of this textual feedback led to the following adjustments to teaching.

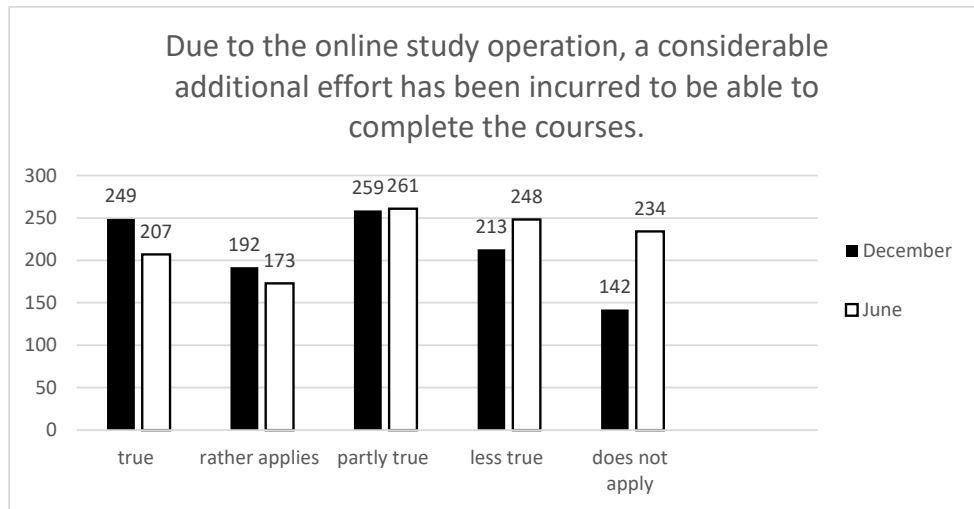


Figure 2. The change of additional effort from December 2020 to June 2021.

If you now look at Figure 2, you can see that the teachers' experiences and the initial adaptations of the lessons meant that significantly less effort was required to complete the course. 16.87% fewer agreed with the question that the additional effort was clearly given, with even 64.79% absolutely denying the additional effort.

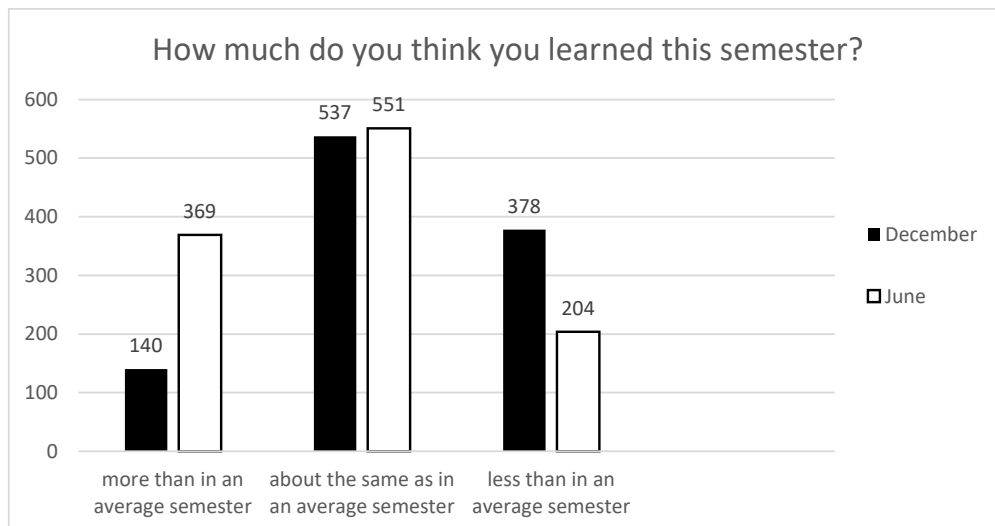


Figure 3. The improvement of learning from December 2020 to June 2021.

The question about the perceived learning success and the extent of the learning success compared to an average semester is also interesting (see Figure 3). Well over twice as many students (exactly +163.57% from December to June) said they learned more than in an average semester. The number of those who thought they had learned less was also reduced to almost half (exactly -46.03%). This means that not only the experiences of the teachers and the

first adaptations are criteria for success, but it turns out that the students learned quickly to get used to the situation and, even more, to use it efficiently to achieve learning success.

In the surveys, numerous answers were also given in text form (to the question “What could the UAS Technikum Wien improve when it comes to online study?”). A few literal answers are:

- “The practical connection is sometimes missing; direct exchange with the professor is difficult via online meetings, especially when the entire class is present.”
- “Better communication. Make Moodle courses clearer. Lecturers should know their own requirements and tasks and judge them accordingly.”
- “Video recordings of the courses must be permitted again by the university management or should become mandatory!”
- “Less material for self-study and consider technical failures!”
- “Better organization of exams. Regulated breaks between courses; uniform access to online meetings; Adjustments of the ECTS to the actual effort”
- “Using a provider (Zoom, Teams, etc.); linking the calls to the calendar.”
- “I think it's a shame that many editors forget to take breaks when operating online. In addition, they often overdo it or sometimes start late. Despite online operation, it should be possible to adhere to the prescribed times (and breaks!) of the course plan, which unfortunately is not the case in all subjects. Sometimes it has also happened that lessons have been postponed without this being changed in the course plan. I think it would be much better if all postponements were always officially in the course plan be entered.”
- “Take the courses more carefully.”
- “Uniform tools that all lecturers must use.”
- “More direct communication with students and lecturers. A lot of information comes very spontaneously for lecturers and students. E.g., specifications for examination modalities.”
- “Offer a centralized system for all lectures, whereby all dates, platforms, links, documents and examination modalities are clearly displayed (e.g. link MS Teams link with the Moodle calendar)”
- “Some lecturers should work on their didactics, as this cannot be transferred 1:1 to online. It's also clear that it happened quickly.”
- “Basically, the teachers are doing a good job during this complicated time. However, there is a clear negative difference in learning effectiveness when teaching the material in webinar form. Given the circumstances, however, the best solution.”

A total of 1,411 textual responses were received, all of which were worked through and discussed in detail. Working groups were formed at the UAS Technikum Wien, which, based on the feedback, defined clear specifications for teaching and the boundary conditions for teaching methods.

A. *Specifications*

The continuous dialog with both, lecturers, and students, has unveiled certain irregularities in the ad hoc transition to online teaching. These irregularities were identified for adjustment. On one hand, the range of tools used was quite diverse and has now been primarily streamlined to a single communication platform. This has cleared up the ongoing confusion about which platform each instructor uses for the courses and how to use these tools. Guidelines were defined for the structuring of the Moodle learning platform for individual courses. This helps to navigate within and between various courses easily. Unfortunately, due to the General Data Protection Regulation, the practice of recording and disseminating online sessions had to be forbidden. This decision faced resistance from both students and educators. To address this issue, we have demonstrated our commitment by creating and providing more screencasts. It is important to note that screencasts do not serve as a complete substitute for recorded online sessions, which allow for subsequent viewing and the ability to revisit various questions and discussions. On the other hand, recordings of online sessions generate unstructured data which are inefficient in finding specific answers. This could be addressed by adding indices and links after recording the sessions. University of Applied Sciences Technikum Wien decided to avoid this additional workload of postproduction and decided to create short screencasts instead. Furthermore, there has been an extensive reassessment and redefinition of the teaching methods employed in each course. The focus of the reassessment and redefinition was on enabling and interacting with more students compared to a classical lecture.

B. *Teaching Methods, Group Sizes, and Attendance Units*

The traditional teaching method of lectures has now been eliminated. Currently, there is a restriction to only four permissible categories of educational sessions, namely integrated courses, practical exercises, (group-based or individual-based) project-based learning, and laboratory sessions. Furthermore, there is a specific delineation of the number of in-person sessions required per ECTS (European Credit Transfer and Accumulation System) for each of these educational methods, as illustrated in the comprehensive Table 4 below. Additionally, students are expected to engage in a prescribed level of self-directed learning, with a clear demarcation of the subjects to be covered during the in-person instructional sessions. It's essential to emphasize that these regulations are closely interconnected with the overall course structure within the Moodle platform to ensure a productive learning experience for students.

Table 4. The group size and attendance units per ECTS.

Teaching method	Group size	Attendance units per ECTS
Integrated course	40	6
Exercise	20	8
Project	1 to 20	6
Laboratory course	20	10

C. *Self-study and On-campus Phase*

The teaching method of a lecture was replaced with a blended learning approach [5]. To give students more freedom to their learning speed and learning time material is provided which is handled by the student during a self-study phase. This phase is loosely coached in terms of moodle forum responses by lectures. Self-study phases are accompanied by on-campus phases to consolidate the learnings in the form of discussions and/or exercises. Alternatively, new topics can be introduced in the on-campus phases and the deepening and consolidation in the form of exercises (or other methods) takes place in the self-study phase. In order to enable a smooth transition to exclusive online learning, it is recommended that these courses adhere to the Flipped Classroom approach, as described in [6]. The alternating mode of on-campus phases and self-study phases is already determined in the course planning and considered in the choice of didactic methods. The scheduling of the courses is done strictly according to this predetermined mode. A common timing of the two phases is one (or two) week(s) of self-study followed by two teaching units on-campus. Of course, other timings are also possible.

D. *Training of the Lecturers*

The strong interventions and changes in the courses regarding planning approach (constructive alignment), concepts (blended learning, flipped classroom and others) as well as the necessary didactic methods were accompanied by a very diverse training offer. The training courses take into account the different levels of previous experience, starting with junior lecturers and ending with senior lecturers. Furthermore, short formats lasting from 45 minutes to more comprehensive courses lasting several hours were offered. Best practices also played a significant role. Experienced teachers with proven solutions were brought in to train their colleagues. The goal of the courses was to efficiently provide teachers with what they needed to meet the new challenges.

IV. CONCLUSION

In summary, the sudden switch from traditional teaching to online teaching in response to the COVID-19 pandemic presented both, teachers, and students at UAS Technikum Wien with major challenges. With little time available for preparation, ad hoc approaches were adopted, which resulted in varying qualities and results. Therefore, two surveys were conducted in December 2020 and June 2021 to assess the situation and identify necessary adjustments. The surveys showed a significant improvement in the perception of the quality of online teaching. The students increasingly agreed that the FH Technikum Wien handled the switch to online teaching and the adjustments between December and June well. This also significantly reduces the additional effort required to complete courses. The learning experience also improved, as more students reported increased learning success compared to traditional semesters. To address issues and irregularities identified during the transition to online teaching, several changes have been made. A more standardized communication platform was introduced and guidelines for structuring the Moodle learning platform were established. Although the recording and distribution of online sessions had to be restricted due to data protection regulations, the UAS Technikum Wien compensated for this by providing

additional screencasts. In addition, teaching methods have been redefined to focus on integrated courses, practical exercises, project-based learning, and laboratory sessions, eliminating traditional lectures. Blended learning was introduced, and the flipped classroom approach was recommended for these courses and specific guidelines for face-to-face events were defined, including group sizes and attendance units per ECTS.

These adjustments reflect the University's commitment to improving the online learning experience, promoting greater adaptability among both, lecturers, and students, and ensuring high-quality education in the face of the ongoing challenges posed by the pandemic.

With the help of feedback from teachers and students, the UAS Technikum Wien has created an academic learning environment and specifications for teaching that can be adapted quickly to changing situations and, if necessary, quickly switch to online teaching.

ACKNOWLEDGEMENTS

In addition to the challenges caused by the Covid-19 pandemic and the resulting mental strain, the change of the courses led to a high additional workload among the teaching staff. Therefore, the staff of UAS Technikum Wien is to be thanked for implementing all these changes so well during this very special time. The staff of the Teaching and Learning Center (TLC) also deserve a positive credit here, they were often exposed to direct emotions and criticism during this challenging time. Despite this, they have not lost their positive attitude and dedication to their work.

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