

FROM DIGITALIZED EDUCATION TO COVID-19 RESTRICTED EDUCATION: CHALLENGES AND DIFFERENCES

Jerker Björkqvist, Tommy Hämäläinen

Department of Information Technology, Åbo Akademi University, Turku FINLAND

ABSTRACT

At the department of Information technologies at Åbo Akademi University, the digitalization of education was being performed with the objective of being able to give higher quality education to an increasing number of students but using the same level of teaching personnel resources. In this work, several actions were performed, such as recording lectures and editing recorded lectures, testing out different systems for automatic grading of exercises, different formats of giving the lectures themselves (such as a flipped classroom). When almost a year of these activities had been performed, the COVID-19 crisis forced a fast change in how teaching was being done at universities all over the world. This paper analysis, with the support of a survey and interview performed, how the transformation to 100% online teaching was performed, knowing that a lot of efforts had been made earlier to digitalize the education. The paper explains the challenges still remaining and analyzes the feasibility of totally remote education. We analyze the difference between a digitalized education and a COVID-19 restricted education, regarding teaching and student motivation, tools being used, dropout rates, and communication issues. The papers also give conclusions on things that both worked well and did not work well in this transformation.

KEYWORDS

Digitalization, COVID-19, Automated assessment, Communication, Student interaction, Virtualization, Standards: 3, 5, 6, 8, 10, 11

INTRODUCTION

The department of information technologies (IT) at Åbo Akademi University in Finland is a rather small educational unit, with a faculty size of approximately 15 teachers, and the number of freshmen students is currently around 60 per year. Additionally, around 20 master level students start their studies every year, mostly foreign students. Åbo Akademi is a Swedish-speaking university in Finland, with four faculties, providing education in humanities, pedagogy, social sciences, economy, natural sciences, and technology. The IT department gives education in natural sciences (computer science) and technology (computer engineering).

The faculty of natural sciences and technology has for long been struggling with an economical deficiency, which has led to a rather defensive faculty recruitment policy, i.e., no new teaching resources. At the same time, the interest in IT studies has become very solid in the department, meaning that we need to give more education, with the same size of faculty. This led to a strategy of strong digitalization development process at the department, where we did development of courses aiming to remove straightforward repetitive tasks in the education, freeing up resources to tasks that the faculty finds more valuable. Correction of exercises was

one task that was automated through different tools like CodeGrade integrated into Moodle. The teachers can instead use the time previously used for grading, for more planning of common classes and for discussions with the students, i.e., perform more qualitative work instead of quantitative work. We also did on-line teaching and video recordings of most of the lectures, to have them available off-site and also for later viewing.

The work on digitalization at the department of IT was analyzed in an earlier paper by Björkqvist and Roslöf (2020), where the main conclusion was that the digitalization efforts made it possible to enable more interaction with the students during the classes, to increase the level of positive learning activities. This paper was due to be published in the CDIO 2020 conference in Bangkok, but that conference was cancelled due to the COVID-19 pandemic (the paper was however published in the on-line version of the conference). Instead, as we all in the educational field know, there was an overnight transformation to online education in almost all educational levels. That meant that the educational sector globally was forced to take a giant step forward into digitalization. In Europe, 85% of classes were transformed to online, 12 % were suspended, and 3% were cancelled (Marione et.al. 2020). So, one of the main questions in this paper is – what was the advantage of doing these digitalization efforts prior to the pandemic? Could we just go on as business as usual, utilizing the digitalization efforts already done?

You should never waste a good crisis is a citation from Winston Churchill. As Zhao (2020) argues, the COVID-19 pandemic either forced or made it possible to rethink the *what, how and where* of education. The *where* was definitely changed, as schools and universities were closed down. The *what* might have stayed quite the same, but *how* was very much moved from classroom lectures to on-line lectures.

In this paper we address the differences and challenges when going from digitalized education to pandemic restricted education. Which components of education did just go on as previously, and which components are rather different now?

Background

The way the Higher Education Institutes (HEI) practice their education needs continuous development. The society around us changes, the technology around us changes. Today we have access to almost all the information there is globally available from our home sofa. This has changed massively in the last 20 years, and the question is how the HEI education has adopted this.

In the international Delphi survey on the future of learning and Higher Education (Ehlers and Kellermann, 2019), the Delphi resulted in hallmark indications on the shift from academic education and teaching to active learning and autonomy. This learning experience is fundamentally different from the model of today. This future learning comprises (1) structural aspects, where learning can be much more spread than today, and (2) the pedagogical design of academic learning. The pedagogical design comprises aspects such as practices of assessment, peer-validation, focus on future skills, learning communities, and interactive socio-constructive learning environments. The experts in the survey believe that changes to academic learning design come before structural changes. Hence, the *how* and *what* we learn will change more than *where* we learn it.

Especially the emerging focus on future skills change the higher education. Instead of having the narrow focus on learning correct answers to known questions, the future skills mean

autonomous learning, self-organization, creativity, and innovation. Students can in the future also build personalized curriculums, interacting with teachers/professors. The future skills mean the ability to perform complex problem solving, dealing with uncertainty, and developing a sense of responsibility. This would go beyond the current emphasis on knowledge acquisition and studying based on a defined curriculum.

In the online article Rowe (2016) discusses the need for greater diversity in the engineering field. Employers are looking for people with system-level skills. In addition to fundamentals, they need to think beyond technical details. With all the information available online, it is creativity that adds the value of engineers of today and the future. The future is about making the world better, people to live longer, the produce a better environment, not just making money.

The CDIO Initiative already from beginning has stressed the system-levels skills from many of its standards (Standard 1 – The Context, Standard 5 – Design Implement experiences, Standard 6 – Engineering Workspaces, Standard 7 – Interactive learning, Standard 8 – Active learning). We could argue that the CDIO standards drive towards the futures skills that Ehlers and Kellerman (2019) in their Survey report find central. We could argue that COVID-19 hinders from implementing the central CDIO standards, if not virtualization is carefully done.

Digitalization of education can provide the tools for going towards the goal of personal curriculums, more interaction with teachers, putting focus on problem solving skills, and fostering creativity. Correctly made digitalization has to possibility too free up resources to other tasks than basic teaching and exercise correction, freeing the teacher resources for the need of future skills.

Research methodology

During November 2020, a half quantitative and half qualitative online survey with 68 questions with topic of “Digitalization in IT-department” was conducted in IT department of Åbo Akademi University. All 15 active lecturers from the department were involved. In total of 37 of 5 ECTS per course were analyzed covering subjects of information technology, programming, automation, internet of things, digital communication, engineering mathematics, algorithms, cloud computing, software and hardware development, data science and machine learning. Lecturers were asked to choose the most appropriate claims and/or describe freely in written about their courses from the beginning of COVID-19 until the end of November 2020 about the following topics:

- Teaching methods,
- Type of coursework,
- Grading methods,
- Course communication and interaction methods,
- Perception towards popularity and enrollment on their course,
- Challenges related to teaching and lecturing -technologies,
- Perceptions towards alternative teaching and grading methods

The selection of topics and questions was based on daily interaction of cooperating with teachers in development and arrangement of online teaching which started already before the COVID-19. Thus, a lot of knowledge regarding teachers’ experiences was acknowledged before the survey was conducted. Two teachers out of 15 were randomly chosen to be interviewed formally after their survey submissions to let them explain their answers more throughout. The rest of the teachers (13) were involved in informal interview-like one-on-one

or group discussions that were documented by taking written notes during the discussions. Referring to the experiences, survey results and interview results a list of issues, ideas, visions, and best practices were summarized.

Results from the survey

The main observation based on the results of the survey are described briefly in the text sections below.

- The most common challenge was the time used in grading. It is viewed as manual labor taking resources from teaching. A typical solution is to use teaching assistants (TAs) to help in grading.
- Classroom whiteboards are used in general regardless of subject, even during lectures that are only given online using video. There is a need to lecture streaming cameras that can show the whiteboards in good quality.
- Some courses are using physical devices, like Arduino boards and Raspberry Pi's. These physical devices are an essential part of education and are hard to make working in a virtual version of the course. Changing from physical devices to virtual ones is possible up to a certain point where it would change the purpose and goal of the course too much. Related to the CDIO Initiative, the standard 5 Design-Implement Experiences clearly suffer.
- The use of group communication tools in teaching such as Slack and Teams are unfamiliar within the department. However, there is a latent interest and therefore a need for demonstrations of the tools of virtual communication. According to the survey, the general interaction during online classes has remained low. Instead of classroom communication, several students tend to send similar questions for teachers via email and therefore a common discussion forum would enable answering everyone at once and perhaps even motivate students into interaction by answering others' questions.
- Teachers want to record lectures in lecture halls, the normal environment for teaching. Recording lectures beforehand in home, office or at designated studio is considered an extra effort that could change the teaching experience from interactive lectures to passive education films.
- Most students work using their own laptops, so classes equipped with computers are not really needed any longer. This concerns mostly the programming courses. Moving from computer classrooms to BYOD (bring your own device) type of concept would bring more flexibility when choosing the environment for teaching.

Many still regard exams as an important part of learning. This on the other hand shows that students are still not motivated enough to learn but also that it is very difficult to measure and reward learning without testing. Exams are considered at the same time easy to arrange but resource consuming, resources here meaning the time of teachers and teaching assistants.

In spring 2020 before COVID-19, there were still paper exams and e-exams on campus. Most eminent changes have happened from the change of paper exams to other forms, for example, adding an extra assignment became a popular solution. Before COVID-19, the course projects

were not graded as often. Writing exams at home and supervised via Zoom¹ became one of the popular COVID-19 solutions as well. In Figure 1 is represented grading methods per course. In 2019-2020, four more courses were arranged than in 2020-2021, which was not related to COVID-19. Using several grading methods in one course increased. Before COVID-19, 41 courses included 51 grading methods and during COVID-19 37 courses used 63 grading methods.

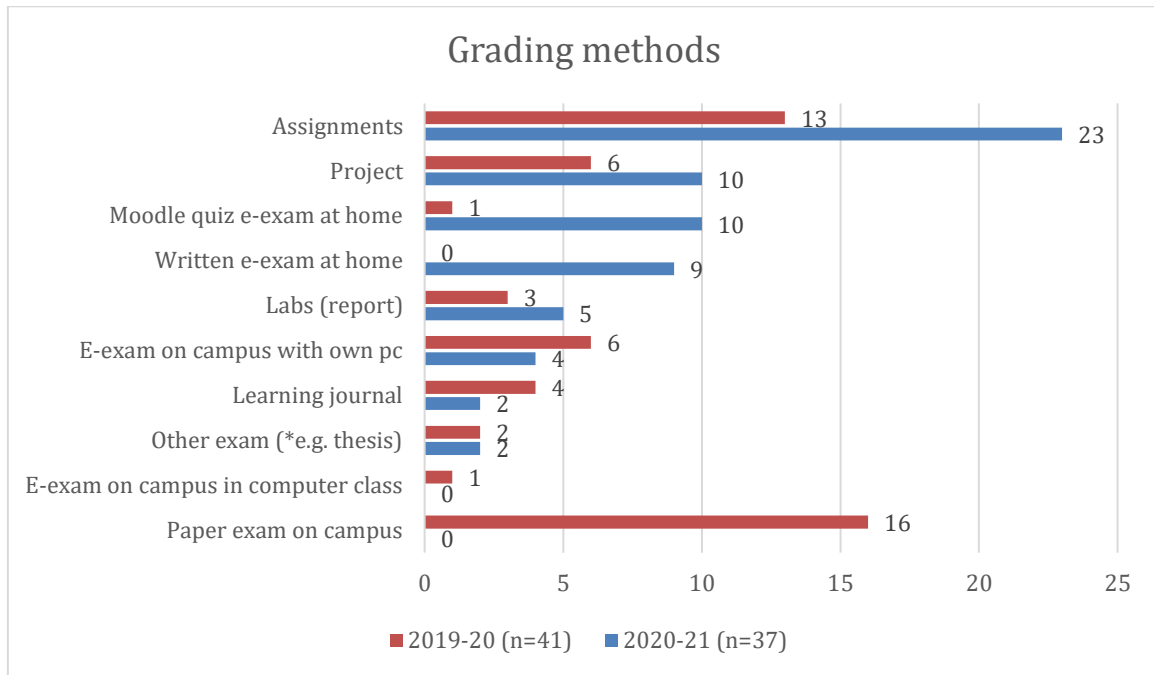


Figure 1. Grading methods used in courses. (2019-2020 n=41, 2020-2021 n=37)

COVID-19 did not change notably the types of coursework. In 2019-2020 semester two courses, with mandatory access to campus lab equipment, were arranged in periods two and three, just before the campus was closed. Same courses will be arranged again in spring 2021, by inviting students in small groups to campus, if possible. Below is a list of coursework used in 2020-2021. Only COVID-19 related changes were slightly increased utilization of quizzes and group work-related meetings done online.

- Written assignments: 19/37 (53%)
- Programming tasks: 19/37 (53%)
- Quizzes: 9/37 (25%)
- Other: 6/37 (16%)
 - Mathematical Moodle assignments, discussion seminars, group discussions etc.
- Group work report: 5/37 (14%)
- Learning Journal: 3/37 (8%)
- Group work presentation: 3/37 (8%)
- Group work, other: 3/37 (8%)
 - Pair programming, group work sessions

A response to the open question “what should remain as non-digitalized? / “what should have not been digitalized” 18 out of 37 replies mention campus lectures or seminar sessions with

¹ Zoom meetings and chat. Website: zoom.us

classroom interaction and communication. Arranging final exams similarly to before COVID-19 was mentioned twice and the ability to arrange projects as before COVID-19 once. In 13 out of 37 courses, respondents did not specify any opinions for non-digitalization. Three respondents did not reply to the question.

In the follow-up question teachers replied that 54 percent (20/37) of courses could not be digitalized more by anyone. 46% (17/37) of courses could be digitalized by someone of which 30 per cent by the teacher and 16 percent by an education development professional or another skilled education professional.

What is similar, what is different?

Going into COVID-19 mode in March 2020 was for many a very abrupt change in working habits. In one week, you should prepare to start giving courses in a format where physical distancing is the norm. The preparation of this included finding if you have suitable equipment, i.e., video cameras, microphones, workspace, computer screens, network connectivity. Most of this had been worked out already at the department if IT, as we had been doing digitalization of education already earlier. However, we could then use equipment available on the campus. Now, we were dependent on personal equipment available at home.

At Åbo Akademi University, an internal teacher and student survey (Wikström, 2020) was performed after spring 2020. That survey showed that the students at the faculty of natural sciences and technology were the ones that were happiest with the distance education given. Both teachers and students had the best knowledge of the technical tools required for remote education. However, in that study, there was already a clear indication of lack of motivation for studies.

To some extent, courses could continue just as before, the major difference was that everything was streamed over Zoom. So, the *what*, and *how* continued as before, the *where* was changed. However, quite soon the *how* also changed. The normal student interaction was missing, the normal after class-discussions with students disappeared, and the discussions with other teachers was not there. Moreover, latest when moving into exams, there was a change of how the exams were performed. The traditional style of doing exams in lecture rooms using pen and paper has now changed to different on-line formats, with fears of being unfairly treated.

In a report by Di Pietro et.al. (2020), the authors list four different elements that are assumed to cause learning loss due to COVID-19 and remote education: 1) Less time spent in learning, 2) Stress, 3) A change in the way students interact 4) Lack of learning motivation. Based on the surveys performed, at least 3) student interaction and 4) lack of motivation was clearly visible in the results.

Realizing that COVID-19 was not just a temporary break in normal habits, but a significant change in how we should work, as the extension of remote studies was prolonged first until the end of fall 2020, and then for the spring semester 2021, there was a change in mindsets of the teachers. Now, we really needed to consider *how* to do the courses. This *how* varied per course. Some courses needed really rethinking, whereas other courses could rely on the digitalization efforts already done.

Quality of education

The change in quality of education has been rather hard to evaluate so far. The quality of education is dependent on several factors. It is the course curriculum, the teaching material, the teaching facilities, the lecturer, the assignments, the assessment, and the interaction. Quality can be observed by student performance and student feedback. Evaluation of teaching quality in the transformation to online teaching under COVID-19 would benefit from statistical comparison to e.g., grades given in previous years in the same courses. The comparison could, however, be affected by potential changes in course content, examination method, students' skills, and other events happening at the same time as that course, that should be taken into consideration.

Course dynamics and communication

The biggest change has been in the course dynamics. With dynamics, we mean everything that happens around a course. In the normal setup of a course, where students are present at physical lectures, the everyday small concerns are efficiently handled in discussions during the course. For the lecturer, it is very easy to follow up on how the teaching is perceived during physical lectures. You can see when you need to put more time into something, when a student does not follow the lecture for some reason or solve un-clarities in for instance exercises. In the COVID-19 restricted education, behind computer screens, this natural communication way of direct interactions was not there. Also, normally, the motivation for studies, the inspiration comes from the interactions during the classes, during the common work and group work. That was now missing.

The teachers could give free-text comments communication in the survey. In this survey, 8 out of 14 answers mentioned problems with communication. In the answers, we find "Students not replying to messages or emails", "No communication at all", "Mainly low interaction". In some courses, it seems to be working better, questions from students were mainly related to assignments.

Post COVID-19 development

Based on the survey we also analyzed what changes should be retained and which changes need to be discarded in the post- COVID-19 development of education. The things that need to be achieved are the following:

- More interaction between students and teachers
- Direct feedback on material and activities
- Class-room dynamics back into an inspiring format

On the other hand, COVID-19 has also forced us to take tools into use and make organizational changes that need to be retained:

- Microsoft Teams as a tool for course discussions and chats
- Virtual communities are now managed by the university (using tools like MS Teams, instead of having ad-hoc virtual communities)
- More on-line material gives new possibilities for off-site learning, which also supports the goal of life-long learning and learning autonomy

- Videos of lecturers can be very useful for students. Many students, for instance, watch lecture videos at 2x speed. Things that require more attention can then be repeated at normal speed. This makes it possible to adapt to the learning speed.

Conclusions

The department of IT at Åbo Akademi University had been doing systematic digitalization of education for more than a year before COVID-19 changed how education was being done globally. The question was – how well did the earlier digitalization process support go into almost 100% on-line education? Could we just go on as business-as-usual, just by talking over Zoom instead of in the same physical space?

During fall 2020, the teachers answered a survey to get information on how the teaching was going. As the first conclusion, based on the feedback from teachers over the survey performed, especially the automated correction of exercises was very useful. However, we believe that they are as useful in a real-world scenario as in an on-online scenario. The original idea was anyhow to let free resources to teacher work regarded as more important for quality – being present for discussions with students and develop the ways students think.

We realized was, that digitalization efforts that worked before the COVID-19 , also worked during COVID-19. The only difference is that the actual fruits of digitalization, to enable more interaction, innovation, and problem solving, were not realized due to COVID-19.

What on the other hand is very different is the teaching dynamics and the discussion spaces. Over Zoom the overall feedback is that discussions are hard to get going. You do not know how the learning process goes forward. In some courses, communication with students disappeared almost completely.

In the long-time perspective, we do not yet know how the actual learning has changed during the COVID-19, it is too early to say, as conclusive data is not yet available. It will be a study object for a long time, and we are sure that we can use this information for further developing the learning environment.

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BIOGRAPHICAL INFORMATION

Jerker Björkqvist is an Associate Professor in Computer Science at Åbo Akademi University, Finland. He has a Phd and an M.Sc. in Systems Engineering at Åbo Akademi University. His teaching activities are on Operating Systems, Programming aspects of Embedded Systems, Industrial Internet, and Project course. He is involved in several projects aiming at improving the Computer Engineering curriculum at the department and faculty levels. His research interests are on Digital Communication, especially Wireless Broadcasting Systems.

Tommy Hämäläinen is a Coordinator of online course development at Åbo Akademi University. He has M.Sc. in Information Systems (Econ. & B. Administration) at Åbo Akademi University. He is interested in transformation and development of digital education concepts from perspective of life-long learning and statistical data.

Corresponding author

Jerker Björkqvist
Information Technology
Åbo Akademi University
Domkyrkotorget 3
20500 Turku, FINLAND
+358 2 215 3348
jerker.bjorkqvist@abo.fi



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