

IT bachelor capstone project during lockdown: Student experiences

Kjetil Raaen, Hanne Sørnum and Rolando Gonzalez
Kristiania University College

Abstract

Medical lockdown was a fact in Norway March 2020. As a result, bachelor students were no longer able to complete their studies in an ordinary way. New forms of collaboration and communication had to be established quickly, while many companies were closed down and employees worked from home. This study focuses on students in a bachelor program in IT working on their bachelor thesis. We used a survey questionnaire and grades from the bachelor capstone project to evaluate effects caused by the situation. The findings show that infection control measures due to Covid-19 has had a significant perceived negative effect on collaboration, communication and results. In contrast to this, the results in the form of grades are unaffected by the situation. This indicates that students felt stressed by the situation, but in practice handled this stress well. For future projects such as these, we recommend guiding students to regularly use online communication tools, even when physical proximity is possible. If major disruptions happen, supervisors should help students focus on this as a learning opportunity.

1 Introduction

Wednesday, 12th of March 2020 the Norwegian government decided to close all colleges and universities with immediate effect. For educational institutions this meant that all universities and colleges in Norway had to literally overnight go from delivering courses on campus to delivering them through digital collaboration tools such as Zoom¹. Some of the courses were project courses which require a high amount of communication both between the students in the group, and between the project groups and their supervisors. These student groups had to go from meeting each other on a daily basis in the offices of a company, to communicating and interacting digitally. In this paper, we will focus on the effects on one specific group: Students participating in their final year capstone project in software development for the students doing Bachelor of IT at Kristiania University College in Norway.

Consequently, we explore the following research question: *How did medical lockdown affect a bachelor capstone project in IT?* In order to provide an answer, we have conducted an online survey with Bachelor students (6th semester). In addition, we have compared grades from 2020 with grades from the last five years (2015-2019).

This paper was presented at the NIK-2020 conference; see <http://www.nik.no/>.

¹zoom.us

2 Background

Towards the end of an undergraduate program, most programming students are assigned a large project allowing them to integrate and utilize everything they have learned during their studies [5]. Dugan presents a thorough review of literature on this kind of course through the year 2011. The age of this review means that agile methods are not yet ubiquitous, and even the agile methodologies mentioned are relatively heavy. There are very patterns common to all these projects beyond the definition of a capstone project. Most, if not all use teams of more than one person. A majority also seems to assign multiple groups the same task. This allows for useful scaffolding such as workshops and presentations where groups can learn from each other. Additionally, some topics also overlap. The most common topics and their frequencies mentioned were [5]:

[software]design (24), requirements (22), groupwork (21), testing (19), writing (17), speaking (15), software process (14), project management (14), large system experience (14) and knowledge integration (10)

In our capstone project course, all these are desired learning outcomes. The goal is to give our graduates a smooth transition to employment in a company.

Capstone project for Bachelor of IT at Kristiania

Our capstone project follows a pattern not unlike many of these others. We focus on real tasks from real clients. During the fall semester, final year students are introduced to the project and encouraged to gather in groups of three to seven students across specializations. Thus, the project is partially cross disciplinary, that is, all participants are within the field of IT, but they have different specializations. The goal is self-organized groups of 3-5 students, though we allow exceptions from this if strongly needed. Before the start of the project, we organise events helping students get in touch with companies who have relevant student projects. For the entire spring semester (four days a week) students work in the client company offices to create a product for the client.

Our final year project allows students to work very independently. We assign supervisors from the faculty. They will have meetings with students during the project to give feedback and advice. Further, there are a few lectures at the start, but beyond that there is limited scaffolding. This is possible because our students go through multiple smaller projects earlier in their education. They are already familiar with both Scrum and Kanban processes. Thus, in the final year project they are allowed to choose and adapt methodology themselves. We discourage strict fixed roles in the organization of the groups. Some decide on one member to make sure the process is followed, usually a Scrum Master, while others rotate this responsibility. Students rarely assign fixed roles beyond this. This is common in agile methodologies.

At the end of the project, students deliver a written report and hold an oral presentation, like many other such projects. Through these, the students present both their product as well as process and reflections. Less commonly, we solicit feedback from the clients about the performance of our students. All this is evaluated by an external examiner in cooperation with the internal supervisor. Grading is based on the standard Norwegian scale of A-E with F for fail. Groups are graded together, and individual grades are exceptions.

Disruption in programming projects

This paper focuses on a specific serious disruption of a capstone project. Finding research on any such disruption has proved challenging. One interesting approach was that of Dawson [4] who has experimented with deliberately introducing disruptions in student project work. They describe 20 different disruptions they call *dirty tricks* that might be introduced to students during project work. Many of these tricks appear naturally in projects with an external client. In contrast to students described in the paper, because of the realistic setup of the project our students consistently handle *inadequate specification*, *uncertain costumers*, *changing requirements* and *wrong assumptions*. Other disruptions are closer to the situation experienced during lockdown, particularly *changing working procedures*. Common for all the tricks, Dawson generally finds that the students learn from them, and appreciate the process. This approach is not a perfect analogy to the Covid-19 lockdown, because students were aware at the start of the course that there would be disruptions.

A newer paper [10] presents a capstone project very much like ours: External clients and agile methodologies. Here, the disruptions described are more mundane and natural. Clients are initially unaware of the competences and capabilities of the student group, and the the group does not grasp the needs of the clients. This might be discovered or at least suspected relatively early in the project thanks to agile tools such as sprint reviews. However, the authors find that such disruptions are not handled in a timely manner and groups as well as clients adapt only slowly.

Digital collaboration in projects

Part of the reasoning behind including team-based capstone projects is to develop the students' skills in analysing and problem solving, collaboration with others, project management and oral and textual communication [2,8,12,13]. The students especially appreciate problem solving tasks that they perceive will help them in their careers [9] and it increases their confidence and give them skills not found in the curriculum [3]. Thoms and Eryilmaz [13] present how Online Learning Community Software (OLCS) can support project teams in interacting and collaborating, resulting in the students being better able to meet deadlines and finally achieve project success. They build their paper upon, among other, theories of learning such as constructivism and communities of practice, where the students work together to share ideas and support each other, and achieve engagement and knowledge building.

Tappert [12] notes how appropriate team management can smooth the process of going from co-located to distributed teams in distance learning. However, they also mention the importance of physical meetings in the beginning to set the communication standards for effective communication and participation. Thoms [13] describes Social Presence theory and discusses how an individual's engagement is affected by how he perceives to what degree the others in the group are interacting and exchanging information through social software. Social software being applications where individual can communicate with each other to create an online community. Thoms refers to research by Richardson and Swan [11] how increasing level of community can yield higher levels of learning when the student's perceived level of social presence is higher.

3 Method

To answer our research question, we relied on two sources of data. A questionnaire designed for the purpose of this study, as well as a historic overview of grades. The questionnaire provided both quantitative data as well as qualitative comments from the respondents. The grades are found in official records, and represent history for as long as the project has followed approximately the same format.

Online survey

The respondents in this study are 3rd and final year Bachelor students in IT (6th semester). We conducted an online survey [6] to reach as many students as possible. We contacted the students through an e-mail with a request to answer the survey, which we sent to all participants in the project. In the e-mail they received a link to the study itself and an introduction to the purpose. The survey was sent to 141 students and we received 48 responses. This corresponds to a response rate of 34%. The survey was conducted in late May-early June, after students delivered their bachelor thesis, but before giving the oral presentation and receiving the grade. The survey itself was designed and conducted using the SurveyMonkey tool. The respondents were anonymous and the participation was voluntary. We developed the questions on the basis of collaboration, communication and implementation of the Bachelor project. The students were asked to respond individually, so that we got the individual experience of the situation we have been through.

The survey consisted of 13 questions and three free-text fields. Each question asked the participant to compare the situation the two and a half months before lockdown with the situation after. This allowed respondents to comment beyond the issues covered by the questions and to elaborate their answers. SurveyMonkey reported that the average time to conduct the survey was four minutes. We found limited literature on similar studies, so the authors carefully discussed which questions should be asked and the use of measurement scale. We chose a custom 5-point scale to encompass possibilities for both better and worse. The questions are closely linked to the content and implementation of the bachelor capstone project in Department of Technology at Kristiania University College. The three authors of this paper are all experienced lecturers and supervisors in this project, and have been involved in the course for many years. This enabled us to confidently develop a questionnaire of high relevance to this study.

Qualitative analysis

For the qualitative data, we applied thematic analysis using Bryman's Four stages [1, 7]. Our process started by reading through the free-text comments from the respondents, noting down ideas, and rereading several times before creating and refining codes. Thereafter we identified the major themes from the text. The final stage is relating one's findings to existing theories and understandings, in addition to adding one's (research team) own interpretation.

4 Results

This work relies on two distinct sources of data, the questionnaire and the grades. The questionnaire contains questions with a five-level scale for answers, as well as open questions with space for text. For the numerical answers, we present

quantitative data, and for the open questions we present a thematic coding of the results. Lastly, we present historical grades.

Quantitative results from questionnaire

The respondents in this survey were distributed as follows: 21% female (10), 77% male (37) and 2% did not want to indicate gender (1). The findings in details from the survey are provided bellow.

Figure 1 shows the results of our questions regarding cooperation. We see that about half the students feel cooperation became worse. Cooperation with the client was the most difficult, while cooperation with the internal supervisor was least affected.

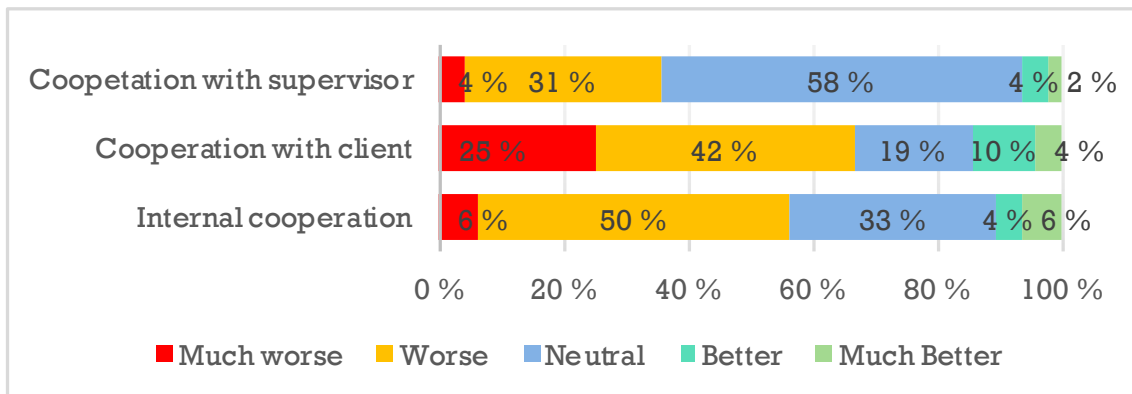


Figure 1: Compared to before Covid-19 how did you experience the following points after lockdown?

Further in the survey we asked about how the students assessed the contact in between and with supervisors, as well as project methodology and learning in the course. These findings are presented in the figure 2. In general, we see that all the measures were significantly negatively affected by the lockdown. This applies to both the contact the group members maintained, as well as the contact with the supervisors. Students felt learning in the subject was greatly influenced in a negative manner. This applies to the experience of the project as whole. Yet we also see that relatively many are neutral and think it got neither better nor worse. No one answered that it got much better. Concerning the ability to follow the schedule for activities in the project (e.g. testing), nearly 80% responded that it became worse or much worse. The execution of the selected project methodology (e.g. Scrum or Kanban) was somewhat less influenced by Covid-19.

Furthermore, we asked questions about how the students felt that Covid-19 influenced the technical solution they developed and the Bachelor project report. The findings are provided in Figure 3. The findings show that the students perceived that both the technical solution as well as the written report were significantly negatively affected by the situation.

Qualitative analysis of the questionnaire

In addition to these findings, the respondents provided us with free-text comments. These comments provided us with more details regarding the students subjective experience of the project period and how they handled the situation. Table 1 shows a summary of the results from the thematic coding.

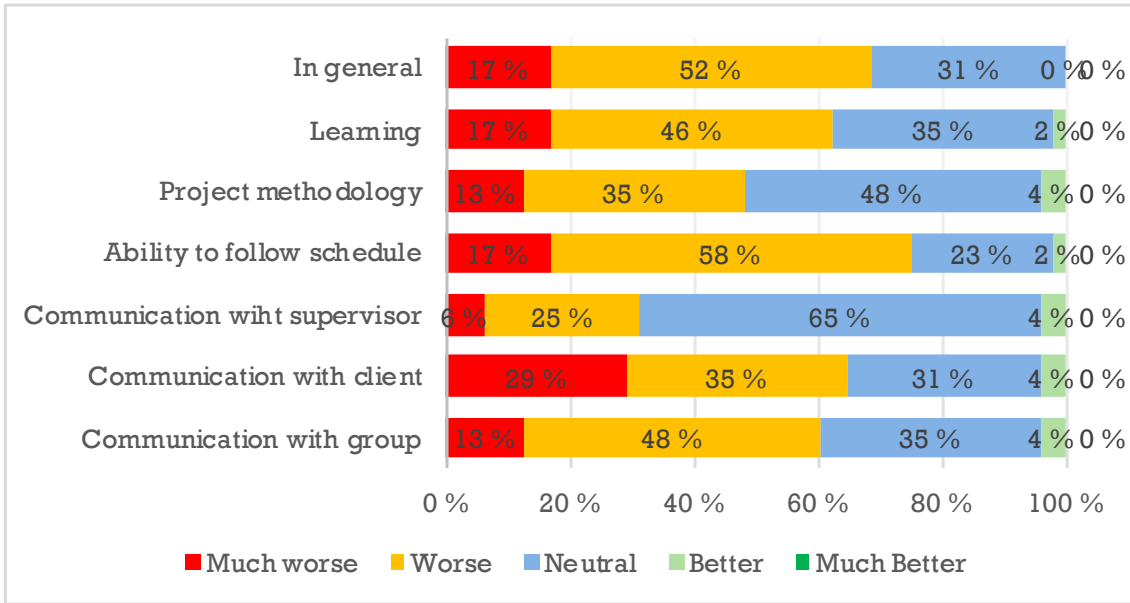


Figure 2: Compared to before Covid-19 how did you experience the following points after lockdown? The row of '0%' to the right of the plot represents the 'much better' response.

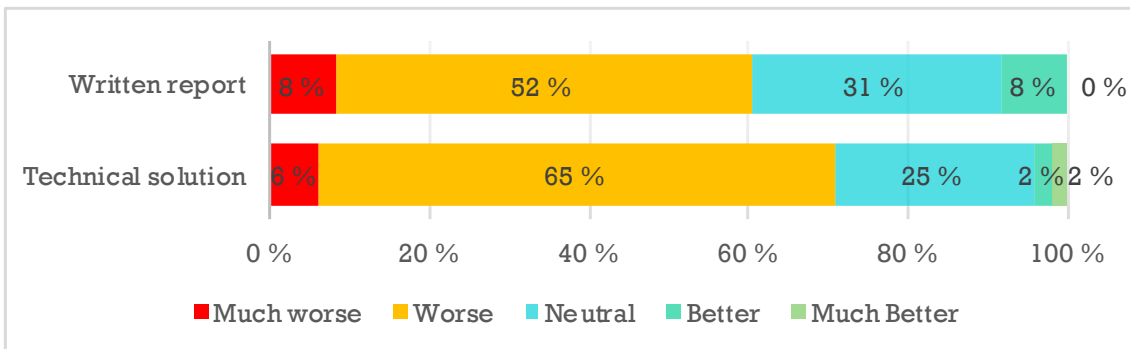


Figure 3: Response distributions for the question on how the products from the project were affected by the situation.

Theme: Project work

Project work is a theme we constructed based on four codes that we perceived as interconnected: collaboration and communication in the group, the organization of the group's work and how technologies were perceived to work to enable the groups working together. The majority of students found the lockdown situation to reduce their ability to collaborate in an efficient manner. The digital meetings became longer and less efficient. They expressed how, when they worked together at the company they could simply walk up to each other's screens whenever needed, to point and discuss there and then. Developers coding the technical solution reported on feeling they were left more to themselves compared to before when they could just ask the person sitting besides them, either peers or people at the company.

An important difference between groups concerning communication in the group is how well they knew each other from before. Knowing each other well from before made it easier to communicate, while if they were relatively new to each other they experienced difficulties communicating. Some noted how their peers were not able

Meaning	Codes	Themes
Online collaboration is harder than face-to face.	Collaboration	Project work
Online communication was frustrating. It allows no body language, and removes the ability for a continuous conversation.	Internal communication	
Organizing and coordinating work is more difficult online.	Organization	
Our students are competent users of technology, but still experienced issues such as lag and running a smooth conversation.	Technology	
The company was a place where students worked together, got regular feedback and help and socialised.	Workplace	The company
The lockdown made communication with the company difficult.	Communication with company	
Difficult maintaining a daily work routine due to situation at home.	Working at home	Home situation
Felt isolated, lost the social aspect and connection to others.	The social aspect	
Motivation was lower due to a combination of different factors.	Motivation	

Table 1: Themes, codes and their meaning from the thematic coding.

to communicate in a clear manner. In physical meetings their lesser ability to speak could be compensated in part by using body language. Communication issues led was frustrating:

Concerning that several in the group already had difficulties in understanding each other orally, it was therefore to much help to look at each other's body language to interpret what somebody said, everything became much more difficult when we became dependant on aids such as microphone and software for communication. This lead to much frustration and affected especially the morale of the group a lot.

As the students no longer could see each other and it was a higher threshold to get in touch with others, having an overview of what the others were doing became more difficult, hence more difficult to organize. Some of the students expressed how they didn't even know if the others were working or not:

It has become more difficult to have an overview of what the group is working with. Even if we sit on Zoom all day it is impossible to know if the group members are actually working on what they should be working on.

Some groups found digital tools that helped them working together as a group, and some even reporting getting more efficient and punctual than before:

Most surprising has been the attendance. We are never particularly late to the meetings when they are digital.

However, the majority of students experienced problems such as lag, and issues not necessarily directly created by the technology but rather its use:

The communication over Zoom, Slack and other similar tools makes the flow of the dialogue worse. One more easily speaks simultaneously, it lags, and so on.

Theme: The company

One theme of the responses concerns the client company. This company provides an important frame for the project work. They act as the client, but also include students in their office space and even social events. After lockdown, students mostly lost physical access to the client company offices as well as any social events. As one of our respondents put it:

The company was available to us and we could contact them when we needed it, but it's not quite the same as being in the office, meeting different people, making contacts and talking about our project and getting input along the way.

These two roles for the client company are clear in the codes we identified. The students felt the loss of the physical and social spaces. The ability to work at and with a real company normally gives students important experience preparing them for their careers. This loss was perceptible to the students. Further, they felt the loss of the opportunities to make connections during their project.

In their roles as client for the student groups, the companies were also affected by the lockdown. Students struggled with communication with the client, who in many projects take the role of product owner. When at the same office, students could easily walk over to a representative of the client and ask questions about specifications or guidance. Without physical proximity such requests have to go through more formal channels. The lockdown also affected client companies directly. In a crisis situation for the company, spending time on students who do not work on mission critical products may not be prioritised.

Theme: Home situation

The last theme we found concerned the home situation. Many students do not have ideal home offices, some share spaces and going to an office daily creates a good routine. One of our respondents said this:

I think for many in the group it was tough. Getting up, going to the desk at home and working systematically is not easy for most people.

The work situation at home is very variable among students. Some lack a quiet, private place with a comfortable and practical work space. Spaces shared with others who do not work on the same project create distractions. The lack of daily routine makes disciplined work difficult. It is easier to sleep longer when nobody sees you arriving, and there are more distractions where you also spend your free time. Some even felt anxious or afraid when spending days at home during an uncertain situation in the world.

Socially, students felt they were isolated and lost this important aspect of working in a group. This lack of connection to the rest of the group negatively affected

motivation and was boring to some. The lack of physical proximity also increased the threshold for asking for help from other members of the group.

Motivation is something that was mentioned in many different contexts and expressed being lower due to several things. The reasons for having lower motivation than before ranged from not being together with the group any more, not being at the company where they expected to learn much, to having difficulties keeping their motivation up as they distracted by other chores or activities at home.

Grades

We now move on to grades given to students after completing their capstone project. These grades are given by independent, external examiners from industry and academia, in cooperation with the internal supervisor for the project. In figure 4 we compare the results in 2020 with the previous seven years. We see that the grades are consistently good, and this year is no exception. If anything, grades are slightly better this year.

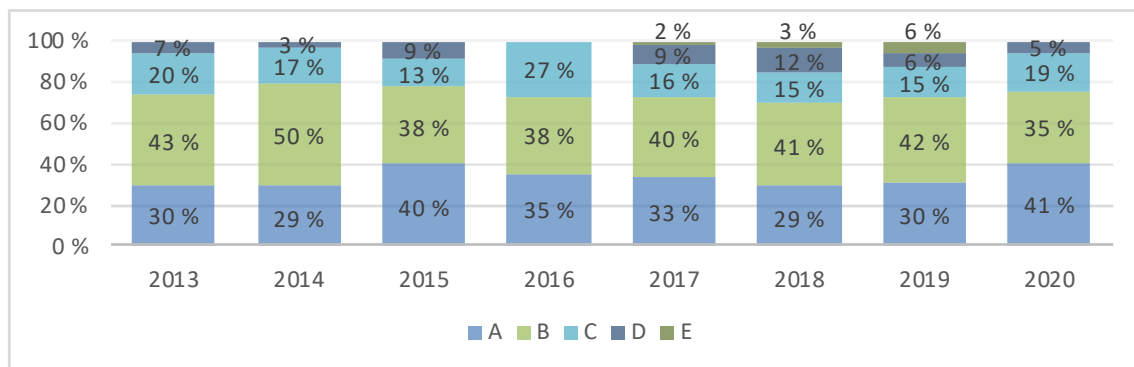


Figure 4: Grade distribution from 2013 to 2020. Failing and not delivered projects are excluded from these statistics. The numbers above the columns represent the E's which are rare.

5 Discussion

We now return to the original question *How did medical lockdown affect a bachelor capstone project in IT?* for further discussion and comparison with relevant background.

The overall picture from our data shows that in general, the infection control measures due to Covid-19 had a significant perceived negative effect on the work on our capstone project. This is not surprising; this was a situation that suddenly occurred and great adaptations were needed in a very short time. Not only were the working conditions abruptly changed, but also the work situation. Businesses were closed, employees were laid off and distanced from the everyday tasks at work. New routines had to be established immediately. Conversely, we expect technology students to be well aware of relevant technologies, and therefore have easier to adapt to such a situation. This also applies to many of the companies the students worked in during the period. This partly bears out in our findings; students do handle the situation well, but are clearly stressed.

A reason for students reacting so negatively may be partly explained in how [3] and [9] point out students working in real industry projects will not only develop

appreciated practical skills, but also appreciate it as a means for preparing for their career and increases their confidence in themselves. When they go from a situation working in a company with professionals, to working from home by themselves, it disrupts the experience of preparing for work life. Obtaining skills as communication, analysis and problem solving [2, 8] requires communication.

A vital part of this project was related to collaboration and that the students worked together physically in a company. Well over half the students feel that this aspect became more difficult after the lockdown and one can discuss how the skills and knowledge expected attained in project work referred to by [2, 8] are affected. A number of the students went from a well established community of practice in the company to a much weaker digital collaboration. Previous work [11, 13] shows that social presence has an important effect on perceived learning. When students are isolated and disconnected from the others, in addition to not being able to keep up the work efficiency, it may also affect their perceived level of learning negatively. [12] mentions how the groups meeting physically in the start of the project could ease the process of working together digitally afterward, and this point is reported on by our students; if they didn't know each other well from before they experience more difficulties working together digitally.

The overall results indicate that our respondents felt that the collaboration among the group members became worse after the lockdown. They had to work from home, had to accept limited physical contact and arrange for mainly digital communication. Although this situation also affected the collaboration with supervisors, they were more positive about the collaboration with the supervisor at the school, compared to the company (external supervisor). One reason may be that the school quickly facilitated digital communication through the use of digital platforms such as Zoom. Training was given in a short time and this became an important meeting point between students and academic supervisors. Traditionally, supervisor visit the students at their workplace for meetings. This allows them to see the students in their normal working environment. Meeting online, which became the norm after lockdown, is easier for the supervisors, and thus probably lowers the threshold for students to request such a meeting.

Compared to Dawson's [4] experiences with *dirty tricks*, the lockdown gave students much less satisfaction, but they seem to have learned many of the same lessons. The main difference between these experiences is that Dawson's students expect the disruption. This indicates that sudden unexpected disruptions divert focus from the learning opportunity to the difficulties.

There is a massive disconnect between students' answers in this questionnaire, which indicates severe difficulties, and the grades, which are excellent. There might be multiple explanations for this. Students are well aware that they are compensating for the difficulties. They run frequent, online meetings which might improve communication. They also keep project planning systems updated. While these measures might be *perceived* as a cumbersome and slow, they could very well improve the results in reality. We very rarely give individual grades on this project, so we do not know if a subset of students have performed worse, even if the sum of the project grades improved.

Unfortunately we did not include questions about how much other work and leisure the students were doing during lockdown. Most of our students have jobs while studying, and some may have lost these. Social activities among the students

were also severely limited. Both these points would give students more time to work with their project.

Further, we cannot exclude the possibility that the grading has been somewhat lenient because of the difficulties students have experienced. Ability to handle unforeseen situations is an important learning outcome, and this situation gave students ample opportunity to show their ability in this.

6 Conclusion

Based on the findings from our study, it is clear that students *perceived* the infection control measures due to Covid-19 as a serious challenge during their bachelor capstone project. They also have the general impression that their end product suffered as a result. However, grades are very good. This means that their perception of difficulty and badly handled challenges does not fully reflect reality. The students have handled this sudden and large disruption excellently. They are good at using online tools, and utilised this skill to the fullest. However, we as an institution need to work on how to prepare students better for this type of challenges. Being prepared seems to be an important factor in how challenges are perceived.

Recommendations

Visiting the students at their workplace is important for internal supervisors so that they can see the physical and glimpse the social situation for the students during the project. However, it does create a barrier for the students to ask for a meeting. Thus, it would be beneficial to use some online meetings with supervisors also in the normal situation. Keeping online collaboration channels open at all times was critical for success during the Covid-19 lockdown. Based on the grades, it seems that it fully compensated for the difficulties even though it felt stressful to the students. Thus, we strongly recommend focusing on collaboration tools even during normal situations. It could be a good idea to ask students to always reserve one day a week to work from home. This would force them to establish the required routines for situations where working from home become necessary.

Further, we see that a learning opportunity might be seen as a negative disruption if it happens unexpectedly. In the future, we should attempt to prepare students for unexpected events, and explain how even the most severe disruption might be handled as a learning opportunity. Maybe the concept of introducing at least one artificial disruption per project is worth looking closely at.

Future work

Based on our findings, there are several interesting opportunities for further studies. First, in situations such as Covid-19, the use of technology is extremely important for maintaining interaction and communication. An important prerequisite is therefore that these function optimally - and, as far as possible, replace physical contact. An evaluation of digital communication channels in the context of student project could therefore be an approach. Usability issues, technical functionality and areas of application should be investigated. Furthermore, it is interesting to investigate the extent to which experience with technology plays a role in this and how. More precisely, is it necessarily the case that those who daily use technology to a great extent experience a higher value through the use of digital communication platforms

in situations where physical contact is not possible. Lastly, how educational institutions handle lockdown situations and work to maintain scheduled teaching, so the students receive the knowledge and learning scheduled in various type of courses.

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