

IT Students Project Group Work in the Day of COVID-19: Understanding the Impact and Attitudes

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Abstract

COVID-19 pandemic has resulted in disruptive impacts on teaching and learning experience around the world. In a particular context of project-based courses, where students need to interact and collaborate frequently, there appears additional challenges in implementing and learning from projects. Understanding the impact of COVID-19 on project-based courses does not only provide recommendations for preparing such courses in post-pandemic eras, but also has some implications for physical IT projects in industry. We investigated 30 student teams in Spring semester 2020, when COVID-19 measures were applied in the middle of the course. We adopted a mixed-method approach; a bottom-up analysis with a thematic analysis, and a top-down approach with attribution theory. We found that COVID-19 measures introduced as external attributions to the course had direct and sudden impact manifestations on individual level, which leads to internal attributions, such as lack of motivation, lack of commitment, realization of usefulness of some online tools, and mental struggle. This creates an indirect impact on team, process and product factors in the course.

Keywords: Project Course, Group Work, COVID-19, Customer-driven, Impact

1. Introduction

Since early spring 2020, universities worldwide have been experiencing the disruptive impact of coronavirus disease (COVID-19)¹ on their students. While many academic programs are facing with delaying graduation, students withdrawing from classes and intending to change majors around the world, Norwegian universities are applying various measures to support students to continue their study in a best possible way².

The request on maintaining social distances is a game-changing factor for project-based courses that emphasize teamwork and collaboration. Challenges to IT students working in groups for projects have always been persistent on regular basis, such as group dynamics, time and location convenience, commitment, and skills (Weland & Marshall 2020). However, these challenges are doubled with COVID-19, as the students had a short-noticed change in the way they communicate and collaborate while keeping up their motivation and the project progress. Students' attitudes have always been a key determinant of their learning process and decisions in managing group work.

This paper attempts to shed light on the impact of the COVID-19 and applied measures to customer-driven project courses at University of South-Eastern Norway (USN). We investigated and analyzed from course perspective, i.e. how students perform differently regarding to software development and student learning experience. Furthermore, we applied the attribution theory to understand internal and external factors that affect individual and team performance in student projects

The paper is organized as follows: Section 1 is the introduction, Section 2 presents related work, and Section 3 is our theoretical framework. Section 4 is about the methodology, Section 5 is the result, and Section 6 discusses and concludes the paper.

¹ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/>

² <https://www.fhi.no/nettpub/coronavirus/rad-og-informasjon-til-andre-sektorer-og-yrkesgrupper/universiteter-hoyskoler-fagskoler-folkehoyskoler/>

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2. Related work

Project-based teaching in engineering generally and software engineering (SE) particularly is not new, and literature reveal some experience and good practices (Mahnic 2012, Bruegge et al. 2015, Feliciano et al. 2016, Broman et al. 2012, Quintana et al. 2020). Mahnic et al. described the experience of giving a strict guideline for teaching Scrum in a Slovenian capstone project (Mahnic 2012). Bruegge described the experience of teaching a large Software Engineering class (size of 300 students) with real industrial clients (Bruegge et al. 2015). The author used a collaborative management environment that automates recurring assessment tasks. Feliciano et al. reported the benefit of using Github and open workflow to support collaboration among students (Feliciano et al. 2016). Broman et al. described a company approach to teaching software engineering project courses. Students were organized into simulated companies and assessed according to process and product features (Broman et al. 2012). However, to date there is no study investigating disruptive influence on project-based teaching in software engineering.

There is a rapidly emerging body of literature about COVID-19 in academia context. Impact of COVID-19 to academic progress and learning is published, however, quite limited work about the context of student project course is found. Weland and Marshall reported students' experience with project-based learning at Duquesne University and found that respondents found medium to significant impact of COVID-19 on their educational experience (Weland & Marshall 2020). Quintana investigated how to design an academic course that is resilient to incident like COVID-19 outbreak (Quintana & Quintana 2020). Matt et al. emphasized different virtual work practices (telework) to be useful during COVID-19 period (Curtis 2020). However, none of these studies reported in detail the experience of students in a customer-driven project course and their concrete learning.

3. Theoretical background

COVID-19 had impact on the students' attitude and effort toward their group project work in the context of our study and, thus, influenced the outcomes of the carried project tasks in the project course. Despite the significant relationship between the attitude and effort in the context of higher education, it has been rarely addressed in previous research (Li 2012). To explain the relationship between the students' effort and achieving the outcomes of the tasks carried out in the project, attribution theory is a fit. Attribution theory considers individuals as active beings that "seek to understand and master their environment and themselves" (Li 2012). Thus, the behavior of individuals and the outcomes of their effort can be attributed to (Heider 1958; Weiner 1979): (1) external attributions, which are factors that are external to the individual and are difficult to control (e.g., difficulty of carrying out the project tasks due to COVID-19 caused teaching and group activities go online), and, (2) internal attributions, which are factors that are within the individual's ability to control (e.g., motivation and effort to collaborate with others to carry out the project tasks).

Internal attributions and external attributions play a role in affecting students' subsequent behavior (e.g., engagement in project tasks) and the outcomes they achieve from performing the project tasks (e.g., success, failure, or incomplete task) (Li 2012) and (Elliot *et al.* 2005). However, it has been argued that internal attributions are more influential than external attributions (Elliot *et al.* 2005). The interplay between the external and internal attribution is not addressed, as they are treated as separate dimensions affecting both individuals' behavior and their achieved outcomes. We use

attribution theory to explain the impact of COVID-19 pandemic on the behavior of students enrolled in project courses at USN and the outcome of carrying out the project group work. We identify the external and internal attributions and possible relationships.

4. Research Methodology

We conducted a multiple-instance case study. According to Yin, a case study design is appropriate when (a) the focus of the study is to answer “how” and “why” questions; (b) there is probably high influence of contextual factors on the studied phenomenon (Yin 2014). The underlying philosophical approach for this study is interpretivist, with the study explicitly focusing on the subjective perceptions and experiences of the participants (Myers 1997). Study design, data collection and analysis were conducted in between January 2020 and July 2020. Various instruments were designed to collect data, including project reports.

4.1. Data collection and analysis

We used student reports as the main source of data. Each team delivered a ca. 60-page length project report describing the project planning, execution and closing processes. The reports include not only technical and process angles of the projects but also students’ experience with communication, teamwork and their learning. A part of the report dedicates to describing challenges student face with COVID-19 and their solutions towards these problems.

In this study, we limited ourselves to a tailored thematic analysis. The objective of our thematic synthesis process was to answer the research questions and come up with a model of higher-order themes describing consequences of COVID-19 to student projects (Cruzes et al. 2011). Students group reports and individual reports provided a good amount of information regarding the challenges, pros and cons of online teaching and remote collaboration. Students were expressive in terms of describing the changes and how those affected their productivity and the end-results. We imported all students’ reports to NVivo version 12 and conducted open coding with the tool. After that, we conducted axial coding to generate second-level order themes. The results are presented in the coming section (Figure 2 and Section 5).

Table 1: Course characteristics

Course instance	USN, Bø campus	USN, Ringerike campus
No. Of students	79	72
No. Of teams	12	18
Student background	1st year students from Bachelor program in ICT	
Customer	An entrepreneur, An academic project leader and, SME company	An academic project leader SME company

4.2. Customer-driven project courses at USN

At USN, we aim at giving students practical experience in executing all phases of a real software development project, equipping them with the ability to organize and carry out large development projects, as well as document and present results to a realistic client and in general. The courses are conducted for second-semester students who already have some fundamental programming courses in their first semester. There is no prerequisite knowledge explicitly required for the course, but we assume that students have system

development and programming knowledge from their first semester study. Each group is given a task from a client that is to be carried out as a project. Students are divided into groups of six to eight students. Normally, the students are given an option to form their team themselves before assigned by the lecturers. Each team decides by themselves about their management and leadership mechanisms. In most of the cases, students organize themselves as flat structure teams. Decision-making is often done collectively and the reasons for important decisions are documented in the final reports. There are several lectures at the beginning of the course covering topics such as project management, team dynamics, Scrum, architecture, and testing.

Students typically engage in three phases of their projects, which are planning, execution and closing. In the planning phase, the students get to know their team members, customers, and their project requirements. The students need to decide roles and areas of responsibility for each member. They also make a preliminary project plan and set up the working environment. In the execution phase, the student teams typically carry out sprints with frequent deliveries to their customers. Each project covers fundamental SE activities, i.e., requirement elicitation, architecture level design, coding, and testing. Students also write a project report that reflects their team’s progress. In the closing phase, students submit the project results in a report, besides, demonstrating and presenting to the customer and course staff (e.g., course instructor, supervising teaching assistant).

4.3. Disruptive changes due to COVID-19 measure

The outbreak of COVID-19 and the measures applied to the project course occurred between week 6 to week 8 of the course. We have had the same intended learning outcomes, assignments and final project presentations for students. However, we adjusted some teaching activities due to the closure of our campuses. Teaching was required to be maintained digitally from March 16, 2020. All exams are turned into digital exams. The direct impact into the courses include:

- Supervision meeting that would occur physically bi-monthly for each team now turned into virtual meetings, scheduled bi-monthly
- Teamwork is limited without physical meetings, working session in the same room and social activities. Instead, students use email, chat messengers, call apps to maintain their collaboration
- Customer involvement in the project activity was less regular and less active.

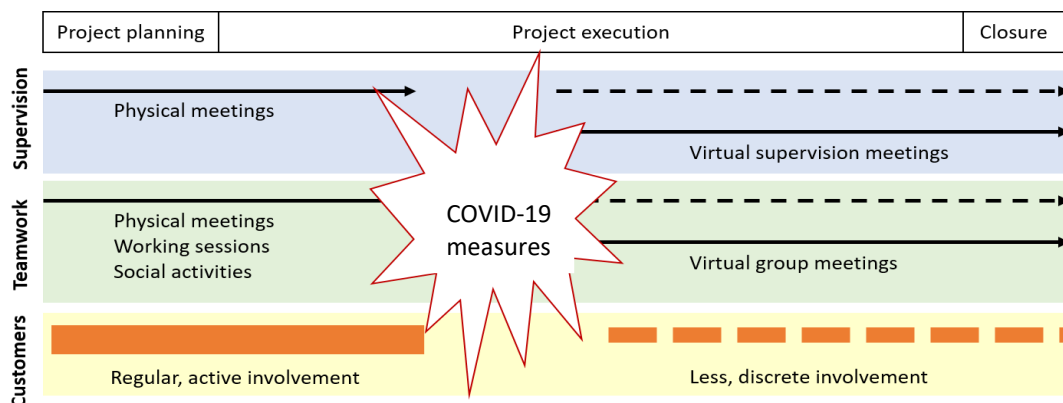


Figure 1: setting changes to supervision, teamwork and customer involvement after applying COVID-19 measure in the course

5. Analysis and findings

In this section, we present the findings from students' comments and analyze them. We can explore the impact of COVID-19 from two perspectives. First one is from i) course teaching and learning perspective where we are interested to see how it affects the students' learning objectives, teaching and learning activities and assessment tasks, and, second one from ii) capstone project perspective where we are interested to see how it affects team collaboration, motivation, working process and the product. In this paper, we will focus on the second perspective, i.e., development challenges of the project and how it (COVID-19) affected the groups and their progress. As for the first perspective, we plan to make a separate study focusing the teaching and learning issues. Even though first perspective can have effects on the second perspective, but here we want to limit our focus only on the project development issues without changing learning objectives and desired learning outcome of the course. Besides, considering both perspectives in this same paper will be too much and will exceed the page limitations or make it shallow in both perspectives rather than in depth study in one perspective. Considering the course as a software development project we have categorised the challenges and issues aligned with software project parameters such as team, project constraints, working method and end-product. These challenges were external and internal, and they are attributed to the effects of COVID-19, some at a small scale and some at large scale.

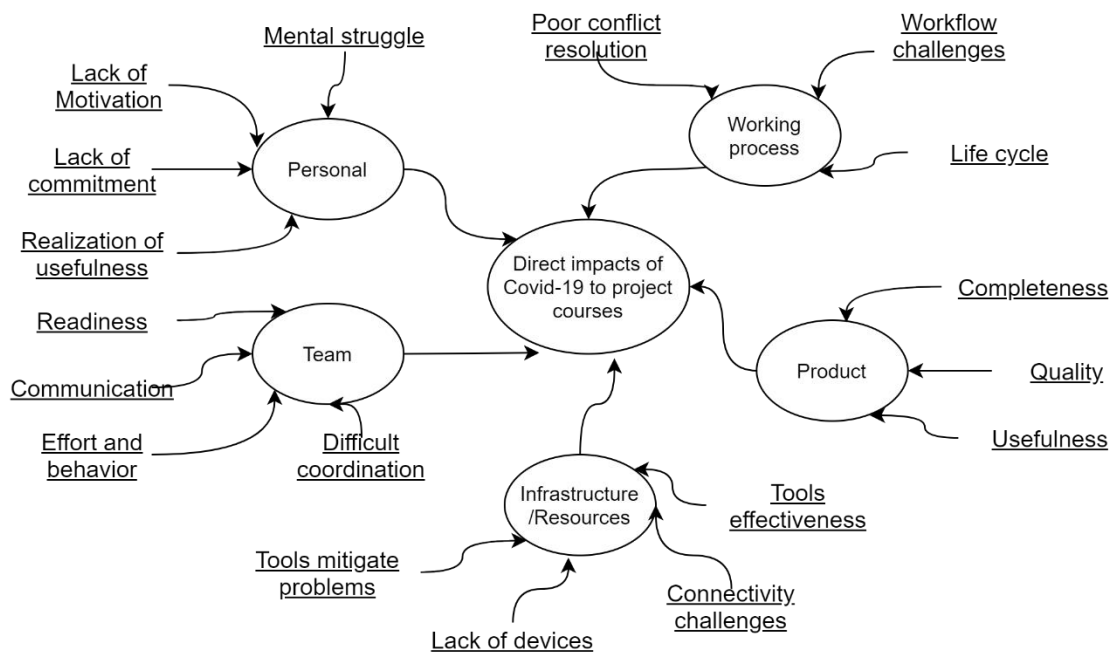


Figure 2: A thematic map of consequent factors of COVID-19 on student project courses

5.1. Person perspective

In personal level, each student was affected by the circumstances that COVID-19 posed on the lifestyle of a person. When lockdown and social distancing was implemented, students were affected mentally. For example, some students mentioned that they **lost focus** because of the lockdown, “*Because of the COVID-19 the university closed, and because of this I lost some of my focus on the project*” (Gr2, IR). Another student reports that s/he loses motivation to work, “*personally I feel that I am a bit*

dependent on meeting in person (physical meetings) because I otherwise lose a lot of motivation to work with the tasks, because I tend to be distracted” (Gr 3).

Other students also report similar **lack of motivation**. Commitment to work was affected in individual level and this had impact on the group work and other members of the group. As one student mentions, *“Corona made it difficult for me to work at 100%, and I saw that my motivation levels dropped hard. I had less control over what was happening, and I think, it made impact on the efficiency of the group, which is my fault. Tasks were still distributed, but it slowed down” (Gr 06)*. Another student realizes the lack of commitment as, *“and I now see that I responded to that in a bad way, where I felt apathetic to the work that was left and wasn’t committed to do what was necessary” (Gr B07)*.

Going to online/virtual mode made the whole project relaxed for some students in a bad way, so that they lost the focus and the urge to do the tasks seriously. As one student mentions: *“Last semester I was stressed for every assignment and deadline, whilst this semester (especially after COVID) I have been way too calm. My stress is what drives me to work, and what drives me to learn. Whilst being stressed is not necessarily a good thing, I feel like being stressed for the right reasons is good” (Gr10)*.

5.2. Team perspective

Lack of individual’s motivation, in turn, affected whole **group’s motivation** and students also acknowledged it. It is natural that if some members of the group becomes less active, or loses motivation, that affects others in the group. As one of the students realizes, *“it(my lack of motivation) made impact on the efficiency of the whole group, which is my fault” (Gr 06)*. Besides, not only because of one individual’s motivation dropping in the group, but the whole team’s motivation dropped down as an effect of lockdown, *“COVID-19 situation has been very challenging, not being able to have a physical meeting made our motivation drop down a little (Gr B04)”*. *“To be honest it has taken quite a toll on us as a group both in motivation and communication” (Gr B07)*.

Communication was affected in the group and many groups reported that they had poor communication in the group due to the lockdown. As mentioned by a student: *“The communication also weakened. This was because we did not meet in person and had to work online. We used “Discord” and “Messenger” for communication, but it was less effective and was not the same as meeting in person” (Gr 06)*.

Another group (Gr B11) asserts that the corona virus pandemic affected their group in many ways where team members were getting sick and *“the motivation was on an all-time low”*. Some groups started the project with a very high morale and every member of the group were ready to go the extra miles for the project, but as the pandemic hit the world, it impacted both **their schedule for meeting** and the morale as a whole. Teamwork of the groups *“has been affected greatly” (Gr B10)*. Students reported that when the school was closed, communication and teamwork *“became very challenging” (Gr B06)*.

Due to these reasons, overall effectiveness of the group was affected as a result. Some groups mention that some members went missing for couple of days because of other priorities, some struggled mentally due to lack of social interaction. One group also mentions that it had **different schedules** among its members (Gr B07), which affected finding common time to work. Even though students used digital tools to collaborate and communicate, but they mentioned that, it was not as effective as meeting in person. As a result, the team effort, spirit and effectivity suffered.

5.3. Infrastructure/Resources perspective

Sudden change of working method and environment made **some tools and resources essential**, which were otherwise not so used in the project. As a result, groups that did not have those tools or had not-properly-working tools were challenged. One of the groups reported that digital meeting proved problematic for them as not everyone had the **optimal equipment** for communicating digitally. Another group member mentions, *“Sometimes headsets were not working, and we didn’t catch everything everyone said”* (Gr B04). Lockdown happened with a short notice and students had to adapt to a new way to collaborate and implement their projects (Gr 03, Gr 11). As students were *“not prepared for this lockdown, they got very short time to adapt with the new conditions, new set up at their home-town and the demands to catch up with the tasks that they left behind in the project”* (Gr 03, Gr 08).

However, some students also reported positive feedback on the changed working environment/tools as it affected them positively, for example, a group discovered an advantage of video meeting is that *“it did allow only one conversation at a time, thus the person speaking got everyone’s attention”* (Gr B04). Even though students were supposed to use project collaboration tools in normal times, but perhaps they did not understand and utilised fully the features of these tools before. However, after corona posed a lockdown situation, they were forced to use these tools. Students highly **appreciated the strength, capability, and usefulness** of these tools in their reports. Several comments from students of several groups (Gr 04, Gr 06, Gr 07 and Gr 15) like, *“Trello was a great tool for coordination”*, *“...Teams and Discord removes the need for physical group meetings”*, *“we were able to cooperate digitally and worked by using digital tools for both communication and documentation”*, *“Zoom helped us to hold meeting among students and between students and lecturer when we worked with assignments”* provides evidence in this regard. Students have used different kinds of tools such as Trello, Discord, Messenger, Microsoft Teams, Zoom, and Google Drive.

5.4. Process perspective

The COVID-19 situation forced the students to use different methods to work on the project. Since they could not meet up at school to work together, their usual meeting and working pattern changed. Many groups used to meet once or twice a week at school for the project work. As these meetings were long and the groups used to discuss, pair program or brainstorm together, they were much more effective compared to virtual meetings. A group mentions that, they decided to have more meetings, more than two times a week to talk about the project and work together to cope up with the changed situation.

Working process and communication process were changed and the groups had to cope with this, from physical to virtual, from classroom collaboration to *Zoom* and *Teams* collaboration. While everyone was at home and it could imply that everyone has more availability for online meeting, but **in practice that did not happen**, as we see that group members started to have different priorities and different sleeping schedule (Gr B07, Gr 08). In addition some members tend to forget, as a group mentions, *“Some members seemed to forget the project, and didn’t take much initiative to get things done - this led to some of us had to do more work than others”* (Gr B02). This kind of situation should not have happened, even though the school was closed, all members have responsibility to do their parts of the project and not let others face the consequences of certain team members not doing what they were supposed to do.

Shutting down of schools **changed the normal workflow**, but students say that since they knew each other, *“it was easier for them to simply just write or call another”* if

anyone needed help or had a question (Gr 04). Groups needed to change their plans: “*we had to reevaluate our plans and reconsider how we move forward*” (Gr B01). Some groups mention of restructuring how they would work further on the project and continue with meetings and work sessions. Groups that had clients needed to restructure client meetings and feedback sessions, “*... it applies to customers as well, all that was physical now has to be shifted to online*” (Gr B03).

The task of **collaboration became harder** for many groups. Though there were several tools that students used for online collaboration, but they experienced that, “*the online communication and work collaboration made things significantly harder*” than they thought those would be (Gr 08). Difficulty in collaboration could also result from students not being able to focus and accomplish the task in needed time (Gr 11). A student from group 11 mention that he becomes tired after two hours of online meeting, where as it was much smoother in physical meeting where they collaborated using a large screen. Other groups also reported that it was harder to collaborate and the effectiveness was reduced: “*Coordinating of tasks was assumed harder by other groups, for example, ‘working together in a group room is much more manageable (in my opinion)’*”. Students also think that team building is very important and that is hard to achieve when they do not meet physically. Some students mention that they had coordinating problems in online Zoom meetings as they had it in physical meetings.

Conflict resolution in online team work suffered, it was poor compare to physical collaboration work. As a student mentions, “*while we were still able to work together online conflicts are much harder to resolve online, and it becomes very easy for people to just ghost (avoid) others and/or responsibilities*” (Gr 02). Even though the group did not have a big conflict, but they realized that, the involvement was poor during the development. We believe that this is because of the seriousness and the commitment that exists in a person-to-person meeting was missing when the students began to collaborate online.

Regardless of the SDLC method chosen by the students, the **adopted engineering methodology was affected**. For example, groups using Scrum as development method reported that it added delays in the sprint delivery. Completing tasks on time was a challenge for many individuals and groups. Some groups could not finish the tasks assigned for a sprint, while carrying the load of unfinished task from previous sprint- “*This sprint was supposed to finish most of the login environment for both the studio and designers, while also getting the ‘about.php’ page we failed to complete on last sprint*”(Gr B10). Some groups had to push the tasks of a sprint into other sprints, “*because of the pandemic, we had to push Frontend into mid-April*” (Gr B11).

A specific example of the affected areas is **testing and programming**. Two groups (Gr B02 and Gr B09) mentioned about usability testing that they had to change their usability test plan, as it was hard to conduct the test with customers due to corona virus. It was not possible for many to do pair programming as planned before the pandemic. Some groups discontinued or cancelled their plans of pair programming, whereas some other kept it voluntary and conducted by online screen sharing.

5.5. Product perspective

The product aspect, as an outcome of student projects are influenced in term of its completeness, compromised features and usefulness. As a direct consequence of personal and team level drop of commitment, the end result of the project was impacted. Often the product delivered was a subpart of what was originally planned. A student group recognized their products as “*more of a shell of what they wanted, compare to the ‘full*

system' that they would have made if it had not been COVID-19 lockdown'' (Gr 10). Because of effects of the lockdown in direct communication and meeting, some groups downsized and compromised the features of their target application, as they could not progress accordingly (Gr 14). Some groups also became a bit disheartened as they discovered that their product will not be in use due to the lockdown, this happened for groups who made travelling websites for Seville, and Seoul for example (GrB 01, GrB 09).

6. Discussion

From the evidence in the previous section, we can see that almost all groups and more-or-less every member in the group was affected by the lockdown. It is natural that lockdown affected the life of every individual who had job, school, or any other routine outside home. The groups that we have observed in the course, being only in the second semester of their first year at USN, were still amateur and learning different project-related skills and responsibilities for the first time. For most of them, it was their first time to work in a big project like this. Therefore, being inexperienced to handle the situation is something that affected them.

The evidence that we have collected from the students contains rich, spontaneous, and open opinions about different perspectives related to project work. We observed that individual-level effects, such as mental disturbance, lack of focus, lack of commitment etc. were propagated to the group level and had adverse effects on teamwork, team spirit, team-level commitment and team bonding. As a result, this affected the development process: collaboration and tasks coordination, conflict resolution, sprint delivery and so on. A direct consequence of this effect was poor end-result and poor end-product that was obvious in the web applications made. Students could realize the effects and some of the groups were prompt and effective to minimize the impacts.

Resources in a normal setting that we counted as working environment, for example, classroom, big screen, sticky notes, blackboards etc., were missing and the groups faced their impacts on their productivity. However, the groups that were agile and responded quickly to the changed situation, adapted the new digital tools and used their features extensively, managed to do well. The groups understood the importance of the collaboration tools. Some groups even experienced that online tools helped them to better concentrate in the meeting as it allows only one person to talk. Some groups realized this incident as a real-life example of project risks and risk management. The groups that stayed ahead in planning and had regular meetings suffered less and tackled the obstacles better. Even though group study was one of the practices that were mostly affected and there were few alternatives that could actually compensate that, but students were still able to learn important features of project development, such as planning, collaboration, use of online collaborative tools, risk management, the importance of project documentations and learned to appraise the things that they considered granted otherwise in a normal setting.

Applying attribution theory to the findings of our study, we interpret the ramifications of COVID-19 as external attribution to the behaviour of the students working as a team on the project, deviation in the process, and the outcome (i.e., the product). The external attributions are the lockdown caused by the pandemic, social distancing restrictions, sudden shift to meet and work online, and cancelled face-to-face meetings. These external attributions had direct and sudden impact manifestations on the individual students, which are interpreted as internal attributions, such as lack of motivation, lack of commitment,

realization of usefulness of some online tools, and mental struggle. We demonstrate our interpretations in Figure 3.

Both the external and internal attributions had impact on team, development process of the project, and the final product. The impact on the team manifested in their readiness for the radical shift to online mode, ability to communicate, coordination in terms of dealing with the difficulty to have a common time to work on the project, and the team members' effort and behaviour to keep up the project work during the lockdown. For example, some team members realized the usefulness of some online tools and made an effort to make a good use of them; thus, they did not have communication and coordination problems. On the other hand, some teams suffered from poor communication due to some individuals lacked motivation and commitment to meet online, as it was not the same as face-to-face meetings to them. Thus, the efficiency and motivation of the whole team declined.

Furthermore, the external and internal attributions had impact on the development process of the project; this manifested in forgetting about the project activities, changing plans, difficulty to resolve conflicts, and deviations in the life cycle activities and deliverables. For example, teams that had individuals with low motivation and commitment could not re-evaluate plans for the project workflow properly, restructure client meetings, and deliver complete sprints. Furthermore, pair programming activities became impossible with going online for working on the project.

The impact of internal and external attributions on the product manifested in ending up with incomplete product that is not functioning as intended, compromised quality of the product, and limited usefulness of the product. For example, the lack of motivation and commitment in some individuals due to the lockdown and having no physical meetings have caused teams to lose these individuals. This resulted in compromising some features that are key to the quality of the final product. Furthermore, since the clients asked the students to develop a product to use for their business, some of those clients were from those industries that were hit by the lockdown, such as travelling business. Thus, the usefulness and the usage of the final product was limited or for the time being remain suspended.

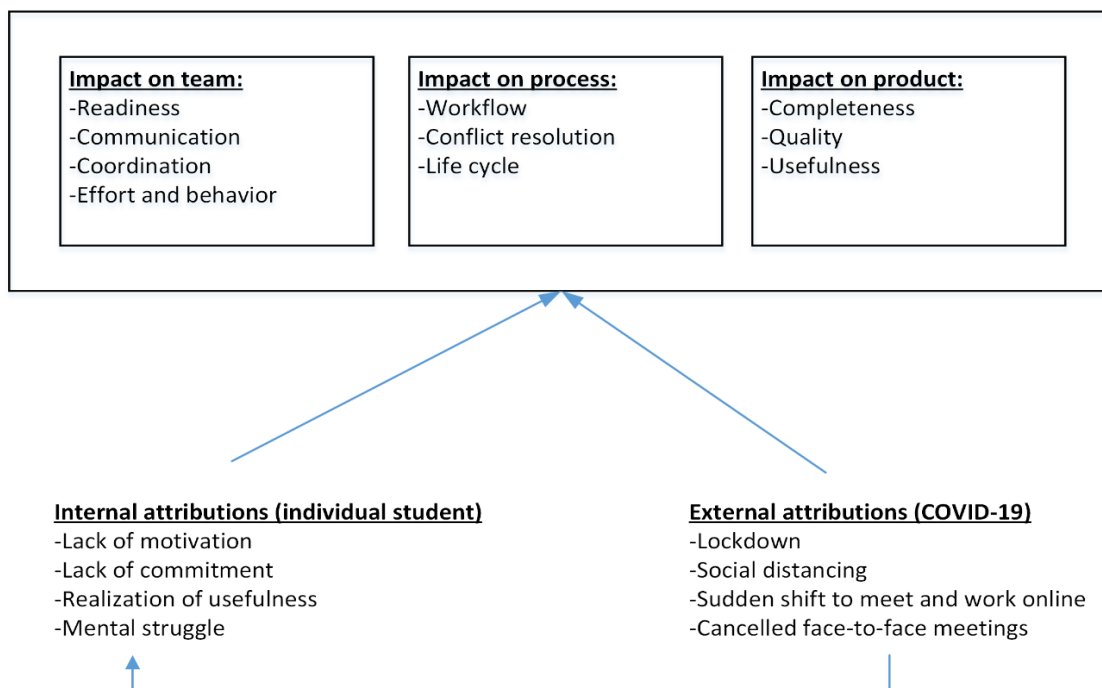


Figure 3: Interpretation of the findings using attribution theory

7. Conclusions

In this paper, we have looked through students reports to find out what was affected as a result of the lockdown caused by COVID-19. This was our attempt to see the affects from a broad angle, considering who, what and how perspectives: who is affected, what is affected and how is affected. This is a sort of case study that asserts the problems and challenges that the students faced, not solutions to the problems. However, we offer our analysis and interpretation, so that future researchers in both project-course education and software project management can proceed with best practices and process for project work under a pandemic scenario. Especially educators can find tips on how to avoid them, how to prepare the students and teachers and how to design the course in a way that reduce the impact of these problems.

In general, the lockdown situation is supposed to affect the groups with adverse impacts in teamwork, overall progress of the project and the product. Students see the effects directly on the progress of the work through project progress measures such as sprint delivery, burnt down chart, project plan etc. They also see the effects in course achievements through different assignment submissions and project documentation, final product and project delivery.

In this paper, we have focused on the software development perspective to see how it affected the team, process and the product. In future, we would like to see from the perspective of teaching and pedagogic: how it affects the learning outcome and how teaching and learning activities can be organized to increase learning outcome and reduce the adverse impacts. Future work can also include identifying the learning challenges students face in capstone project compared to other courses such as a theoretical course or a programming course. Besides, challenges from a capstone project can be also compared with projects in industry settings, where small and medium sized groups were forced to collaborate online due to lockdown. Lessons learned from the case of course setting and the case of industry setting can be shared and exchanged in order to improve each other's knowledge by identifying the strength and weakness of each context.

Reference

- Bruegge, B., Krusche, S., & Alperowitz, L. (2015) Software Engineering Project Courses with Industrial Clients. *Trans. Comput. Educ.* 15, 4 pp. 1–31
- Broman, D., Sandahl, K., & Abu Baker, M. (2012). The Company Approach to Software Engineering Project Courses. *IEEE Transactions on Education*, vol. 55, no. 4, pp. 445–452
- Cruzes, D. S., Dyba, T. (2011). Recommended steps for thematic synthesis in software engineering. In: 2011 International Symposium on Empirical Software Engineering and Measurement, p. 275{284
- Curtis, M. (2020). (Re)Awakening to the benefits and climate impacts of telework during COVID-19. <https://escholarship.org/uc/item/7nf8k2q6>
- Elliot, A. J., Shell, M. M., Henry, K. B., & Maier, M. A. (2005). Achievement goals, performance contingencies, and performance attainment: An experimental test. *Journal of educational psychology*, 97(4), 630.
- Elliott, J., Hufton, N., Willis, W., & Illushin, L. (2005). *Motivation, engagement and educational performance: International perspectives on the contexts for learning.* Springer.
- Heider, F. (1958). *The naive analysis of action.*

J. Feliciano, M. Storey, and A. Zagalsky. Student Experiences Using GitHub in Software Engineering Courses: A Case Study. 2016 IEEE/ACM 38th International Conference on Software Engineering Companion (ICSE-C), pp. 422–431, 2016

Li, L. K. (2012). A study of the attitude, self-efficacy, effort and academic achievement of CityU students towards research methods and statistics. *Discovery–SS Student E-Journal*, 1(54), 154-83.

Mahnic, V (2012). A Capstone Course on Agile Software Development Using Scrum. *IEEE Transactions on Education*, vol. 55, no. 1, pp. 99–106, Feb. 2012

Myers, M. (1997). Qualitative Research in Information Systems. *MIS Quarterly*, vol. 21, pp. 241-242

Quintana, R., & Quintana, C. (2020). When classroom interactions have to go online: The move to specifications grading in a project-based design course. *Information and Learning Sciences*, ahead-of-print(ahead-of-print). <https://doi.org/10.1108/ILS-04-2020-0119>

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of educational psychology*, 71(1), 3.

Weland, Z., & Marshall, N. (2020). Project-Based Learning in Social Statistics: Direct and indirect assessment of student learning outcomes. *Undergraduate Research and Scholarship Symposium*. <https://dsc.duq.edu/urss/2020/proceedings/10>

Yin, R., K. (2014). *Case Study Research: Design and Methods (Applied Social Research Methods)*, 5th ed. SAGE Publications, Inc.