

# ADDRESSING CHALLENGES OF HYBRID CAPSTONE PROJECTS IN A PANDEMIC ENVIRONMENT

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## ABSTRACT

Capstone courses are a common way to bring together earlier learnings into a practical demonstration of the skills acquired. At Åbo Akademi University, our Capstone course, or Project Course, has been running as a very practical, hands-on course, emphasizing the physical presence and interaction among students. The Covid-19 pandemic made it impossible to run the course in the standard way affecting the main course objectives. This article discusses the challenges and solutions of running the course in both hybrid and online format, and what learning can be drawn from this. The different tools and methods used for forming the teams and formulating the projects are analysed and evaluated, both through a student survey and using the lecturer's qualitative hindsight. We show that by using proper tools and methods we can compensate for the drawbacks and limitations of a Pandemic environment.

## KEYWORDS

Hybrid and online teaching, capstone course, standards: 5,6,7

## INTRODUCTION

The IT department at Åbo Akademi University has since the start of engineering education in IT had a project course on the curriculum. The course is designed to map on the CDIO stages (Crawley et al., 2011) as follows:

- Conceive - the student team negotiates with the customer the project proposal and the initial requirements
- Design - the student team designs the architecture, subsystems/components, UI
- Implement - The student team implement and validated the system
- Operate - decide internally how the interaction with the customer takes place, how feedback is collected, how different versions of the product are demoed and delivered.

One of the main goals of the Project Course is to teach students the so-called *soft skills*. Soft skills is an umbrella term that describes a list of non-technical skills such as social aptitudes, language and communication capabilities, friendliness, and ability to work in a team (Cimatti, 2016). Recent research has shown that soft skills are becoming increasingly popular and in-

demand term in the industry, many times companies give a higher weight to the soft skills compared to the technical (hard) skills when hiring (Cimatti, 2016). Research studies have also shown that there is a discrepancy between the soft skills taught in academic environments and those needed in the industry (Börner et al., 2018).

Our capstone Project Course attempts to close this gap by creating an environment in which students can experience and learn soft skills while completing an IT project. Teaching soft skills is hard (Idrus, Abdullah, et al., 2009) and in our course we approach it as a *problem-based learning* (PBL) teaching situation Barrows, Tamblyn, et al., 1980; Hung et al., 2008. In PBL, students are supposed to identify solutions to real-world problems. Differently, from traditional teaching, PBL challenges students to think deeper and learn to defend their decision, work in complementary teams towards a common goal, utilize previous knowledge to critically analyze complex issues, and be motivated by understanding from the beginning the goals of the course (Nilson and Nilson, 2010). Furthermore, previous studies have shown that PBL and CDIO can be regarded as complementary approaches (Edström and Kolmos, 2014).

In our version of the capstone course, the teams and the projects are self-organized. That means, that the students are required to find a suitable team and a suitable project to perform during the next 6 months of their studies. This was traditionally done using physical meetings and mini-workshops, where the students had time to meet face-to-face and discuss possible topics and roles in the team. The Covid-19 pandemic changed how the course startup could be made and there was an abrupt change in how the course was started. In order to mitigate this issue, we had to adapt and resort to online tools and increased supervision.

After two course startups in a pandemic environment using the new set of tools and methods, we have analyzed the impact of our measures. The main objective of the analysis was to investigate to which extent the deployed methods and tools were able to compensate for the lack of physical presence. The research questions addressed in this analysis are the following:

- RQ1: How did the remote setting affect the course?
- RQ2: How did the newly adopted tools affect setting up the course?
- RQ3: How suitable is it to continue using the adopted online tools in the future?

Since the teaching of soft skills in this course was directly affected by the pandemic, the analysis is focused mainly on the tools and methods used to assist with collaboration, communication and general project management practices.

The basis for this analysis is both the opinion of the teaching personal involved in the course and a survey that was answered by the students of the two courses. The survey is analyzed and supported by the lecturer's perspective and compared to similar studies.

## **THE TRADITIONAL PROJECT COURSE**

The project course has been running in quite similar format for the last 5-6 years. For the current version, the following learning goals are given:

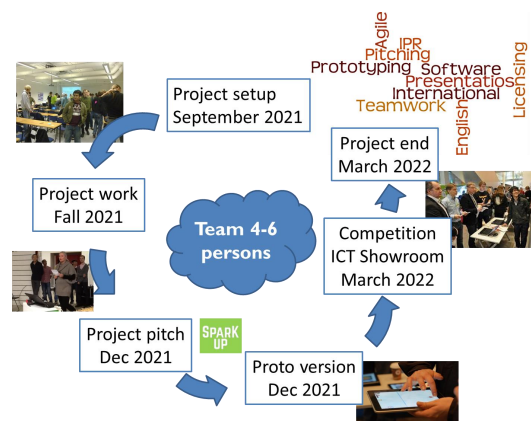


Figure 1. The flow of the project course for academic year 2021-2022

- **Interact with a customer** and learn how to communicate requirements and design decisions.
- **Plan and follow up** a software development project. Review the plan during the execution of the project and reflect over your initial expectations and estimations.
- **Work in a team** via team coordination, meetings, planning and internal communication. Use basic collaboration tools in software development such as an issue tracking system and a software repository and version control system.
- Carry out a **development project** from beginning to end: Create and document a design. Implement the design. Test the implementation.
- **Define** the business goals for the software project
- **Presentations** of the project, product, work plans and documents to colleagues, stakeholders and the general public.
- **Produce documentation**, both technical and for end-users, that is usable and understandable.
- **Personal skills:** project management tools, project planning, project evaluation, business evaluation

The course starts with a one-month introduction part (**Phase 1**) with weekly meetings. In these meetings, there are lectures on topics related to running the course, but the main focus is to get teams formed from collected project ideas. Project ideas are provided by companies and researchers at the university, but the student teams can also implement their own ideas. **Phase 2**, running until the Christmas break, is a core project development phase, where the students work on their product, ending at a Business pitch and a prototype demo event. **Phase 3** consists of further development and finalization, ending in a student project competition called ICT Showroom, common for all IT students from three different universities in the city of Turku. The overall flow of the project course is shown in Figure 1.

This paper focuses on the analysis of Phase 1, where the student are forming the teams and selecting/creating a project idea to work on. Most of the challenges due to pandemic restrictions imply that the normal ways of getting to know each others and doing brainstorming is not

available.

## HOW COVID-19 RESTRICTION AFFECTED THE COURSE SETTINGS/ LEARNING GOALS

With the entry into effect of the Covid-19 related restrictions, on-campus teaching has to be suspended throughout the Project Course. This had a negative impact on the course settings and on the learning environment as follows.

- **team forming** - previously students from different study lines and degree programmes would meet in class, get to know each other via different social games such as the *Marshmallow Challenge*<sup>1</sup>, and form teams based on their interests and complementary skills.
- **execution of the project** - previously students would meet and work in groups for different deliverables of the the project (source code, status reports, technical documentation).
- **communication with customers and project demonstrations** - before the pandemic, these interactions with the customers will take place face to face and sometimes complemented with teleconferences. However, all the demonstrations of the product at different phases of maturity would take place face-to-face with all the teams present.

## PREVIOUS RESEARCH ON HYBRID / DISTANCE LEARNING

University teaching and learning have increasingly become what some authors call post-digital; a combination of elements that is neither completely online nor entirely physical (Green et al., 2020). The transfer to distance education that was forced by the Covid-19 pandemic meant a sudden necessity for educators to eliminate physical elements and build a heightened reliance on online elements. Previous research discusses the designable elements in a course design to be of four types: epistemic design (learning tasks), physical or set design (tools, artefacts, learning spaces), social design (groups, roles) and learning outcomes (Goodyear et al., 2021). When transferring the project course online, the epistemic design and learning outcomes remained largely the same, but the physical and social design required thinking anew. Liukkunen et al., 2010 describe challenges related to online communication falling into five categories: loss of communication richness, coordination breakdown, geographical dispersion, loss of 'teamness' (diminished effectiveness of collaboration due to issues with trust and problems with knowledge management), and cultural differences. To successfully complete a complex group task in a distance setting, individual students need to be given possibilities to build interpersonal relationships and community (MacMahon et al., 2020). In addition, Gama et al., 2021 observed that online socialization and synchronous (rather than asynchronous) work played a key role in engagement and achieving better results in a group project. In the distance setting, also teachers' possibilities to observe non-verbal cues and provide support in student interactions change, which should be taken into account when planning the physical design of the course. In summary, when choosing tools for the physical design of a course, providing possibilities for groups to socialize and build community is important. Any tools or artefacts should ideally help in overcoming the above mentioned challenges of online communication.

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<sup>1</sup><https://www.marshmallowchallenge.com>

Yuan and Kim, 2014 present some guidelines for achieving 'communities of learning' in online course settings. They propose a mix of both synchronous and asynchronous tools, to ensure that both students and teachers are visible and active in online environments, to employ diverse formats for discussion, to promote both social and task-oriented discussions, and - if possible - to arrange a face-to-face orientation meeting. The students' background and digital competence should also be taken into account. Toti and Alipour, 2021 highlight that university students on lower-level courses have a more difficult time transitioning to online teaching, most likely because of the heightened self-efficacy and independence required in online learning. It seems intuitive that students with a high level of digital competence, such as computer science students, would more easily make the switch to online learning. Toti and Alipour, 2021 find, however, that even though computer science students have an advantage due to their digital competence, they do find many aspects of online teaching challenging; some issues related to technology are mentioned, but most prevalent were challenges related to social interaction - asking questions and interacting with peers, teachers and teaching assistants. Some previous research has evaluated the effectiveness of specific tools or artefacts in remote teaching. For instance, Gama et al., 2021 identified Discord as a helpful tool for groups to socialize and engage with group tasks. Ironsi, 2021 evaluated online resources such as Padlet, Mentimeter and Zoom breakout rooms and found student opinions to be varied, as students experienced not only confusion about the goal of using the tools but also found them helpful in aiding interactions. Emenike et al., 2020 focused on the role of learning assistants in remote instruction, concluding that the role of the learning assistants was in many cases quite central to the success of student learning.

In light of previous research, communication and interaction appear to be among the most salient issues that need to be supported when transitioning online. Most of our course participants are masters level students and digitally competent, which gives them an advantage but does not eliminate social issues. Thus, the tools we introduced in the course were chosen mainly with the purpose to improve online communication and interaction.

## **CHANGES PERFORMED TO SUPPORT HYBRID TEACHING OF THE COURSE**

Covid-19 pandemic started in March 2020. The project course 2019-2020 ended the day lockdowns started in Finland, but it was likely that the next version of the course needed some changes. Fall 2020 started in hybrid mode, with a restricted number of students in class, and the rest in Zoom. The objective was to use the format of the normal project course as much as possible and provide tools to deal with the issues of not meeting physically in class using digital tools and alternative activities. These were the changes that were done to facilitate starting up the project course in a hybrid format:

- **Extensive use of the Zoom and Zoom breakout rooms.** Lectures were performed both in class and over zoom. To facilitate getting to know each other we performed different kinds of exercises over Zoom breakout rooms so that students were forced to interact. Typically we assigned them to rooms by random, to perform "get to know each other"-tasks similar to those you can do on-site.
- **Miro board for idea development and forming teams.** The Miro online collaborative Whiteboard was used to visualize the current situation of the idea and team formation

status. The idea was to try to provide a visual picture of the team forming situation, corresponding to the situation one can see in the classroom: What project ideas are available, what is the current team forming situation, which students are still looking for partners, etc.

- **Teaching assistant / social officer.** We also started with a new position of a teaching assistant with the special role of what we called "social officer", with the task of communicating with people and making sure that everyone finds their teams. The main task of the social officer was to online connect students with each other, which normally happens during the physical meetings especially in the beginning of the course.
- **Special networking session.** For the year 2021-2022 we also introduced a special networking session. For 2021-2022, we had Covid-19 restrictions for indoor activities, but we organized an event in an old barn "Kurala" that allowed enough distance between persons to facilitate the event. This was to drive the student out of the normal work environment and to inspire them to think openly.

## EVALUATION OF THE APPROACH

The data for this study was collected through a self-completed online survey available for three weeks in November-December 2021. An invitation to participate in the study was sent out to all students participating in the course during the 2020-21 and 2021-22 academic years, 47 students in the first group and 42 in the second. The first cohort completed the course in March 2021; the second set of students have just ended phase 1. The questionnaire comprised of three main sections: (a) background information on respondents, (b) a set of questions gauging the respondents' experience with different aspects and tools used in the project course, measured as attitude scale questions, and (c) a set of open-ended questions giving the respondent the possibility to provide more information on the tools used in the course. The main focus of the questions was on phase 1 of the course, where team formation, team building, and choosing a project take place. Answering the survey was anonymous. As an incentive for answering, respondents were offered the option to participate in a lottery of a small prize; contact information for the lottery was collected separately from the questionnaire answers.

### ***Results from the survey***

Thirty students participated in the data collection. Eight took the course in 2020-21, and 22 are attending the ongoing course 2021-22. Thirteen of the respondents identified themselves as international exchange students or participants in an international master's program.

From the responses, it was found out that the most difficult parts are to get to know the other students, form a team, and become a team (Figure 2). With becoming a team we meant the process of achieving a well-operating team, not only a formal team on paper. This very much reflects the assumptions of the lecturers of the course, that getting the teams formed is the main challenge.

When it comes to the different tools that support the different activities, the results of the survey are collected in Figure 3. Looking at which tools or activities best helped with solving the challenges of the course, weekly hybrid course meetings would best solve the challenges of

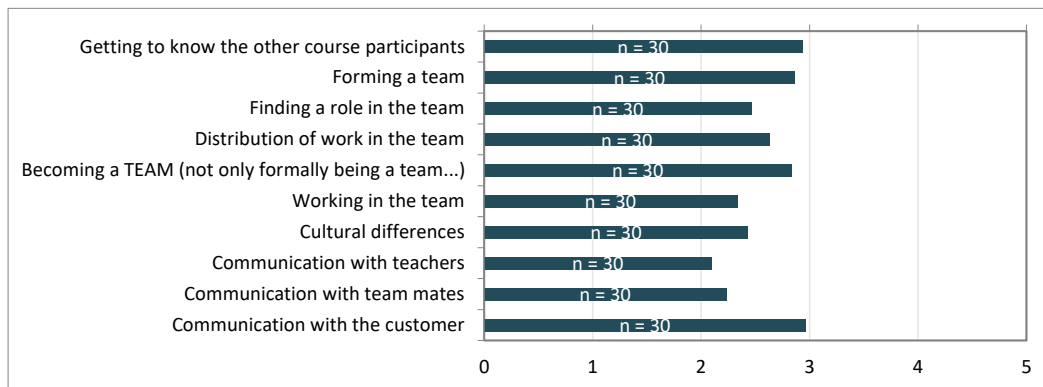


Figure 2. How would you rate the following aspects of the Project Course (1=easy, 5=difficult)

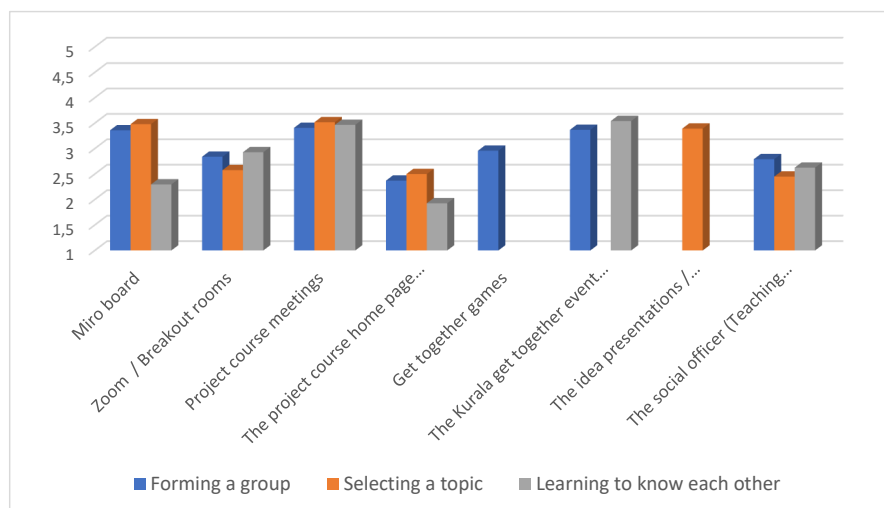


Figure 3. How did different tools contribute to the different aspects of the course (1=did not help, 5=helped a lot)

the course. For selecting a topic and forming a group, the Miro online board tool was clearly on the top, whereas the Zoom breakout rooms were the second most helpful. We also see that the teaching assistant, new for helping form teams during Covid-19 restriction, also was of help.

We also collected information of which tools the students were using for group work, this is shown in Figure 4. Git was clearly the most used tool, as the teams are supposed to create and version software. Next are tools for online-meeting and sharing documents, which also is very logical. The tools WhatsApp and Discord are commonly used by students. In this list of tools, there was not really anything that was very surprising, it reflects the common tools being used for project work.

Students, in general, were happy with the tools used for handling the hybrid situation (figure 5). To note, however, that the physical meetings and company idea presentations were the most liked methods. This is a clear indication that the students still think that the normal ways of working are still more efficient.

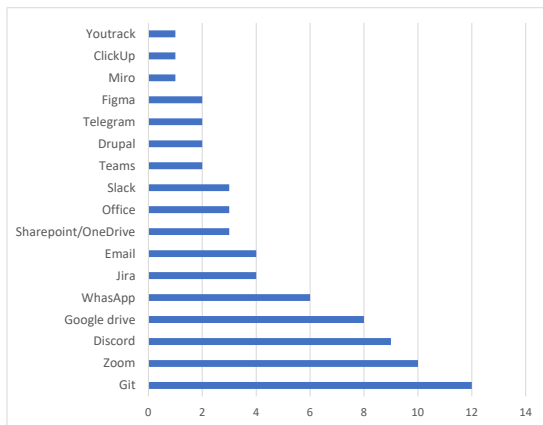


Figure 4. Tools used by different teams, reported by the students

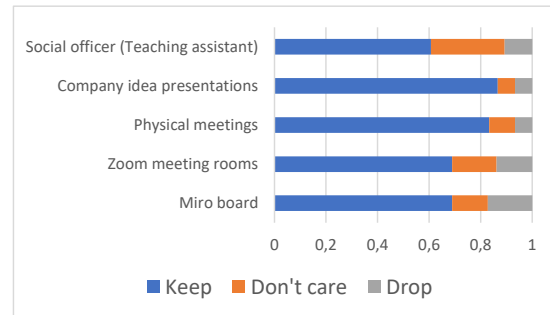


Figure 5. Student opinions on tools/methods retention

We asked the students for open comments on tools, we got the following:

- "It was challenging to participate in Zoom activities while being physically in the classroom - it could be good to be notified before the lesson that we should for example take headphones with."
- "Our team had some on-site meetings in the beginning which I felt were vital in getting to know one another and finding a common vision for the project. Later on in the fall once we got going and during the spring our weekly meetings were using Zoom."
- "The tools used in the project course are very suitable for the current situation."
- "Obviously, Covid-19 is a problem for physical meetings, but these are very important imo."
- "A great course, allows you to explore new roles and learn new things about project work while on the same time offering repetition."

The results from the survey quite clearly show that the traditional ways of getting the teamwork going using physical meetings were the most popular. However, in the hybrid setting, the tools that have been used are considered useful and functioning. There were no direct new ideas received from the students.

## CONCLUSIONS

With respect to RQ1, Covid-19 restrictions changed significantly how the Project Course at Åbo Akademi University could be implemented. We had to move from a very physically oriented course to an online version. Using a student survey, we analyzed how tools can be used to compensate for the lack of physical meetings. The survey showed that the traditional ways of physical meetings are the most popular, but by effectively using online tools, the drawbacks of Pandemic lockdown and isolation can be handled. The tools in our course, Miro and Zoom, seem to have achieved enough interaction to still facilitate the forming of groups.



We can also make use of the adopted tools and methods used at the point where we get back to normal on-site education. The Miro tool taken into use was very powerful for documenting project ideas and monitoring student activity, and will most likely be used also in the future.

Regarding RQ2, the adoption of online tools was rather smooth, as our students are IT students, and are used to dealing with online tools. However, from a teacher's point of view, the main drawback of a hybrid format is the very limited direct feedback from students.

Some of the adopted tools and approaches (e.g., the social officer) will be applied also when we return to normal on-site teaching. Miro is useful also in a physical setting for having a written record of project ideas and participants, which makes it possible to access them in between meetings.

The answer for RQ3, as shown in feedback from students the online tools deployed, were useful in both the hybrid version of the course as well as in the future on-site version. This conclusion is based both on the results of the survey and on the opinions of the teachers involved in the course.

The results of this study show that addressing the Covid-19 restriction challenges in capstone courses can be done via a proper selection of online tools. Such tools compensate for an on-site presence and based on the student and teacher feedback some of them will be used in the future also in on-site settings.

What remained unsolved was how to handle the lack of insight in the project work from the teachers point of view, due to only virtual presence. This made it difficult to spot internal team problems in time and give relevant feedback during the course.

## FINANCIAL SUPPORT ACKNOWLEDGEMENTS

The authors received no financial support for this work

## REFERENCES

- Barrows, H. S., Tamblyn, R. M., et al. (1980). *Problem-based learning: An approach to medical education* (Vol. 1). Springer Publishing Company.
- Börner, K., Scrivner, O., Gallant, M., Ma, S., Liu, X., Chewing, K., Wu, L., & Evans, J. A. (2018). Skill discrepancies between research, education, and jobs reveal the critical need to supply soft skills for the data economy. *Proceedings of the National Academy of Sciences*, *115*(50), 12630–12637. <https://doi.org/10.1073/pnas.1804247115>
- Cimatti, B. (2016). Definition, development, assessment of soft skills and their role for the quality of organizations and enterprises. *International Journal for quality research*, *10*(1).
- Crawley, E. F., Malmqvist, J., Lucas, W. A., & Brodeur, D. R. (2011). The cdio syllabus v2. 0. an updated statement of goals for engineering education. *Proceedings of 7th international CDIO conference, Copenhagen, Denmark*.
- Edström, K., & Kolmos, A. (2014). PBL and CDIO: Complementary models for engineering education development [Publisher: Taylor & Francis \_eprint: <https://doi.org/10.1080/03043797.2014.895703>]. *European Journal of Engineering Education*, *39*(5), 539–555. <https://doi.org/10.1080/03043797.2014.895703>

- Emenike, M. E., Schick, C. P., Van Duzor, A. G., Sabella, M. S., Hendrickson, S. M., & Langdon, L. S. (2020). Leveraging undergraduate learning assistants to engage students during remote instruction: Strategies and lessons learned from four institutions. *Journal of Chemical Education*, 97(9), 2502–2511.
- Gama, K., Zimmerle, C., & Rossi, P. (2021). Online hackathons as an engaging tool to promote group work in emergency remote learning. *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1*, 345–351.
- Goodyear, P., Carvalho, L., & Yeoman, P. (2021). Activity-centred analysis and design (acad): Core purposes, distinctive qualities and current developments. *Educational Technology Research and Development*, 69(2), 445–464.
- Green, J. K., Burrow, M. S., & Carvalho, L. (2020). Designing for transition: Supporting teachers and students cope with emergency remote education. *Postdigital Science and Education*, 2(3), 906–922.
- Hung, W., Jonassen, D. H., Liu, R., et al. (2008). Problem-based learning. *Handbook of research on educational communications and technology*, 3(1), 485–506.
- Idrus, H., Abdullah, N., et al. (2009). Challenges in the integration of soft skills in teaching technical courses: Lecturers' perspectives [<https://education.uitm.edu.my/ajue/wp-content/uploads/2019/04/Challenges-in-the-Integration-of-Soft-Skills-in-Teaching-Technical-Courses-Lecturers'-Perspectives-.pdf>].
- Ironsi, C. S. (2021). Strategies for student participation with remote online learning: Instructor expectations. *The International Journal of Social Sciences World (TIJOSSW)*, 3(01), 24–36.
- Liukkunen, K., Lindberg, K., Hyysalo, J., & Markkula, J. (2010). Supporting collaboration in the geographically distributed work with communication tools in the remote district sme's. *2010 5th IEEE International Conference on Global Software Engineering*, 155–164.
- MacMahon, S., Leggett, J., & Carroll, A. (2020). Promoting individual and group regulation through social connection: Strategies for remote learning. *Information and Learning Sciences*.
- Nilson, L. B., & Nilson, L. B. (2010). Teaching at its best, third edition: A research-based resource for college instructors.
- Toti, G., & Alipour, M. A. (2021). Computer science students' perceptions of emergency remote teaching: An experience report. *SN Computer Science*, 2(5), 1–9.
- Yuan, J., & Kim, C. (2014). Guidelines for facilitating the development of learning communities in online courses. *Journal of Computer Assisted Learning*, 30(3), 220–232.

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