THE DESIGN OF SOFTWARE ENGINEERING COURSES FOR FUTURE REMOTE WORK

Marijana Teljega, Daniel Einarson

Department of Computer Science, Kristianstad University, Sweden

ABSTRACT

The pandemic has forced teaching as well as as the Software Development industry, to be performed remotely. The educational institutions are therefore facing the situation of training and steering the students in, not only complex work, but also in remote-based work and it processes. Specific challenges here relate to project work with larger groups of developers, with testing, and integration of technical components for complete solutions, but the psycho-social factors come into play as well. This paper considers the situation that has arisen as a consequence of the pandemic and regards how project-based courses should be adapted to 'The New Normal'. In focus is a course in Software Engineering, where a large-scaled project shall be developed remotely. Representatives from IT-companies act at the course remote, and at specific occurrences. The course is observed by the teachers to see its outcome, as well as different aspects on attitudes towards future remote work. Interviews and surveys regarding attitudes of students, as well as involved company representatives are presented, where the focus is on process, productivity, work environment, interest in remote work, as well as social aspects. The main findings, based on the surveys, motivates hybrid solutions for university courses, to meet the corresponding companies' way of future working style.

KEYWORDS

Remote work, Group dynamic, Teamwork, Social aspects, CDIO Standards 5 - 10

INTRODUCTION

As a consequence of the pandemic, many indicators address that working remotely will most likely be applied as a future way of working in IT-companies (Einarson & Klonowska, 2021). Preparing students for remote practices means that teachers as well need to adopt and run project course activities remotely. Here, benefits include training students to be the best version of a future employee, but also guides teachers on how to design course activities that train students abilities to work both remotely and at office. Moreover, close and continuous contacts with industry are here considered important, to understand the real-world conditions.

The course *Software Engineering 2* is a course for third year students in the International Software Development Program at Kristianstad University in Sweden (Einarson & Teljega, 2021). The main course project consists of bigger project groups, where each of those is further divided up into 4-5 subgroups with the purpose of developing sub-components to be integrated to fulfil the project, as a whole. What teachers especially have observed during many years of providing this project on campus, is that the communication is crucial to achieve a successful result. Currently, the course runs remotely, and as such, it is considered important to observe what tools are used by students for remote communication and what tools support remote development process. Company representatives are involved in the course, acting as a bridge between the industry and university, and, among other things, share

information on what tools are used at companies and how working remotely in reality is performed.

The study behind this contribution observes both students' and companies' points of views on future employee/employment situations, as well as on how the university can prepare students to work remotely. It could be seen that companies believe that future work will result in hybrid solutions, where employers can let employees work remotely several days in a week. Still, variations occur, such as, where some companies only offer working fulltime at office, while, for instance, "Gig–employees" have shorter employments and can be working remotely globally.

Remote working does furthermore point out needs for reflecting on psycho-social circumstances (Einarson & Teljega, 2021), and discussions with students on this matter have also been taken place. For instance, observations performed in this study show that students believe that working remotely is best suited for personalities that are a mix of both introverts and extroverts, while company representatives claim that introverts are best suited to work remotely. Another observation is that there are some parts in the working process which are not satisfying when performed remotely. For instance, when there is a lack of information during online meetings where perception of body language is not available.

Conclusions, based on students' and companies' points of views, contribute to pedagogical developments, where teachers should be prepared to design course activities that train the students' abilities to work both remotely and at office.

The rest of the paper is outlined as follows: A background will provide the context and a project-based course of this study. Thereafter the method, based on the investigations, will be presented, followed by the result of the investigation. The paper will then discuss the outcomes and add with further teacher-reflections, and after that provide conclusions.

BACKGROUND

The Context

According to (Saul, 2021), a direction towards remote work has actually been a long-running process, with changes towards digitization of workplaces, the expansion of remote and flexible work, and virtual education. The pandemic has only helped to accelerate this process. There are several examples of how teaching even before the pandemic was conducted remotely (such as (Zhuge, Brodie, & Mills, 2012), and (Meikleham, & Hugo, 2017)), and that this form of teaching also works well in the context of CDIO-based education (Lucke, Brodie, Brodie, & Rouvrais, 2016). Furthermore, for example, Asatiani, Hämäläinen, Penttinen & Rossi (2018), show how technology industry also even before the pandemic adopted remote forms.

In this context, there is also a debate about how teaching should take into account the preparation of students' skills in order to function well in a possible transition in industry to remote work (including (Smith, 2021), (Paykamian, 2021), and (Somashekar, 2021)). Furthermore, Einarson & Klonowska (2021) conducts a preliminary survey of a number of companies to see how they themselves have coped with a forced remote work situation, and what they want from students' skills to function well in such contexts. Several generic skills are pointed out as desirable, including: *good communication and cooperation*, *work ethics*, *self-discipline*, *presentation techniques*, and *tools knowledge*. Furthermore, Einarson & Klonowska (2021) shows a shift from traditional Agile working style to the DevOps methodology which,

among other things, enables greater transparency in each other's contribution to a specific project under development. This has been seen as especially valuable in cases of remote work with less space for informal discussions through physical meetings.

A Course of Study

In the autumn of 2020, the course Software Engineering 2 (SE2) was given at a distance, as a consequence of the pandemic. The course has a focus on one main project, where up to 60 students shall develop Smart Home-techniques in project groups of approx. 15 participants. A project group is then divided up into subgroups of about 3 to 4 students to solve subtasks of the main project. Due to the remote situation, special challenges lie, for example, in controlling and steering the process, testing and integrating subcomponents to form a whole, as well as functioning socially and communicatively.

Einarson & Teljega (2021) further describes the course, and presents a survey towards the students regarding their attitudes to the course and the forced circumstances. Among the discussions that took place between the teachers (the authors of that contribution, and this contribution), and the students, it emerged, among other things, that one could see a possible game-changer for more future remote work. These insights, along with the positive outcome of the course, inspired the teachers in a direction towards consciously providing courses of this kind to prepare students for such a game-changer. During the autumn of 2021, the course was therefore given as before, but with this special condition. An addition to the previous course opportunity, was to invite representatives from the IT industry to act within the course, to further make a situation with remote work training a reality.

METHOD

The contribution of this paper addresses views on remote work, both from students' point of view, and from company point of view. A purpose is here to increase the understandings at the teacher perspectives, to plan for future actions when developing courses for remote work even further. To puzzle together the whole picture, survey, interviews, as well as teacher observations were used as research methods.

- The survey consists of opened questions, with qualitative nature. The survey is answered anonymously. In some cases, it was easier to validate the answers if they were answered anonymously. The questions were answered by both the students (53) and the participating companies (4) where the companies answered through email which means that teachers know what answers are connected to which company.
- The interviews are preformulated by the teachers and collected during the project meetings and during the midterm and final project presentation, where students could answer individually but also respond as a group. The interviews are performed 7 times.
- The observations are simple notetaking during the whole project timeline, done by teachers and reflecting on how working on distance is affecting the project work, the teamwork, and the product result itself. The observations are overt, meaning that the students know they are observed.

The collected answers from the three research methods are analyzed and used to validate the results, and give suggestions for the further working. It shall here be clarified that the students have been through about one and a half year of remote work. They are used to the situation, also in contexts of project-based learning. Still, previously project groups have been on sizes of maximum 4 persons, while here several groups cooperate in larger groups of about 15 students. The discussions with students are done at zoom-based project meetings.

Unfortunately, as also for other types of meetings, those are not enough to give most precise answers, since only a restricted number of students act in the discussions.

INVESTIGATION

The investigation is structured in several sections, each presenting answers to specific topics. Following sections are answering questions about what students think about the *course running remote*, *remote working* as a future reality, what *tools are used during the development*, on *different personalities*, how a *project-based course should be designed for working remotely*, and how *new 'normal' working week should look like*. Below an excerpt from the result of the investigations provided.

Students on the remote course

Some students believe that there seems not to be any specific needs for physical meetings, since students are quite used to the way that they interact. Good to see each other occasionally, but that's all. Messenger, Discord, Zoom, WhatsApp and other platforms seems to be sufficient enough to maintain a social contact with one's colleagues. You can have online 'fika' coffee breaks, or/and online afterwork and of course the video should be turned on! Still, as claimed:

- *'It would be good to have weekly or bi-weekly meetings in person.'*

But students think that there is absolutely a difference in meeting physically and only being seen at distance, for example if working on hardware together then this is better in physical meetings. Some like better to work close to others and can clarify on things better that way. Mixing online and physical meetings is preferable in some cases.

- *'using tools like Zoom is completely doing the same job as physical meeting without wasting any extra time such as travel time. It is best way to participate without any hassle, even possible to participate while being sick'.*

Still, distance takes away some personality, get more separated, was amongst the comments from students. Some of the students enjoy working alone and do not feel they need to interact socially with people every day, because the social part is only energy consuming. Still, close to the finishing phase of the project, quite different comments came from students pointing out several risks. Misunderstandings can lead to anger and in the end, lead to the project collapsing. Suggested solutions for handling the possible risk is to work both remotely and physically.

What students have noted during the project is that the trust is important - you are trust dependent! Trust between developers, developer and project manager, and trust on digital tools.

Students on remote work

Students believe that remote work is here to stay. It will be a normal way of future working where companies may recruit talents from outside that do not have to be in place. It will be more and more like this. Still, social points are also important. Remote work may cut off costs for offices. Perhaps there will be work at office some days, but not 5 days a week. Work at home is the new office. Probably it will be mixed between remote and in companies' offices. Employers may find local talents, but if not, they may hire globally, and then also save office costs.

Amongst the risks with remote working is mentioned (also pointed out above) that misunderstandings can lead to anger and in the end, lead to the project collapsing. Furthermore, for introverted people it can be even harder to reach out to which is not so good for his/her project manager and can lead to delays. If not meeting colleagues regularly the ideas will rarely be shared. Moreover, feeling that you are stuck and work alone for others who are not contributing may lead to not meeting the deadline. Suggested solutions for handling that possible risk is to work both remotely and physically. For a junior developer at a company, one should have in mind that it can take longer time and be more difficult to come on board.

While discussing with students about how programming, testing and integration of the code works from distance, students agreed that some things are hard to integrate remotely. And that meeting physically could improve such situations. Working globally have been claimed to work, without loss in productivity. But communication is essential, this may be supported by good-enough tools. Remote work works for talents recruited worldwide. Students also express that the risk on remote work was decreasing after a while, while you got used to it.

Many IT-companies use DevOps processes (Einarson & Klonowska, 2021) to accomplish the whole process starting from planning, developing, integrating, testing, marketing; supporting the creation of the product and getting it out to the customer and supporting the customer with possible bugs fixing due reporting back to the development team to handle the bugs (Sommerville, 2020). As well companies that contributed to this project stated that they are using DevOps practices in their work. Students argue that they used DevOps processes as it gives a whole picture, instead of material passed over to different roles. Responsibility for what has been done was visible and clear through tools for DevOps. DevOps as well contributed to seeing what is going on between the subgroups.

Development tools used during remote work

Different programming tools have been used for different kind of work; if working with Android applications, Android Studio was used that is a part of IntelliJ. Many groups have been using GitHub[1] and IntelliJ[2] as main tools for coding and sharing code. Those have many good features, especially the newest update for the platform where there is a possibility to code with others in the team at the same time and also make a video, and sound calls during the coding[3].

Tools used for code integration are several with different opinions if they are good or not, where amongst many are GitHub, Collaborator (can be integrated with Jira[4]), and CodeScene[5]. Jira[6] was suggested by teachers to be used in this project because companies connected to this course also use Jira. On the positive side with GitHub was that students could share good ideas and, in that way, can synchronize their work. Students also expressed that it was easier to contribute to the source project, documentation, integration options, and track changes in the code across versions. On the negative side was that there was no restriction on pushing code so that even if the code was pointless, students can also do push it.

[1] GitHub: Where the world builds software · GitHub
[2] IntelliJ IDEA: The Capable & Ergonomic Java IDE by JetBrains
[3] Code With Me Beta: Support for Audio and Video Calls | JetBrains News
[4] JIRA Integration | Collaborator Documentation (smartbear.com)
[5] Software Quality Visualization - Tech Debt | CodeScene
[6] Jira | Issue & Project Tracking Software | Atlassian

Tools used for code testing are also different depending on what the development group is working with. Some have used Junit[7] and GitHub, and it worked well when it was set up right. Some subgroups have used GitHub actions[8] and Cypress[9] mainly. And some students have used Junit and manual testing when working with GUI[10]-parts of the application. Other testing tools that have been used are Firebase Robotest[11], Mockito[12], and Postman[13]. Much of the coding have been tested during the coding, but students suggest that you can also let another student look at your code before you push it to GitHub.

During the project, students learned about new integration and testing tools and suggested to teachers to look at if they were good enough to use in project courses. Students suggested as more specific tools that could be used, like Telerik TestStudio[14], Watir[15] and Ranorex[16].

Personality styles

Amongst the tasks during the course covered in this paper, students took personality tests, answering questions related to how their personality types can be used in teamwork, as well as if they think that introvert, extrovert or mix of both[17] is best suited to working remotely. Also, the participating company representatives gave their view on that situation, explaining what tools are used to manage employees and how they see the future work with respect to personalities.

Results from companies and students present slightly different views on who is better suited to work remotely. No students see themselves as extroverts. 75% of students see themselves as introverts and 25% as mix of both. Even if ¾ of students are introverts, 43% of students believe that working remotely is best suited for personalities that are a mix of introverts and extroverts because communication between workers is important to develop a correct product and different personalities complement each other. Introverts do not need to socialize as extroverts to gain energy and can work more effectively by themselves. Extroverts can satisfy their socializing needs by keeping in touch with their remote team by using live streams and video chats as Zoom or Teams. Company representatives, on the other hand, claims that introverts are best suited to work remotely because introverts can handle isolating during longer periods of time. Moreover, amongst those that have leading positions at companies, are 25% seen as introvert, 50% as extroverts and 25% mix of both.

Overall, how do you look at the universities' educations to prepare students for future working methods with remote work at Companies?

According to the investigation, students believe that it is not realistic to say that universities can prepare students 100% to work online in IT-companies. Some other reasons communicated by students are that students needs a lot of internships and constant practical work. Students point out that it is different to work remotely and learn remotely.

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[7] JUnit - Wikipedia
[8] Features • GitHub Actions · GitHub
[9] JavaScript End to End Testing Framework | cypress.io
[10] Graphical User Interface
[11] Get started with Robo tests | Firebase Documentation (google.com)
[12] Mockito framework site
[13] Postman API Platform | Sign Up for Free
[14] Web & Desktop Automated Testing Software That Just Works | Test Studio (telerik.com)
[15] Watir Project
[16] Test Automation for GUI Testing | Ranorex
[17] Ambiversion is a concept used for the spectrum between being introvert and extrovert: What is an Ambivert? Are You an Introvert, Extrovert or Ambivert? (scienceofpeople.com)

Suggestions to teachers when designing next year project course include that there should be further scope to communicate with others, for instance, with representatives from the IT-industry. Those should share following information with students:

- 'How they are really synchronized, what are the demand in the marketplace now.
- Possible internship to help training the students and prepare them for future job market.
- What are they looking for, how can we stand out, how it is to work as a software engineer workflow, schedule, company etc., what are skills that we need to improve on that are not readily apparent.
- Practice places, free positions, type of work, salaries, techs that they are using.
- They should give us more suggestion based on their work, for example if anyone is interested in particular companies, they should provide specific information about the skills they are looking for.'

Moreover, students pointed out that project work should be rotatory. The meaning behind this is that there should be guarantees that everyone, for instance, got training in significant tools for test or integration of code.

How should 'a new normal' working week look like?

Working remotely 5 days a week?

Both students and the participating company representatives answered questions regarding demands if the employee should be at the workplace 5 days a week or work remotely 5 days a week, or to work from home more than 1 day in a week. Another interesting demand reflects whether the employer should offer ergonomic solutions for the home office.

How do you relate to demands from an employer regarding:

- That you should be at the workplace 5 days a week
- That you should be remote 5 days a week

The students' point of view is that employers should not have requirements on presence at office all days, and that today we have new attitudes that should be accepted. Some students point out that, depending on personalities and the work, 5 days at office bothers a lot, because working only at office is not so efficient, so working half the time in a week at office and half from home is the best solution. Working at office can be very time consuming, while working from home can save traveling time as well as traveling costs. The idea with flexible schedule and mix of both ways of working gives a freedom to plan the hours of the day so it fits the employee. Furthermore, if working as a developer it can be silly to demand working from office 5 days in a week. Still, meeting frequently like 2 days in a week for checkups and meetings and to meet colleagues is fine. Still, as one statement points out:

- *'Rather remote 5 days a week than 5 days at the workplace. Unless there are reasons to be present everyday'.*

The companies' point of view is also suggesting a combination of both ways of working. If the company is a consultant company it means that the company needs to be flexible to meet demands from the customers. This also means that the employee-contract may say that you should work 40 hours a week at office, and that cannot just be changed. Sometimes the customer demands that the work should be done from the customers office, but sometimes customer doesn't care where the workers are sitting, as long the work is done. But companies strive to discuss different possibilities with the customers and in that way keep the flexible way of working.

- *'Already today, some teams have decided to work from office (even they do not need), while other teams decide to work from office on Tuesdays and Thursdays, and the rest of*

the week they can decide by themselves where to work from. If both the teams and the customers are happy, we do not need to make any changes. However, we want all to come to office during certain frequency space to check how everyone is doing. So, working all 5 days remotely is not considered at this company for the moment.'

How do you view demands made by employees regarding:
- Must work from home more than 1 day a week
- That the employer should offer ergonomic solutions for the home office

The students' points of view take up different aspects on responsibilities to offer home office solutions. Some students believe that it is a freedom to work from home and that employees should be responsible for the ergonomics. Working 2-3 days from home would be enough to request the employer for a home office solution. Some students think that the employer should offer an initial budget for the office equipment and a yearly stipend to maintain the office equipment for example computer, desk, chair, and the cost for the extra room. Offering home offices is cost effective and a smart idea.

Students also point out that already today there are some examples where companies buy chairs for their employees. But the situation where employees make a demand reflects a split situation, where some employers may demand for some conditions, and some employees for some others, and meeting each other's demands is the best solution.

- *'The more work from home the better. If there is a demand to work from home, the employer should provide the tools to do that. If it is voluntary, the responsibility might not be on the employer.'*

The companies' point of view is that working from home 5 days a week, is not considered right now, based on the employee contracts, because of the need to physically meet all to see how everyone is doing. And that is the same reason regarding working 1 day a week. As stated before, the companies are striving to be flexible, and if customers or employees have demands on distance or at office working, they will discuss and come to flexible solutions. During the pandemic some companies states that they drove home to the employees raise and lower desc, and chairs. As well, companies believe that they need to look more into it to give best ergonomic solutions for their employees when working from home. Some other companies, though, are not at all interested in having employees working from home and because of that they are not interested right now in offering home office solutions.

DISCUSSIONS

The course Software Engineering 2 was during autumn semester 2020 forced to go remote, and during 2021 the teachers (also authors of this paper) made the choice of providing the course remote, no matter the state of the pandemic. The purpose was to prepare students for the predicted future remote work within the IT-industry. The course will later undergo some revisions, and observations of the current course, as presented in this paper, will be used as input to those revisions.

Even though many students argue that remote is enough during the course, the hybrid solutions are probably more suitable, both for the sake of the course, and for the sake of realistically correspond to the most probable future work situation. In either case, the hybrid contributes both to project precision, and to social needs. No matter what, a process style clearly suitable for the remote working style must be of use, and supporting tools, as suggested in the above section, as well.

Participation of company representatives have been considered clearly valuable. They have contributed by being a bridge between industry and academia, and with their technical competences, as well as experiences on remote work. Many discussions between teachers and students have considered remote work, and a reflection from the teachers' side is that those discussions in themselves have brought awareness to the students on such themes. Therefore, input to the revised Software Engineering course is that discussions on remote work should be especially emphasized, not only as a part of a process model, but as a concept of discussions.

CONCLUSIONS

Several sources show that the after-pandemic situation brings a 'New Normal' that means that much work within the IT-industry will be performed remotely, and it is essential to address this specific situation also in education. That is, students should be trained in this new normal, and it is necessary to address ways of supporting this at educational institutions. This contribution has elaborated further on those themes via student surveys on attitudes towards remote work, where students worked on a large-scaled project, that can be seen as especially challenging to develop remote. Representatives from IT-companies have acted at the course to contribute with expertise on techniques and project work.

The surveys, where 53 students and 4 companies answered, observations and interviews, generally show a readiness from the company side in approaching a future remote work situation, even though a hybrid solution is mostly preferable. This corresponds well to many of the students' anticipation upon their future careers, that is, part time work at office, and part time from home. Things that must be considered is choice of process model, and tools that support remote- and yet transparent work. Here, the DevOps process model is the choice from both student and company perspective, and several tools are mentioned, such as, GitHub, and a variety of tools especially for purposes of testing and code integration. Moreover, the psycho-social situation has been reflected on, and from such perspectives, generally it seems as both remote and physical meeting points are essential, even though in some cases show that there are, more or less, no needs for physical meetings.

While the course covered in this paper was provided completely remote, a final observation is that a project course to prepare students for future remote work, should be done in a hybrid way, with more weight on the remote work. This probably corresponds best to future working situations and is beneficial for communication and process agreements, as well as social aspects. DevOps should be used as process model, and students should be trained in tools, such as, GitHub. Furthermore, discussions should be performed on themes of remote work, especially with collaborating company representatives as further contributing values.

The design of courses for remote work shall contain remote meetings where deliverables are discussed with teachers. We suggest that companies contribute after the students have done ¼ of the project and can formulate the questions based on their work. It is recommended for the companies to join major meetings during the project but also give their own presentations on working processes and what tools are used by the companies. Companies and students can both benefit from connection trough social platforms such as Discord and exchange questions and answers.

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BIOGRAPHICAL INFORMATION

Marijana Teljega has an MSc in Embedded Systems and a BSc of Science in Engineering from Kristianstad University, Sweden. She has also been involved in designing and teaching project-based courses, applying active learning activities in parallel with Agile style of working.

Daniel Einarson has a PhD in Computer Science and has several years of experience in teaching Computer Science and Software Engineering. Furthermore, he has been experimenting with several different forms for project-based learning.

Corresponding author
Marijana Teljega
Kristianstad University
291 88 Kristianstad
Sweden
+46 -44-2503149
marijana.teljega@hkr.se