Offline and Online Active Learning: Lessons in Teaching Software Engineering to Multicultural Groups

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***Abstract*—The past two years have seen a huge increase in university courses offered online, due to the impact of the Covid-19 pandemic. At the same time, as the active learning approach is one of the most pursued approaches in teaching engineering disciplines, new strategies of implementing it online had to be pursued. Whereas the benefits of active learning have often been highlighted, the question arises whether the (sudden) transition to online teaching can remain successful in its pursuit of active learning, especially in multicultural groups. This short paper will be based on the experience of teaching an undergraduate software engineering course to a multicultural group of students. It will describe the active learning strategies employed during offline classes and will highlight the changes made once the course was suddenly switched to an online format, providing important lessons for software engineering instructors.**

Keywords-software engineering; active learning; culturally-responsive teaching; multicultural students.

I. INTRODUCTION

Software engineering has always been considered a discipline necessitating a hands-on approach. The concept of active learning is often applied in teaching this discipline, as a means to impart to students the practicalities of developing a software application. Researchers agree that projects using "active methodologies" help students to "develop deeper knowledge and apply it in a practical way according to a work plan" [1]. A lot has been said about active learning and its benefits in the past few years. During traditional "passive" classes, students listen to experts who impart their knowledge [2]. When active learning is used, students "must do more than just listen: they must read, write, discuss, or be engaged in solving problems" [3], engaging in analysis, synthesis, and evaluation" [3].

The 2020 Covid-19 pandemic forced many academic institutions to move their courses to an online format; this sudden shift, taking place with no preparation, was termed Emergency Remote Teaching (ERT) [9]. As the name suggests, this was different than the well-established online class teaching method, which took years of work and gradual improvements until it reached a well-established teaching format. Its purpose - as a response to crisis - was to provide temporary access to instruction quickly and reliably [9]. Whereas implementing active learning has its own predefined challenges, the sudden move to ERT brought with it its own set of challenges. This short paper will highlight some of these challenges, along with lessons learned in teaching software engineering to a multicultural group of students at a national university in Japan, during an introductory level course. The structure of the paper is as follows: Section II describes the details of the course, whereas Section III shows how active learning was implemented; Section IV provides conclusions and directions for future work.

II. COURSE DESCRIPTION

A. Basic Course Description

This paper highlights the experiences of teaching an introductory software engineering course at the University of Tsukuba in Japan. The course is offered as an elective for master's students in the computer science department, which covers the majority of the class participants. Every year, however, a number between 2 and 5 students belonging to other departments enroll in this course, as well. Stretching over 10 weeks and awarding two credits upon completion, the course introduces basic principles, methodologies, theories and notations used by software engineers during various phases of software development. The language of instruction is English, and the class participants are a mixture of local Japanese students and international students enrolled in graduate school at the university.

B. Format and Number Changes

This course has been offered since 2016 and its need emerged from the necessity of providing more graduate school courses in English. Figure 1 illustrates the changes in numbers and format, along with a brief overview of the style and type of activities used during classes.

For the first 4 years (until 2019), the course was provided in the classical face-to-face format. It started with 15 students in its first year, followed by 26, 35 and 66 students enrolled in subsequent years, respectively. With the sudden change in online format, or to be more precise, ERT format (due to the Covid-19 pandemic), the number reduced to 35 students in 2020, followed by an increase to 53 students in 2021. At the time of writing this paper, the current 2022 edition of the course is taking place online, with 66 participants. Whereas the previous two years were held in the ERT format, a third year can already be considered beyond ERT.

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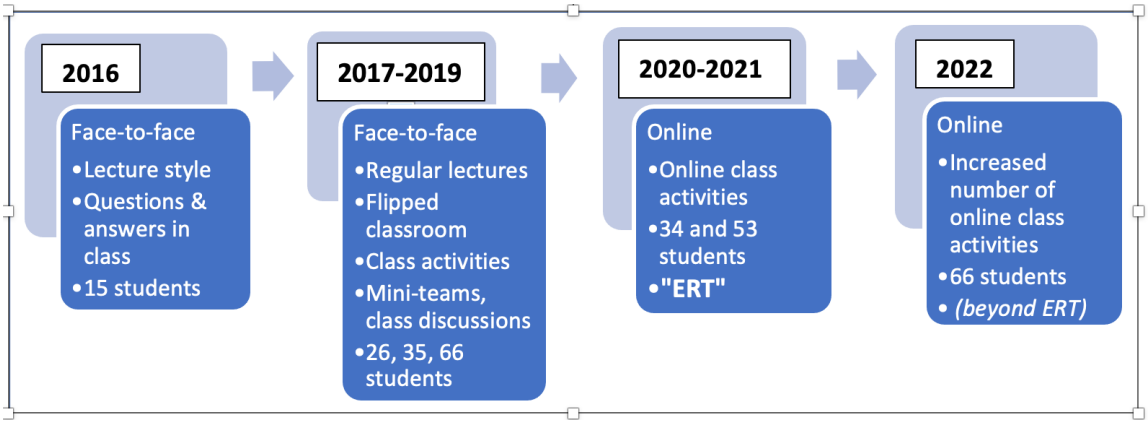

Figure 1. Software engineering course format over the years

III. Implementing Active Learning

A. Active Learning in Face-to-face Settings

In its first four years, the course was held in the classical face-to-face format. In its first edition, 15 students enrolled in the class. Such a low number of participants allowed rather easy interactions between the instructor and the students. However, the novelty of the course, along with the inexperience of the instructor at the time did not facilitate implementing active learning on a large scale. The simple method of constantly asking students to answer various questions in class was, however, implemented. Although it was observed that the international students (making up most of the class, i.e., 9 out of the total of 15 students) were more active in answering the questions and generally interacting with the teacher, efforts were made to involve the Japanese students, as well. It is important to mention that, at the time, lectures in Japanese classroom generally meant passive participation of students: the teacher would stand in front of the classroom and teach while students simply listened. This is still often the case in many Japanese classrooms and the root causes stem form cultural characteristics. There is ample research on this topic (e.g., [4]), but it is essential to emphasize that things are slowly, but steadily improving: more and more (higher and even secondary education) institutions in Japan encourage active participation of students in class and active learning in general.

In the subsequent two years, flipped classroom was attempted (one time each year, experimentally), in order to observe its impact on overall class performance. At the end of the course, a questionnaire was administered and the students were asked about their preference for different class styles: lecture style, discussion style, combination (of lecture and discussions) and flipped. As shown in our previous work [5], the experimental flipped classroom was the least popular with the students. However, it was perceived as both more challenging and more enjoyable ([5]).

At the same time, class activities were introduced, along with the creation of mini-teams which were given tasks to solve during classes. Our previous works ([6] and [7]) show how collaborative learning was used and the lessons learned during this time. In 2019, with 66 students enrolled, a micro-project was introduced, along with an increase in class activities (often more than one within one class). The feedback gathered from the students at the end of the class, as well as through questionnaires administered by the instructor, showed that the course in 2019 was quite successful. As one student stated, *"the lecturer changed the students' silence into discussion and projects"*. This implies that the course was successful in persuading the students more inclined to be silent in class to participate more. Furthermore, some students believe that they learned things that could prove useful not only in software engineering, but in other fields, as well (to quote one other student, "*the principles that I learned in the class changed the way I approach problem solving in general"*).

Overall, as active learning was implemented on an increasingly larger scale, the instructor felt that every year more progress was being made. However, as described in the next section, the course format in 2020 suffered a major change.

B. Online Active Learning

As explained earlier, the Covid-19 pandemic brought with it a sudden transition to online teaching all over the world, at various levels of education. According to Whittle at al., the focus was shifted towards "the method of delivering instruction rather than the learning goals" [8] and this made implementing active learning more challenging. In the software engineering class, in the spring of 2020, the number of enrolled students was almost half that of the previous year (34 students, as opposed to 66 in 2019). In the author's opinion, this was brought upon by the uncertainties regarding the online environment, along with the (too optimistic, as it turned out) expectation of return to a face-to-face format in the near future. (This would have meant that the students

could enroll in the class later, once the class returned to the regular format.) Furthermore, the number of students dropping the class in the first couple of weeks was more than 10 (in our university, the students have around two weeks to decide the classes they register for, allowing them some time to observe, before making a decision). As discussed in [7], these students felt that combining the difficulties of sudden online learning with the requirement of being active participants (in a multicultural class) represented a hurdle impossible to overcome.

This was the first year when active learning was attempting during online, ERT-style classes. The classes were held online, synchronously, using MSTeams [10] and Zoom [11]. All class materials were placed on *manaba* (which is the learning management system employed by our university [12]). Several international students were still abroad at the beginning of the course (they could not arrive in time or were not allowed to enter Japan, due to the pandemic restrictions). In order to accommodate the time differences and different locations, the classes were also available on demand: each lecture was recorded, and the recordings were placed on MSStream [13] (with links to them placed in *manaba*). At the end of the course, the instructor administered a questionnaire, to find out the students' opinions and perceptions regarding online classes, active learning and specifics of the course they had just taken (the results were summarized in our previous work in [6]).

The teacher continued to make efforts to involve all students in the learning process. Although conversations online were more difficult to implement than in a classroom, the instructor asked questions and attempted to engage all students in the discussions. Each class started with a "light" topic for discussion, usually a piece of technology-related news, which acted as a warm-up activity.

Various class activities were adapted to an online format. Instead of teams created in a classroom, organized by desks, the instructor created breakout rooms in Zoom; each such room acted as a group, and they held discussions and performed various tasks given in class.

Dealing with a multicultural classroom (with 6 Japanese students and 28 from 4 other countries) meant that cultural differences had a strong impact on discussions. Often the same students responded to questions every time in the main meeting. However, within the breakout rooms, it was easier to involve the less communicative (or less confident) students. The most obvious reason is the number of peers present: breakout rooms consisted of only 5-7 students (as opposed to over 30 in the main meeting), which made it easier to overcome the lack of confidence, particularly with regard to language skills (English was not the mother tongue for most students). Most students agreed that active participation in an online setting may be more difficult, as can be seen from the following two responses.

- *"I feel like when classes are held online, people will be very hesitant to participate unless they are picked on directly."*

- *"I think the online environment keeps many people silent, or because they don't speak and no one can see so they keep silent. Such discussions are not very effective and there will be problems in the allocation of discussion time."*

However, one participant expressed a different opinion, stating that asynchronous work allows different modalities of work:

- *"I think that online classes can result in *more* discussion than face-to-face classes because students can work asynchronously and in different modalities. I don't need to see someone or hear them to discuss, there are other ways of communication."*

Moreover, when questioned about the class activities, about 90% of the students stated that they found them useful (a lot or in a moderate amount), whereas about 80% found them enjoyable (a lot or in a moderate amount).

As mentioned earlier, when it comes to group tasks, the implementation was adapted to the online format. Not all activities could be carried out online, thus some of them had to be completely eliminated (e.g., the agile game "paper airplanes" [14]). The most challenging part proved to be collaborating to perform a task and express the results in writing. At first, a generic request was made by the instructor in each breakout room, for one student to share their document (which could be in various formats), listen to the other group members' opinions and take notes (draw diagrams, write text, etc.). Often, no student was willing to take the initiative, to guide the discussions or to share their own screen. In later classes, the instructor designated a student to be the "sharing" member, and this proved to be a more effective strategy of involving students.

Overall, despite the initial worries that the classes would be less interactive than usual, the instructor believes that active learning was implemented to an acceptable level, considering the circumstances. The following year saw the software engineering class held online again.

In 2021, a number of 53 students enrolled in the class - an increase from the first online class. Taking into account the fact that students often consult with their seniors on which classes to enroll in, a larger number of students might hint to the impression that the online edition was rather successful and the students this year were encouraged to take it. Not only more international students enrolled (37, from 9 different countries), but the number of Japanese students increased, as well (from 6 to 16 participants).

The format used was very similar to the one from the previous year: classes were held online, synchronously, they were recorded and made available offline for the students. By now, the instructor had a better idea of what could work in an online setting, and she organized even more class activities. At the suggestion of one of the students, an online document was shared, with sections available for each group in the breakout room. This way anyone could edit the document, and anyone could see what other groups are working on.

As usual, the instructor gathered feedback from the students with regard to the current class. At this point, 40% of the students stated that they preferred online classes, whereas almost 25% preferred face-to-face classes. Interestingly, 30% of the students responded that this depends on the class they are taking. One participant stated that *"No matter what kind of classroom form, the activity of the classroom is very*

important.". Another student responded with *"I think "Class Activity" are interesting. But I am Japanese and not good at English. If I could speak English very well, I would have been able to participate more actively."*. Moreover, *"The class with discussion activity should be Face-to-Face."* and *"Face-to-face classes are more interactive and engaging"*, supporting the idea that class activities may be perceived as more successful in a classroom setting.

The participants were asked which format they consider more successful for class activities/discussions. About 43% considered that they are more successful if held face-to-face, approx. 27% stated that they are about the same, and just over 13% believed that they are more successful if online (the remaining ~17% responded that they do not know).

When asked to compare online classes with face-to-face classes in terms of cultural differences, almost 49% of the students considered that cultural differences are more visible in face-to-face classrooms and about 15% thought that they are more visible in online classes. 20% of the students found no difference between the two (with the remaining 16% stating that they do not know). Last, but not least, the students were asked whether they find the class activities useful/valuable on one hand and enjoyable on the other hand. The results are summarized in Table 1.

TABLE I. CLASS ACTIVITIES: ENJOYABLE VS. VALUABLE/USEFUL

	A lot	*Moderately*	*A little*	*Not at all*
Enjoyable	24.44%	53.33%	20.00%	2.22%
Valuable/useful	32.11%	60.00%	8.89%	0%

We can observe that more than three quarters of the students find these activities enjoyable and more than 90% find them valuable (either a lot or moderately). These results show us that, despite the cultural differences and the difficulties inherent to online environments, the students generally found the active learning implementation not only useful, but also rather enjoyable. The instructor's observations are in line with these results: based on the impressions gathered in class, she felt that the course was successful and that the activities and discussions played an important role in this success.

IV. CONCLUSION AND FUTURE WORK

This paper described the experiences of teaching an introductory software engineering course to a group of multicultural students. It highlighted the approaches used by the class instructor to implement active learning, both in the face-to-face format and the online setting. Based on the instructor's observations and the feedback obtained from the students, it was concluded that active learning could successfully be carried out, despite the challenges brought upon by the sudden switch to an online format. In future work, the instructor plans to gather comprehensive feedback from the students and incorporate all the lessons learned in the previous years, to be prepared for implementing this course in either format necessary.

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