More Than Just Listening: Active Learning in Face-to-Face and Online Multicultural Software Engineering Classes

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***Abstract*—Active learning is essential for the learning process, particularly when teaching an engineering discipline, where the practical aspects are crucial to the overall understanding of the concepts and their usefulness. This paper describes the implementation of active learning in an introductory software engineering course. It is based on the experience of teaching the course for 6 consecutive years, with the first four years in a face-to-face format, followed by two years in an online format.**

Keywords—active learning, software engineering education, emergency remote teaching, multicultural education

I. Introduction

Engaging the students in everything that takes place in a classroom has a positive impact on their learning. Active learning (AL) is a method employed by teachers in which they ensure student engagement. As shown by Bonwell and Eison three decades ago, in 1991, during active learning, students "must do more than just listen: they must read, write, discuss, or be engaged in solving problems" [1]. Moreover, when participating in active learning, students "engage in such higher-order thinking tasks as analysis, synthesis, and evaluation" [1]. Along with active learning gaining increased support from instructors around the world, online learning has also seen increased popularity in the past decade. On the one hand, instructors make use of the traditional online learning, which entails thorough preparation and well-established methods; on the other hand, the academic world had to deal with emergency remote teaching (ERT), brought upon by the sudden switch to online learning during the 2020 pandemic [2]. Active learning has been implemented in the traditional online learning by many educators, but it acquired a new meaning in ERT - instructors had to find innovative ways to implement it in the new learning context.

At the same time, empirical evidence shows that collaborative and cooperative learning lead to improved academic results. Studies like that of Terenzini support the idea of "greater effectiveness of active and collaborative learning compared with more traditional approaches to developing students engineering skills" [3]. Moreover, Hsiung shows that "cooperative learning is more effective than individualistic learning" [4].

Software engineering has traditionally been considered a discipline where hands-on teaching is crucial and many instructors strive to implement active learning in these courses. This paper will describe the effects that ERT had on implementing active learning in a software engineering course. It will observe the differences between implementing AL during the traditional face-to-face classes and during the online (ERT) classes.

II. Software Engineering Course Description and Evolution

A. Software Engineering Course Description

The target of our study is a software engineering course taught at the graduate level at the University of Tsukuba in Japan. The course teaches introductory software engineering concepts and is offered as an elective course in the computer science department. The language of instruction is English, and the class participants are usually a mix of Japanese students and international students. Most of them study for a master's degree in computer science, but students form other majors occasionally enroll, along with a small number of exchange students. The course, which has been held since 2016, covers topics like software development models and life cycle, requirements gathering and specification, user interface design, testing, project planning and management etc. For the first 4 years, the classes were held face-to-face; since spring 2020, the classes in this course were switched to an online format, due to the Covid-19 pandemic. The number of students enrolled changed as follows: 15 students in the first year (2016), followed by 26, 35 and 66 in subsequent years; in the first year of the pandemic, 35 students enrolled in the online version of the course, followed by 53 students in 2021 (also held online, in an ERT format).

B. General Course Evolution

The course transformed in its delivery style, as the number of students changed (mostly growing, but not every year), and as more and more lessons were learned from its implementation. Fig. 1 summarizes the course evolution between 2016 and 2021.

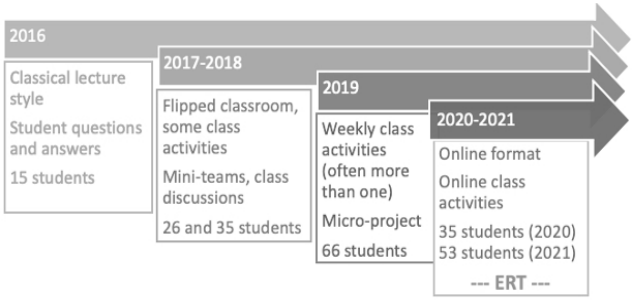

Fig. 1 Software engineering course evolution (2016-2021)

III. Active Learning: Face-to-face vs. During ERT

Throughout the 6 years in which the software engineering course was taught, the instructor strived to implement active and collaborative learning in the classroom, incorporating the lessons learned along the way. This section will describe how the course evolved in this period.

- Year 2016

In its first edition, the course mostly followed a classical lecture style: the teacher held the lecture in front of the students, while they listened; however, as often as possible, the instructor tried to engage them, asking various on and off topic questions. With 15 students in the class, the interactions were easy to implement. Considering that the students came from different cultural backgrounds, the instructor learned first-hand about how different cultures approach the learning process. For instance, the Japanese students were often reluctant to participate actively in the class, whereas most international students were eager to express their opinions. The Japanese are often categorized as "passive" learners, i.e., listening to the instructors without asking questions and generally participating less. (There is ample literature regarding this subject, e.g. [9].)

- Years 2017-2018

The number of students enrolled in the course increased to 26 in 2017 and further to 35 in 2018. With a larger number of participants, the class discussions became increasingly animated, as the class progressed. Furthermore, besides discussions, more class and group activities were added. At this point, every class included several discussions and one or two activities. Gradually, group tasks were added and mini-teams were created; these teams collaborated in achieving a given task. Being in a physical classroom made it easy for the instructor to observe how each group interacts, to listen and guide the group interactions.

Whereas at first the Japanese students were more reserved in expressing their opinions, they became gradually more involved and, slowly, but steadily, started to enjoy the group discussions. Although they appeared to favour discussions with other Japanese colleagues rather than with the international students (mainly because of their lack of confidence when speaking in English), the instructor made sure to create mixed groups for the discussions, with both Japanese and non-Japanese speakers.

At the end of the 2017 course, the students were asked about their preferences for a certain teaching style; about half of the participants preferred a combination of "classical" lecture style class and "interactive" style. Encouraging feedback was received from students, with regard to class discussions; a large proportion appeared to agree that these bring benefits like acquiring new perspectives, forming opinions or discovering new arguments, as well as sharing their own opinions. Listening to others and hearing new or contradicting opinions were chosen as being enjoyable during class discussions, along with "listening to new, creative and interesting ideas". (Results and analysis of the data collected were published in [5].)

The flipped classroom format was also tried out in a specific way, as follows. At the beginning of the class, the students were given reading material to study individually (for approximately 50 minutes). Next, they were paired with a colleague, with whom they discussed what they had just studied (the discussions took place in the language of their choice, mostly English or Japanese). Finally, they had the opportunity to clarify difficult issues with the instructor, who responded to their questions in front of the whole class. This format had a certain degree of success: slightly more than half of the students found it "enjoyable"; moreover, almost half of the students questioned responded that they found this format more challenging than the usual classes [5].

- Year 2019

This year saw a large increase in the number of participants: 66 students enrolled in the course. More diverse activities were included, and their number was largely increased (averaging two or three activities in each class). It is worth noting that out of the 66 students enrolled, 33 were international students. This made creating multicultural groups easy to implement; each time, the instructor made sure that students were placed in groups with colleagues from different cultural backgrounds. The advantage of this approach is that students who tend to be reserved in expressing their opinions can be placed in groups with "more "talkative" students. This often (though not always) gives them the courage to express their own opinions more openly.

A micro-project was also implemented, with students working in teams and using the learning management platform *manaba* ([6]) to support their project work. Its purpose was understanding the difficulties that may arise during the requirements elicitation phase in the development of a software product. Creating an opportunity for the students to work together in teams allowed them to experience first-hand the challenges of working in a multi-cultural group – an important facet of global software engineering education.

As a rule, after the activity was completed, each group reported their results or made comments and observations in front of the whole class. The instructor usually asked for a volunteer to do the reporting; sometimes the reporting member was chosen as soon as the activity/task was given. In the instructor's opinion, this helped with relieving the anxiety of possibly being asked to speak in front of a large number of a people, often in a language not spoken "well enough".

- Year 2020

This year marked the beginning of the Covid-19 pandemic, in which ERT was employed for this course (similarly to numerous other courses in institutions around the world). The main function of ERT was to provide temporary access to instruction quickly and reliably [2]. According to Whittle et al., this brought a shift in focus, towards "the method of delivering instruction rather than the learning goals" [7]. Indeed, the "how" appeared to have a bigger significance than the "what": institutions and educators struggled on deciding what is the best way to deliver their courses, leaving less time and effort for deciding on precisely *what* to teach the students.

The software engineering course was held online using Microsoft Teams [10] and Zoom [11] platforms. A team

in MSTeams was created for the course and the introductory lecture was conducted there. Starting with the second class, the instructor chose to switch to Zoom, in order to make use of the breakout rooms (at that time, only available on Zoom). The learning management platform *manaba* continued to be used this year (just like throughout all the years mentioned in this paper).

Along with the sudden switch to online classes, the number of students enrolled in the course dropped significantly, to 35 students. As explained in our previous work ([8]), we believe that, besides the obvious reason of the course suddenly being held online (a premiere for most students), there was another reason for this reduction in number of students. During the first lecture, the instructor explained that the course would include various (and numerous) class activities. With so many uncertainties surrounding the online learning process, along with the presence of several international students (who could seemingly converse in English fluently), the prospect of an online class in which active participation is expected did not seem appealing to the Japanese students; they were expecting to attend a lecture-style class, i.e. one in which the instructor lectures and the students are mere passive listeners. Since the students have approximately two weeks to make changes to their class registration (including cancelling), at least 10 students dropped the class they signed up for. This issue is explained in detail in [8].

Particular efforts were made to implement active learning in the online format, as well. Whereas it was not possible to carry out the class activities in the same manner as during the face-to-face classes, most of these activities were adapted to the new format. With the exception of two games (which require actual physical space to be carried out) and which were completely removed this year, all the activities from the previous year were either implemented as in the original format (but in the virtual environment) or were transformed so that they could be implemented online. Work in teams was achieved through the use of breakout rooms. These were at first randomly assigned (through the Zoom platform); in subsequent classes, the instructor was careful to create different teams, making sure that students get to work with different people every time, as much as possible. It is worth noting that, at first, as expected, the Japanese students were mostly reluctant to speak out in front of their seemingly "fluent" English-speaking colleagues. This is a familiar issue for the instructor, who has encountered it many times in the past: the lack of confidence in their speaking skills impedes the Japanese students' participation in discussions. Based on the instructor's class observations, this is often not true for other non-native English speakers: even though they do not consider themselves "fluent" in English, they are generally active and, most importantly, they do not view the language itself as a barrier in class participation.

As weeks passed and more and more activities were carried out, all students (including the Japanese) seemed to accept increasingly easily the requirement of participating/speaking/communicating with others in English. It is true that, on several occasions, groups which contained mostly Japanese students tended to speak Japanese, in the same way as groups including mostly Chinese students were inclined to conduct discussions in Chinese. However, this generally lasted for a very short time (a couple of minutes at most), after which the group switched to the common English language.

It is important to understand the role of the class instructor as a moderator during discussions. As a meeting organizer, the instructor can join the breakout rooms at any time, moving between different rooms throughout the class. First by simply listening and then using gentle encouragement, the instructor tried to elicit more discussions in each group and even to persuade certain members to speak. If discussions were stalling or the task at hand did not seem to be achieved, the instructor gave additional directions, asked simple questions, or reminded the students what they are supposed to do. Most of the times, using English as a common language was required. However, there were situations in which – incidentally - groups were entirely made up of fluent Japanese speakers (either natives or international students who happened to speak the language very well), in which case, for the sake of achieving group collaboration, the instructor chose not to impose the use of English. In these cases, however, upon return to the main meeting, when reporting the group's results/conclusions, the group representative spoke English without being specifically told to do so. On a few occasions, this happened with groups of Chinese students, as well (in this case, the group members being native Chinese speakers). In this manner, the goals of the activity were achieved: the students collaborated in fulfilling their task, they communicated without any language barriers (either in English, Japanese or Chinese) and, when they interacted with the whole class, they were easily understood by everyone, through the use of English.

At the end of the class, in the course evaluation questionnaire, as well as during informal communications with the instructor, the vast majority of the students expressed their satisfaction with the class activities. Several students admitted that their lack of confidence was the largest obstacle at first, but this was overcome within a few weeks. (A thorough analysis of the students' responses is planned for our future work.)

- Year 2021

An increase in the number of participants was observed this year: 53 students eventually registered for the class. (As always, within the first two weeks, the numbers fluctuate, until students make their final decision about which classes they want to enroll in.)

The class continued to be held online, with Zoom as the main platform used. By now, both the instructor and the students were much more familiar with the online platforms, as well as less anxious regarding the fact that everything takes place in a virtual environment. A similar manner to the one employed in 2020 was used for implementing class activities: constant encouragement to participate, groups created in breakout rooms, requirement for cameras to be turned on during discussions. Discouragingly, this last requirement was often ignored; however, the students did seem to participate more by speaking for increasingly longer periods of time and being involved in an increasingly large number of discussions.

At the suggestion of one of the students, a shared document was made available for each group; any member could edit this file, so it allowed students to include not

only information relevant to the given task, but also comments, observations and anything else they found important to transmit. The document was visible to the whole classroom, but separated in specific sections for each group.

Based on the instructor's observations, the course was generally successful in its active and collaborative learning techniques; the students appeared more at ease with the online environment, as well as with the requirement of being active, particularly during group activities.

As a note, at the time of writing this paper, the 2022 enrolment for this course has just ended: a number of 66 students decided to register for this course (again, held online). Considering that students often ask for advice regarding elective courses from their seniors, this large number appears to suggest that the course was successful in the previous year (2021): the active learning techniques were fruitful, participants enjoyed the class and/or considered it worth taking.

IV. Discussion

As a rule, every year, during the introductory lecture, the students were instructed with regard to the requirement of being actively involved; the instructor explained that the course employs active learning and that their participation is crucial for the success of the class. To be precise, the first time that the course was held, in 2016, this issue was not stressed by the instructor during the first lecture. However, as the class progressed, the students were slowly encouraged to be more active, answer various questions posed by the instructor (occasionally off-topic), with the sole purpose of helping them become accustomed to actively participate in the teaching and learning process.

As explained earlier, Japanese students are mostly passive participants in classes. Usually, courses held in Japanese universities are lecture-based; in them, the instructor introduces the new material while students simply listen, considering the instructors as authorities which should not be challenged. This behaviour has its roots in culture-specific views of power distance, collectivism/individualism etc. (as shown, for instance, by Hofstede et al. in [12]). The software engineering course instructor's goal has always been that of transforming the students from passive listeners to active class participants. This task seemed almost insurmountable at first, but persistence and lessons learned from experience helped overcome the initial difficulties.

By carefully observing the class interactions, as well as by being sensitive to the different culturally-based approaches to learning, the instructor managed to implement active learning and collaborative learning, in both the physical classroom and the virtual classroom. As mentioned in the previous section, most activities used in the past during face-to-face classes were adapted and transferred to the virtual environment. (One notable exception is the paper airplanes game, which is often used to introduce some of the agile development concepts [13]. This game requires the physical presence of participants, who create paper airplanes, and it cannot be implemented virtually.) Moreover, the online environment enabled seamless collaboration among the team members, facilitated sharing documents, along with the capability of simultaneous editing of a document. In many respects, this was an improvement from the "paper" version of some of the activities.

Whereas active learning seems to be easier to tackle in a real classroom, overall, the instructor believes that it was successfully implemented in the two years of online course, as well. All the lessons learned during this time are going to be implemented in 2022, during another online edition of the course. In the future, even upon returning to face-to-face classes, some of the techniques used online will be adapted for face-to-face and, in some cases, even kept as they are, to be implemented digitally (e.g., an editable file and not a physical piece of paper to be used during group activities).

V. Conclusions and Future Work

This paper described how active learning and collaborative learning were implemented during face-to-face classes on one hand, and online classes, on the other hand. Strategies for encouraging students to actively participate were highlighted, along with culturally-dependent issues arising from the multicultural componence of the class. In future work, the feedback from students shall be analyzed, in particular that received in the past two years (in the virtual classroom), with the aim of obtaining quantifiable measures of success (or lack of) in the software engineering classroom. The lessons learned during this time can contribute to an improved teaching and learning process, in a multicultural – physical or virtual – classroom environment.

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