

Active and Cooperative Learning in a Multicultural Software Engineering Class: Impact of Switching from Offline to Online Classroom Modality

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Abstract - Three years after the start of the Covid-19 pandemic, the academic world is still feeling the effects of the sudden changes brought along by this unprecedented event. With most academic institutions abruptly switching to online teaching in 2020, pursuing the goals of implementing active and collaborative learning has turned into a challenging endeavour. New strategies had to be imagined and the question arises whether this abrupt transition to online teaching can remain successful, especially in multicultural groups. This paper is based on the experience of teaching a graduate software engineering course to a multicultural group of students. It describes the active and collaborative learning strategies employed during offline classes and highlights the impact of switching from an offline to an online class modality. The results show that the sudden switch to online teaching was managed successfully and the active and collaborating teaching activities were successful in fulfilling the course objectives and offering student satisfaction with the course and the learning process.

Keywords - software engineering; active learning; cooperative learning; multicultural environments; classroom modality.

I. INTRODUCTION

Active and collaborative learning are two important concepts with a multitude of benefits in the education field, being applied in teaching various disciplines. Software engineering is one such discipline, in which a hands-on approach is traditionally considered important ([1], [2]). Maxim et al. noticed that students may be exposed to the necessary concepts during courses, but they are often "not asked to apply these skills in project settings" [3]. They showed that active learning can improve software engineering education. By implementing active learning, students can acquire knowledge in a practical way; by using collaborative learning, teachers can create an environment emulating future work environments, where software engineers need to work together to produce software applications.

At the same time, multicultural environments are ubiquitous – in the workplace, in the academic world, in our daily lives. Teaching in multicultural environments has its own set of challenges [4], but also its particular advantages [5]. In case of teaching software engineering, a multicultural classroom offers the benefit of simulating distributed teams of software developers. Students learn in one classroom together, but they can get a glimpse of how they would have to interact

with their future developer colleagues belonging to different cultures and thus having different values, different behaviour and various working styles [5].

Software engineering education suffered, along with many other disciplines, during the Covid-19 pandemic. Academic institutions were forced to suddenly move their courses to an online format, with very little preparation. The changes in classroom modality, from offline to online, created new challenges for instructors and students alike. Academic institutions and the process of instruction faced an unprecedented situation; going through it provided numerous valuable lessons for everyone involved in the learning process. In our previous paper [1], we highlighted some of the challenges encountered, along with lessons learned in implementing active learning while teaching software engineering to a multicultural group of graduate students at a national university in Japan, during an introductory level software engineering course. This paper extends our work with data from the course held in 2022 (the third year of online teaching), as well as with more considerations regarding collaborative learning. Moreover, it discusses to what extent the various factors which make a successful course depend on the class modality, i.e., face-to-face or online.

The structure of this paper is as follows. Section II describes the background of our work, along with related work. Section III provides a description of our course, whereas Section IV illustrates the implementation of active and collaborative learning. Section V includes a discussion on course effectiveness and lessons learned during our study; conclusions and directions for future work are provided in Section VI.

II. BACKGROUND

This section will offer an overview of concepts like active learning and collaborative learning, and it will present recent related work, published in the context of the sudden switch to online learning that took place in 2020 after the onset of the Covid-19 pandemic.

A. Active Learning and Collaborative Learning

A lot has been written about the concepts of active learning and cooperative learning and their benefits. Simply explained, active learning is "any teaching method that gets students actively involved; cooperative learning is one variety of active

learning which structures students into groups with defined roles for each student and a task for the group to accomplish" [6]. During traditional, lecture-based, "passive" classes, students listen to experts who impart their knowledge [7]. In 1996, Gremmels used a truck analogy for lecture-based teaching: "So we in effect load our pedagogical dump truck as full as we can, back it up to the classroom, and unload it onto our students, burying them in teaching ... When we use the dump truck method, we overwhelm our students with more skills and strategies than they can possibly absorb in an hour. That's our first mistake. Then we fail to give students the opportunity to practice any of the strategies and skills, virtually guaranteeing that they won't be internalized." [8]. During active learning, students must do more than just listen: "they must read, write, discuss, or be engaged in solving problems" [9]; importantly, they must engage in "higher-order thinking tasks as analysis, synthesis, and evaluation" [9].

Based on a meta-analysis of 225 studies, Freeman et al. concluded that active learning increases student performance in science, engineering, and mathematics [10]. This was based on reported data on examination scores or failure rates when comparing student performance in traditional and active learning [10]. Generally, 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" [11].

Cooperative learning is one form of active learning, in which students work together with the goal of maximizing their own learning, as well as their peers' learning [12]. According to Keyser [6], planning is important for cooperative learning to work well. It is essential to clarify the role of each member of the group, as well as to carefully consider the size of the group [6].

Both active learning and cooperative learning promote the achievement of student engagement, which is a common goal of all educators in academic institutions.

B. Emergency Remote Teaching

The 2020 Covid-19 pandemic forced many academic institutions to move their courses to an online format. Online and remote learning became a necessity in times of lock downs and social distancing [13]. The sudden shift to an online format, taking place with virtually no preparation, was termed Emergency Remote Teaching (ERT) [14]. As its name suggests, this way of teaching was different from the well-established online class teaching method, which took years of work and gradual improvements. Its purpose - as a response to crisis - was to provide temporary access to instruction quickly and reliably [14].

Unfortunately, most faculty had no prior training in teaching at a distance, and most universities were unable to support them in the way universities with traditional online programs generally do [15]. The courses which were to be delivered in this manner were meant to be a temporary solution to an unprecedented, emergency situation, and not a long-term replacement of face-to-face courses. In reality, ERT continued for a couple of years in many academic institutions; a third year on remote teaching should not be named "emergent" anymore. In fact, Stewart et al. use the term

"sustained remote teaching" (SRT) to represent the method of teaching employed in the second year of the pandemic [15]. Overall, the abrupt change in delivering courses in 2020 brought innumerable challenges for instructors and students alike.

C. Related Work

After the onset of the 2020 Covid-19 pandemic, as mentioned earlier, most higher education institutions had to suddenly switch to an online learning. The experience and the lessons learned were described in various research papers. In 2020 alone, Google Scholar lists a little over 2000 research paper mentioning "emergency remote teaching". Later on, as of June 1st 2023, more than 20,000 papers dealing with this subject appear on this platform.

One of the earliest papers published after the proposal of the "emergency remote teaching" term [14] was that of Shim and Lee [16]. Using thematic analysis, they analyzed South Korean college students' experiences of ERT within the first 4 weeks of ERT, in March-April 2020. Positive features, along with areas of complaints in the context of ERT were highlighted. Their conclusions emphasized the importance of college students' educational environment, and showed that "the quality of interactions can vary depending on the teachers and technology used" [16]. In the same year (2020), Bozkurt and Sharma [17] acknowledged that "online distance education is one thing and emergency remote teaching is another thing". Moreover, they remarked that the distinction between these two is particularly important, because the degree to which educators believe in distance education during the early days of the pandemic would "play a significant role in the prosperity of distance education in a post-COVID world" [17].

The experience of dealing with ERT was the subject of numerous research works after 2020. In [18], Chierichetti and Backer explored faculty perspectives on teaching engineering during ERT; their view is that faculty members in engineering "have always viewed online teaching with skepticism". Their study concluded that the sudden transition to online teaching in engineering at the public university where they teach was mostly positive and that the teachers' concerns were mainly focused on methods of assessment and student engagement. Douglas et al. [19] provided recommendations for future moves to ERT, which included providing mechanisms for informal conversations students-students and students-instructors, availability of instructors for just-in-time feedback and questions etc.

Furthermore, Chiu's research [20] argued that the delivery of knowledge in a digitalized form is dynamic and it relies on the efforts of all course participants. The interactions between students and teachers were studied and the results pointed to the fact that the effectiveness of online learning is strongly reliant on the dynamic between the teachers and the students.

III. COURSE DESCRIPTION

This section will describe the course that constitutes the subject of this paper, its setting and content, as well as the number of students and format changes throughout the years.

A. Course Content and Description

This paper is based on the experience of teaching an introductory software engineering course named “Principles of Software Engineering”. The course is offered as an elective for master’s students in the computer science department at the University of Tsukuba in Japan, and it belongs to the “Degree Programs in Science and Information Engineering (Specialized Subjects)” category. The language of instruction is English, and the course takes place during modules A and B of the spring semester (each module is made up of 5 weeks, thus stretching the course over 10 weeks); upon successful completion, students acquire two credits.

The goal of this course is to introduce basic software engineering principles; students learn about the necessity of software engineering as a modern engineering discipline. The main topics covered include software development models, life cycle, agile methods, requirements engineering, user interface design, testing (verification and validation), project planning and management, software engineering tools (IDEs, UML) and business aspects of software development.

The participating students are a mixture of Japanese students and international students, with the latter group making up the majority. The reason behind a high percentage of international students is most likely related to the language of instruction. On one hand, the number of courses offered in English is not very large; international students take every opportunity to attend classes held in English. On the other hand, Japanese students often lack the self-confidence to enroll in classes not held in their native language.

Whereas most of the enrolled students belong to the computer science department, other participants major in material sciences, library, information and media studies, intelligent and mechanical interaction systems, policy and planning sciences etc. Occasionally, one or two undergraduate students enroll in the course, as well (as a general rule, only high achieving undergraduate students can attend graduate school courses). Also occasionally, exchange students take part in classes; they study mostly engineering, but they might major in other fields (e.g., linguistics).

Table I shows the total number of students and the number of international students participating in each of the 7 years since the course was established.

TABLE I. INTERNATIONAL STUDENT ENROLLMENT IN SOFTWARE ENGINEERING COURSE

	<i>Total number of students</i>	<i>Number of international students</i>	<i>Percentage of international students</i>
2016	15	9	60%
2017	26	18	69.2%
2018	35	24	68.5%
2019	66	33	50%
2020	34	28	82.3%
2021	53	37	69.8%
2022	66	33	50%

As can be observed, whereas the total number of participating students decreased suddenly, the percentage of international students did not reduce during the pandemic, despite the fact that there were simply fewer international students physically present on the university campus. Japan was one of the countries with the strictest border controls during Covid-19. Candidates from abroad already accepted in various undergraduate or graduate programs were unable to acquire a student visa for more than one year and thus unable to enter Japan. However, they were able to enroll in classes remotely, which was also the case for many local students, who chose to remain in their hometowns and be physically away from the university campus. Moreover, there were no exchange students entering Japan for the first year; in 2021, in theory, it was possible to become an “online” exchange student (remaining in own home country but allowed to enroll in the online classes offered by the partner university, i.e., the University of Tsukuba). However, this arrangement did not prove particularly popular and, consequently, there was a very low number of students participating in these exchange programs in the first two years after the onset of the pandemic. Fortunately, the situation has returned to pre-pandemic conditions in 2022, i.e., exchange students are now allowed to enter Japan and they can join the university for a period between three months and one year. Summarizing, whereas the ratio of Japanese to international students did not change much from the previous years, the total number of participating students was drastically reduced at first, but it slowly returned to its pre-pandemic numbers.

B. Format and Number Changes

The introductory software engineering course was first offered by the author in 2016; its establishment emerged from the necessity of providing more graduate school courses in English. Throughout the past 7 years, the course suffered a few changes, in terms of format and number of students. Figure 1 illustrates these changes, along with a brief overview of the style and type of activities used during classes.

In its first year, the course participants were evaluated based on a final exam; in subsequent years, students had to submit one mid-term and one final report, bringing the evaluation method in line with most of the other courses that the participating students enrolled in as part of their graduate studies in our university. Importantly, the students were allowed to submit their reports either in English or in Japanese, to accommodate the often-encountered lack of confidence in their English skills of the Japanese students.

Between 2016 and 2019, the course was provided in the traditional face-to-face format. It started with 17 students enrolled in its first year, followed by 26, 34 and 66 students enrolled in subsequent years, respectively. A major change occurred in 2020, with the sudden change to online format (i.e., ERT [14]), due to the Covid-19 pandemic. The number abruptly decreased to 35 students in 2020, followed by an increase to 53 students in 2021. By 2022, even though the class was still held online, the number of participants grew back to pre-pandemic levels (66 participants).

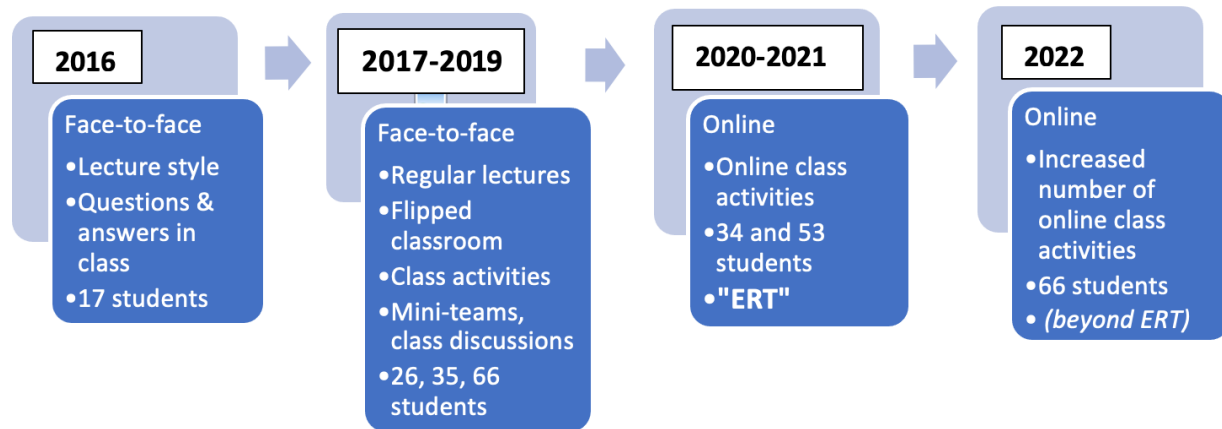


Figure 1. Software engineering course format and number of participants over the years

IV. IMPLEMENTING ACTIVE AND COLLABORATIVE LEARNING

This section will describe how active and collaborative learning were implemented throughout the 7 years that constitute the subject of this paper.

Note: the questionnaires mentioned in this section were administered as per the ethics regulations of the University of Tsukuba; approval was received for gathering and using the data acquired through these questionnaires.

A. Face-to-Face Format

a) Year 2016

The traditional face-to-face format was used between 2016 and 2019. In its first edition (in 2016), the course was taught in a rather small classroom, with - for the most part - the instructor lecturing in front of 15 students. Interactions between the instructor and the students took the simple form of asking students to answer various questions in class. The instructor was constantly hoping that these questions would elicit (lively) discussions among students. This happened increasingly more often, although with a very slow start. The first class introduced the students to the teaching style of the instructor (students may have been surprised at first by the requirement to participate, at least in giving brief answers). Using a small classroom facilitated the interactions: eye contact was easily established, and students found it difficult to engage in unrelated activities (e.g., checking their phones or their personal computers). Moreover, it was easy to address students directly, to remember and to be aware of the precise level of participation of each student.

Out of the 15 participants, 9 were international students; they were more eager to answer questions and generally more inclined to engage with the teacher and with their peers during classes. The instructor made sustained efforts to involve the Japanese students, as well, with relative success. As a general observation, it is worth mentioning that, most often, lectures

in Japanese classrooms do not involve active participation of students. Traditionally, the instructor teaches new topics in the form of lectures, while standing in front of the classroom, whereas students simply listen, making them passive participants. According to various research works (e.g., [21], [22]), the root causes of this type of behaviour are culture related. It is promising that the past few years have seen a slow, but steady increase in higher and secondary institutions in Japan encouraging (and often requiring) active participation of students in class and active learning in general.

b) Years 2017-2018

In the subsequent two years, along with the regular practice of asking questions for the purpose of eliciting class discussions, one session each year was used to experiment with the concept of “flipped classroom”). In order to observe the impact on overall class performance, a questionnaire was administered at the end of the class; in it, the students answered questions about their preference for different class styles: lecture style, discussion style, combination (of lecture and discussions) and flipped. Although it proved to be the least popular with the students, the experimental flipped classroom session was perceived as both more challenging and more enjoyable (as shown in [23]).

The instructor introduced several class activities, which appeared to elicit a certain level of enthusiasm, in particular with the international students, who made up the majority of class participants (18 students out of 26 in 2017 and 24 students out of 35 in 2018). In these activities, the students were required to give solutions to a set of given small-scale problems arising during the software development process. They were also involved in replicating certain activities that need to be implemented in the real world, during various phases of software development (again, small scale problems, that can be easily replicated in the classroom).

Moreover, some activities required the creation of mini-teams, which were given tasks to solve during classes. In order to complete their tasks, the students needed to communicate and collaborate with their colleagues/team-mates. After

completing their task, each team chose a representative to report the results in front of the classroom. Our previous works ([24] and [25]) show how collaborative learning was used and the lessons learned during this time.

Considering that the class composition was multicultural, whenever teams were created, the instructor made sure, as much as possible, that the members belonged to different cultural groups. This approach enables the students to leave their comfort zone and helps them acquire a different perspective. In terms of the language used, the instructor insisted that the interactions take place in English, thus making sure that everyone understands everything that is being discussed in a team. However, as it turned out, not all team interactions took place in English, even in groups of students with different mother languages. This often happened because the majority of the Chinese students, besides being proficient in English, often speak Japanese fluently, as well. Considering the traditional reluctance of the Japanese students to speak other languages, their Chinese colleagues usually switched to Japanese, in order to facilitate a smoother communication in the team. Nevertheless, it was understood that the reporting in front of the whole class should take place in English. The drawback of this requirement was that the reporting student was seldom a Japanese student; however (as already shown in [26]), the instructor made sure to elicit a minimum level of verbal participation in English from the Japanese students, as well (in the form of brief new comments or at least approval/disapproval of colleagues' comments).

c) Year 2019

A number of 66 students enrolled in the course in 2019. The class activities were continued, with an increased frequency; often, several activities were included in one class. Furthermore, a micro-project was introduced, handled through the learning management system (LMS) in use at the university, i.e., *manaba* [27]. The LMS facilitated the creation of teams, whose members were assigned by the instructor. Items submitted in the project on the LMS could be either visible by the team only or by the whole class. The purpose of the micro-project was teaching the students about the issues that arise during the requirements elicitation phase in the development of a software product and how cultural differences impact the creation of requirements documents. The students' tasks were divided into three parts. In the first part, two members acted as "customers" and 4-6 members acted as "developers". The "developers" created a questionnaire which the "customers" answered in writing. A requirements document was created, using "shall" and "should" items, for necessary and desirable requirements, respectively. In the second part, the "customers" were swapped with those from a different team, after which they gave feedback to the requirements document created by the "developers". In the final part, the requirements documents were shared and discussed with the whole class.

The instructor observed carefully the interactions between students during the implementation of this mini-project. Collaboration between team members played a crucial part and cultural differences had to be overcome at this stage. On one hand, a group of assertive students could be observed,

who led the activities and decided the manner in which the mini-project would be conducted. On the other hand, the students who appeared less confident had to overcome their fears and respond/react to the demands of their more assertive colleagues. The team composition was carefully selected again: students from different cultural groups, with different mother languages were assembled in one team.

The benefits of this activity were two-fold: highlighting cultural differences in the classroom (while learning) and depicting cultural differences in the workplace (while developing a software product).

Based on the feedback gathered from the students at the end of the class, along with the additional questionnaires administered by the instructor, this edition of the course was the most successful so far, in terms of implementing active and collaborative learning. As one student stated, "*the lecturer changed the students' silence into discussion and projects*". Indeed, based on the instructor's observations, the course was successful in persuading the students more inclined to be silent in class to participate more in the various discussions and activities. Notably, several students admitted that what they learned would be useful later, 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*").

To summarize, these first three years of teaching the course featured the use of active and collaborative learning on an increasingly larger scale. Sudden and major changes were about to happen in the following year, as described in the next section.

B. Online Format

As mentioned earlier, the Covid-19 pandemic brought with it an abrupt change in the method of delivering instruction to students and pupils all over the world. According to Whittle et al., the focus was shifted towards "the method of delivering instruction rather than the learning goals" [28], making the implementation of collaborative and active learning even more challenging than usual. The following will describe how these concepts were implemented during the pandemic.

a) Year 2020

The software engineering course starts in April every year; the spring of 2020 represented the beginning of the pandemic and the time when decisions regarding implementation of classes had to be taken. All classes were switched to an online version; there was little time to consider the consequences and there was no realistic view of what the (near) future would bring. In this year, 34 students enrolled in the class (a rather large drop in number from the 66 participants in the previous year). Two of the reasons for this relatively low number could be explained as follows.

First, in the author's opinion, in March 2020 (when students had to register for their spring semester courses), there were many uncertainties regarding the online environment, seconded by an optimistic expectation of return to face-to-face classes in the very near future. These factors enabled the students to think that there was no need to

participate in an “online” class, when a “real”, face-to-face one would be back “soon enough”.

Second, in our university, students have around two weeks to observe a course, after which they must make a final decision regarding whether they enroll in the course or not. During the first class in 2020 (held online), the students were told that an active participation is required for the duration of the whole course. Moreover, being in an online environment made it more difficult for them to choose their discussion partners. As shown in [25], in case of a physical classroom, the students choose where to sit (usually, next to familiar faces, friends or colleagues who share the same mother tongue). At least for the first two or three lectures, they are allowed to discuss and form groups with the students seated nearby. After a few classes, the instructor specifically asks them to be part of multicultural groups. By this time, the students are familiar with their colleagues; moreover, even if they wanted to, they could not drop the class at this point. In this new virtual environment, several Japanese 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. As result, more than 10 students cancelled their registration immediately after the first class [25].

In this first edition of online course, the classes were held synchronously, using Microsoft Teams [29] and Zoom [30]. All class materials were placed on *manaba* (the LMS used in our university [27]). Notably, 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 Microsoft Stream [31] (with links to recordings 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 [24]).

At the beginning of each class, which started with a warm-up discussion (usually a piece of technology-related news), the students were gently encouraged to turn on their cameras. Some students did that in the beginning, but, as the class progressed, they became more reluctant to speak or show their faces. Moreover, several students became distracted, often engaging in a completely different activity. This was easily observed by the instructor, either when she tried to address them directly and there was no response, or when there were group activities and certain students were not present in the newly created online groups.

The instructor continued to make efforts to involve all students in the learning process. Although conversations online were more difficult to implement than in a classroom, she asked questions and attempted to engage all students in the discussions. Various class activities were adapted to an online format. Instead of teams created in a classroom (organized based on the physical location of the desks), the instructor created breakout rooms in Zoom; each such room

acted as a group, where participants held discussions and performed various tasks given in class. (Recording of the meeting was paused during the switch to breakout rooms.)

After organizing the students in breakout room and “opening” the rooms, the instructor took turns visiting each breakout room. She was initially muted, merely observing how the activity is being conducted. If the group appeared to be silent or not active, she would gently guide the activity, suggesting questions, and, if necessary, addressing the non-participative students directly or guiding the group towards deeper discussions. If important issues were raised in a group and the instructor believed that they can be shared with the whole class, or she observed that certain clarifications are needed, she would “call” the participants to the main room and address the issue immediately. (The breakout rooms would be reopened later, as necessary.)

It is worth noting that, in the online version of the classes, more time is needed to organize activities. Switching from the general meeting to breakout rooms and back takes a certain amount of time; thus, planning all the activities in advance is essential.

As previously described in [1], 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 regarding language skills (English was not the mother tongue for most participants). The majority of 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.”*

Nevertheless, one participant expressed a different opinion, stating that asynchronous work allows for 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.”*

Importantly, 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).

Unfortunately, not all previously used activities could be adapted for an online environment, with some of them having to be eliminated. One example is the agile game “paper

airplanes” [32]. This game teaches the benefits of teamwork, working in sprints, planning and retrospectives. It includes the task of physically creating paper airplanes and flying them in the classroom; even though it is considered a “classic” game to illustrate agile development, there was no way of adapting this game to the online environment.

In this first year of online teaching, during the first few classes, one of the most challenging parts proved to be the collaborative part. At first, after providing a task to be completed, a generic request was made by the instructor in each breakout room, for one student to share their document (which could be in almost any format desired by the group), 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 did not ask for a volunteer, but instead designated a student to be the “sharing” member, and this proved to be a more effective strategy of involving students.

Despite the sudden changes in class format and the initial worry that the classes would be much less interactive than usual, the instructor believes that active and cooperative learning were implemented to an acceptable level, under the given circumstances, i.e., in the ERT format.

b) Year 2021

In 2021, with the pandemic situation not improving, the software engineering course was held online again. A number of 53 students enrolled in the class - an increase of more than 50% from the first online class. Considering 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, despite its new format. 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, either on Zoom or on Microsoft Teams. They were recorded and made available offline for the students, through the LMS. By now, the instructor had a better idea of what could work in an online setting, and she organized even more class activities. Some of these activities were adapted from those originally used in a face-to-face setting, other were simply new ones.

To facilitate the completion of the group task and to make sure that important ideas exchanged in a group are recorded, an online document was shared, with sections available for each group in the breakout room. This idea came from a student, who noticed that it would be beneficial for the whole class, not only the group involved. In this way, anyone could edit the document, and anyone could see what other groups wrote and what they were working on. Often students who completed their task in their own group would browse the common document and comment on other groups’ work. A certain level of competition could be observed; allowing the participants to see other people’s work made them try to improve their own work. From this point of view, this was an improvement from the offline class modality: in a classroom,

students could not see in real time what other groups are working on, unless their notes were presented in front of the whole classroom, at the request of the instructor.

Just like every year, the instructor gathered feedback from the students with regard to the course. At this point, 40% of them 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 (see Figure 2).

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.”. Other comments included “The class with discussion activity should be Face-to-Face.” and “Face-to-face classes are more interactive and engaging”, supporting the idea that discussions and class activities may be perceived as more successful in a physical classroom setting.

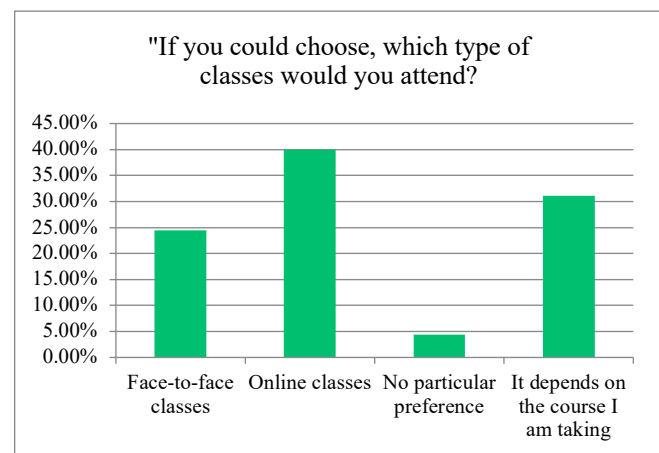


Figure 2. Format preference for attending classes in 2021

The participants were further 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 questioned whether they find the class activities useful/valuable on one hand and enjoyable on the other hand. The results are summarized in Table II. As can be observed, 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 achieving this.

TABLE II. CLASS ACTIVITIES IN 2021:
ENJOYABLE VS. VALUABLE/USEFUL

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

c) Year 2022

This past year, the course proceeded very similarly to the one in 2021. One might wonder why there was no return to the physical classroom yet: Japan was still rather strict with its pandemic related rules and there were still students who had not managed to enter Japan. The decision was made to continue with mostly online classes. Coincidentally, the number of students enrolled was the same as in 2019, i.e., 66; similarly, the number of international students was exactly the same as in 2019, i.e., 33 students. By this time, all the students were familiar with the online environment, Microsoft Teams and Zoom (as well as *manaba*, i.e., our university's LMS).

With the official course team created on Microsoft Teams, the first few classes were conducted on this platform. During subsequent discussions with students, it was revealed that several of them have a strong preference for Zoom; one session was therefore conducted on this platform, at the students' request. However, the remaining classes took place on Teams – a decision taken by the instructor together with the students. There were minor differences between how classes took place on the two platforms. One of them is that the students could easily choose their display name on Zoom, but they could not change their already assigned display name on Teams. This name was decided when they first signed up for Microsoft 365, as part of the university's organization. In the case of Japanese and Chinese students, their names were often written in "kanji" (Chinese characters). For the international students who cannot read them (and considering that names are particularly difficult to read), this raised problems in recognizing their colleagues' names in the group.

Whereas the course was held again online, synchronously, one notable difference from the previous year is that the instructor decided not to record the classes. The assumption was that there were no particular factors preventing the students from attending the classes in real time. Moreover, the instructor's (undeclared openly) intention was to make sure that students attend every week and pay attention in class, as much as possible (thus not relying on class recordings).

Most of the class activities were similar to those from the previous year. There were slight differences in the level of

participation, i.e., the international students seemed to blend slightly better with the Japanese students. However, this is most probably a very personal aspect – different students with different personalities participate in each year. The groups were created by the instructor and seldom randomly assigned. This year, the students were allowed to use any language they wanted in the breakout rooms, as long as they made sure that everything that was said was understood by all the group members. This meant, for example, that Japanese was used in a group where everyone spoke the language (either Japanese students only or a mixture with other students proficient in Japanese). English remained the main language of the course, as well as the language used for plenary discussions.

At one point, the instructor conducted a poll in which students were asked if they prefer language-based groups, randomly assignment groups or if they simply believe that this aspect does not matter. Less than a third of the respondents preferred language-based groups, with another third preferring randomly assigned teams; the rest of the students simply stated that it did not matter. This was a pleasant surprise for the instructor, who had assumed that the students would insist on being able to speak their own language. However, it is also possible that the meaning behind these preferences is simply that, at least in case of some of the students, they did not care about the groups because they did not want to participate anyway.

After the course ended, the instructor asked the students to answer a questionnaire about their experiences with the online software engineering class, to which 33 students ended up answering (this number represents exactly half of the total number of participating students). At first, the students responded with regard to their preference for an online or face-to-face class; their answers are summarized in Figure 3.

We can observe that the general preference of the students has changed compared to last year. At this point, most students prefer face-to-face classes ("*Face-to-Face would be more productive*"): more than 40%, compared to 25% last year. As for online classes, the percentage of students who prefer them decreased from 40 in 2021 to slightly more than 30. Same as the previous year, several students stated that their preference depends on the course they are taking (almost 20%).

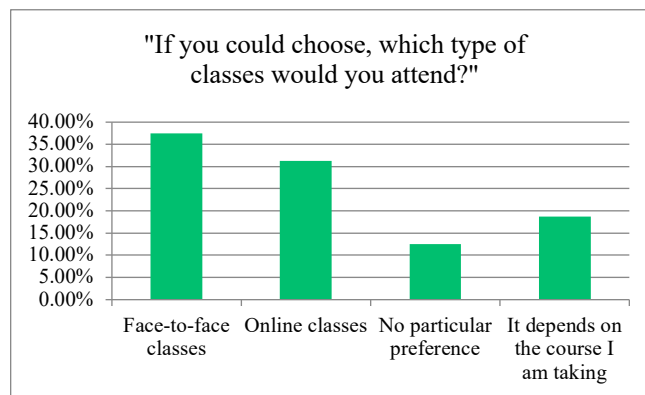


Figure 3. Format preference for attending classes in 2022

Some of the observations that students made reflected their feelings toward different formats. One student commented on the convenience of online classes, but used the term “invisible” to show that this is detrimental to the presence in the group: *“Although online classes are convenient, I think it does not help regarding student participation. One would think that not showing yourself would be a plus, but in fact it is used to be even more invisible”.*

One advantage of being in an online environment was highlighted, with regard to the seating in a classroom: *“I can speak up and ask questions in a flat environment, regardless of whether I am in the front or back of the classroom.”.* Unfortunately, with all the restrictions and their impossibility to arrive to Japan, there were students who had never been in a face-to-face class at the university, so they could not make a justified comparison. As one student stated, *“I [...] never took face2face class since I was here, so it's hard to justify.”*

Next, the class participants were asked to express their preference for the class style used in the software engineering course (see results in Figure 4). They had the following choices: "Lecture" style: teacher speaking in front of the whole class, students listening” (27.27% respondents), "Discussion" style: new things are taught/learned through continuous discussions between students and teacher (21.21% respondents), "Combination": half lecture-style teaching by the instructor, half interactive communication/discussion with students (48.48%) and "Flipped classroom" style: students read the new materials at home, then they come to class and ask questions, discuss etc.” (3.03% respondents). Almost half of the students chose the “combination” style, which is precisely the style employed by the instructor for this course. This is a promising result, showing that the class was relatively successful, and the students were satisfied with the style used.

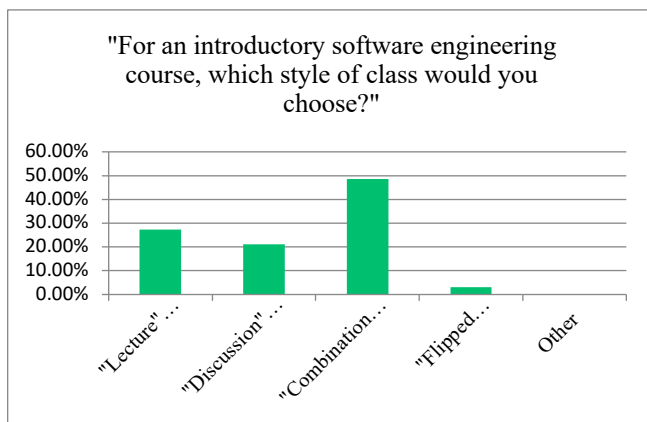


Figure 4. Preference for class style

When questioned about cultural differences in face-to-face classes vs. online classes, the responding students considered the two formats equally influential in how visible these differences are (as results show in Figure 5). Almost 40% of the students considered that cultural differences are more

visible in face-to-face classrooms; the same percentage stated that they are more visible in online classrooms.

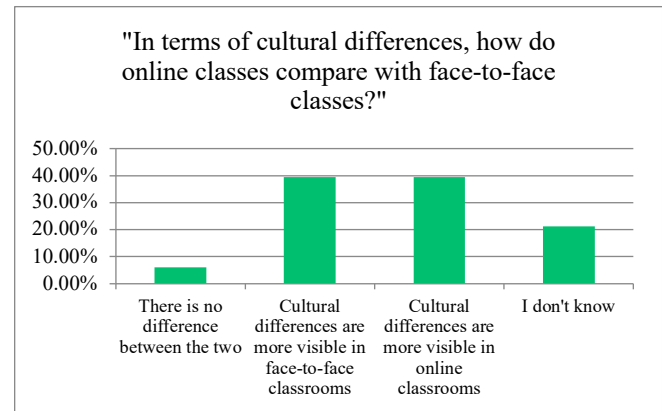


Figure 5. Differences between online classes and face-to-face classes in terms of cultural differences

Only 3% of the students found that there is no difference between the two formats. This is an interesting result which shows how the perceptions of online classes have changed for the participating students. One conclusion that could be drawn is that, at first, students believed that the cultural differences easily distinguishable in a classroom would attenuate in an online environment. After two years of almost exclusive online classes, their perceptions seem to have changed: they realized that the differences not only remained when online, but they are often even more difficult to overcome.

The class activities are an important part of implementing active and collaborative learning. In fact, from the point of view of the instructor, this is one of the greatest improvements that she managed throughout the years of teaching the course. Every year, more numerous and more diverse activities were introduced. The instructor wanted to know whether the participating students enjoyed these activities on one hand, and whether they found them useful/valuable on the other hand. Furthermore, she wanted to learn precisely what the students liked and what they did not like about these activities. Table III summarizes some of the data obtained from the questionnaire administered to the students.

TABLE III. CLASS ACTIVITIES IN 2022: ENJOYABLE VS. VALUABLE/USEFUL

	<i>A lot</i>	<i>Moderately</i>	<i>A little</i>	<i>Not at all</i>
Enjoyable	45.45%	33.33%	21.21%	0%
Valuable/useful	60.61%	27.27%	12.12%	0%

As can be observed, more than three quarters of the responding students found the activities enjoyable (either a lot or moderately). At the same time, almost 90% thought that they were valuable/useful (a lot or moderately). The results are similar to those from 2021 and, again, they show that students do recognize the usefulness of the activities even when they do not enjoy them very much.

The respondents were given 3 choices in regard to what they like about activities. Most respondents (63.64%) chose “listening to what other people think”, followed by “saying what you think”, which was chosen by 24.24% of the respondents. Some students (12.12%) chose “nothing” (simply not enjoying the discussions at all). When asked to specify what they did not like, several responses stood out. By far, the largest complaint expressed regarded the participation of the other students (often Japanese), as seen below.

- *“I felt like I had to force discussion with others sometimes.”*
- *“Limited number of people speaking up, only two or three may participate in team activities”*
- *“That Japanese people do not interact much in the class.”*
- *“After we're divided into breakout rooms, some people don't join the discussion. I don't know why, but I want them to join.”*
- *“I wish all the students participate in the discussion so that I can interact with them.”*
- *“Many students do not speak.”*
- *“Just some people not being involved in the class 100% of the time.”*

With the same complaint, some students' opinions included more details:

- *“I like the discussions, but sometimes I'd prefer to not have this kind of activity because of the number of times everybody stays quiet in my room. I feel I waste more energy trying to do the exercise alone or getting some else to talk. I understand everybody has its reasons, but these situations are hard for me.”*
- *“It is hard when one's put in a room where nobody wishes to talk. (Now I kind understand how the professor feels) Although everybody may have their reason, it affects how I enjoy the class as I think I waste more energy: Doing the exercise alone or trying to get someone else to talk. I'd say it even gave me a little be on anxiety sometimes, as sometimes I noticed that if I didn't start to make the requested exercise, nobody in the group say or do anything.”*

One interesting piece of feedback highlighted the fact that some students “talk too much on irrelevant topics: *“i. people won't talk in breakout rooms ii. some would talk too much on irrelevant topics”*. From the instructor's point of view, in a class where most Japanese students are very quiet, talking “too much” is beneficial for the class, even considering that the topics are “irrelevant”.

One respondent's comment referred to one of the sessions when the groups were constituted on the basis of a common language (as much as possible): *“Maybe we didn't do ice breaking properly, and when we were in breakout room, no one speak. There were some classes that there was a real discussion. The first one is when we group student based on language we speak, and the last one that we discussed about risk assessment. About the first one, I think it because of there were so many Latin American students which shared a lot in their culture so it was easy to connect for them. I think if everyone know each other more, we are likely to share a conversation.”*

Not all the students were eager to take part in class activities, even though they appreciated the content, as one

participant explained: *“The content of the class was very useful. Only in my point of view, I think that maybe not having so many activities together would have helped me.”*

Regarding class participation and ways to increase it, one interesting suggestion came from a student: *“Attributing the participation score may motivate more people to participate in the class.”*. Whereas this is an issue worth considering, it would most probably be hard to implement. Students joining a software engineering class would expect to be evaluated more on the knowledge they acquired and less on their participation skills.

Another participant pointed out that easier (and more “enjoyable”) tasks might entice the students to speak more during class: *“I am shy and not good at speaking and listening English. So, I want to do easy and enjoyable tasks or games, for example, estimating rule from dice results on 6/8. Thanks to this game, I understood and talked in English.”*.

A third suggestion came in the form of suggesting “ice breaking” activities: *“Some people (e.g., me) are unlikely to discuss with someone I am not familiar, but will talk a lot with close friends. I think a lot of people are like me. So, I think we need some kind of ice breaking activities. Also, I have not met anyone in my degree since I have been here too.”*. (The last part refers to the fact that the student is the only one joining the course from his department (“degree”).)

Some participants believe that online classes are helpful for “shy” students: *“online class is more flexible for me, and relax for shy people, i am sure i would only speak less in a face to face class.”* At the same time, other participants believe the opposite: *“Offline courses will make shy people more likely to participate in discussions”*. In the instructor's experience, it is difficult to generalize: some students are more comfortable participating online, whereas others, although initially “forced” to participate in a real classroom, become increasingly more confident in the presence of other students. Understanding the factors that contribute to better participation and making a systematic comparison between online and offline classes (from the active and cooperative learning point of view) would make an excellent topic that could be studied in future work.

Last, but not least, even in informal discussions, many students expressed their hope that the face-to-face classes will return soon. Here is an example of one such comment: *“I wish the classes to be face-to-face so that I could get a chance to interact with more people and exchange the ideas I have and get their opinions as well. I wish to come out of the “online” class mode and interact with other students directly. Hope this changes soon.”*.

Finally, when students had the opportunity to express free thoughts, they made comments like the following:

- *“I am grateful that [she] always listened to the opinions of the students and responded to everything on-time, even though it was online”* (translated from Japanese).
- *“The course hours are interactive and this keeps a student engaging in the classwork”*.
- *“It was nice to have an English discussion”* (translated from Japanese).

The only request for change took the following form: “*It would be better if the lecture could be posted to manaba before class*”, followed immediately by “*Anyway, thank you for your teaching*”. All the remaining comments received were of a positive nature, expressing students’ satisfaction with the way the course was conducted.

V. DISCUSSION ON COURSE EFFECTIVENESS AND LESSONS LEARNED

The changes from offline to online classes provided an invaluable experience, to both the students and the instructor. While it is generally rather difficult to measure learning and its effectiveness very precisely, two of the most common ways to assess learning effectiveness are course completion rates and learner perception. This section discusses these two methods and offers some lessons learned by the instructor during the teaching of this course.

The software engineering course completion rates are shown in Table IV. Although slightly lower than those for the previous 3 three years (but higher than that for the very first year, i.e. 2016), the completion rates for the three “online” years were still very high, with the lowest being 94.11%.

TABLE IV. COMPLETION RATES OF SOFTWARE ENGINEERING COURSE

	2016	2017	2018	2019	2020	2021	2022
Number of students enrolled in course	17	26	35	66	34	53	66
Number of students completing course	15	26	34	65	32	52	63
Completion rate (%)	88.23	100	97.14	98.48	94.11	98.11	95.45

Regarding the students’ perceptions, the results obtained from the questionnaire administered by the instructor, as described in the previous section, show that they were overwhelmingly positive towards the class’s effectiveness. Furthermore, data from the university-prepared end of course questionnaire results support the same idea. (The University of Tsukuba prepares a short questionnaire at the end of each course, which the students are strongly encouraged to answer, usually during the last class of the course. This questionnaire is independent of the one administered by the instructor, as described in the previous section.)

The students provided their answers on a scale of 1 to 5, corresponding to “strongly agree”, “agree”, “neutral”, “disagree” and “strongly disagree”, respectively. Table V summarizes the answers given by the students to 5 of the questions in 2022, the last year of the online classes. As can be observed, with only a few exceptions of respondents choosing “neutral”, all the participants selected either “strongly agree” or “agree” with the 5 statements. It is encouraging to observe that participants developed a stronger interest in the subject after taking this course. Also, even though the class took place online, they believed that the ways

in which the instructor explained and planned the class contents were suitable for the course. They also recognized that there were sufficient opportunities to ask questions during class. Last, but not least, the students were satisfied with the course, as shown in their responses: 26 chose “strongly agree”, 14 chose “agree” and 1 chose “neutral”.

TABLE V. RESULTS OF END OF COURSE QUESTIONNAIRE (1: STRONGLY AGREE; 2: AGREE; 3: NEUTRAL; 4: DISAGREE; 5: STRONGLY DISAGREE)

	1	2	3	4	5
“The instructions were well prepared for the course.”	29	12	0	0	0
“The ways the instructor explained and planned the class contents were suitable for the course.”	23	17	1	0	0
“Attending this course, I developed a stronger interest in the field of study related to this subject than before.”	21	17	3	0	0
“Overall, I am satisfied with this course.”	26	14	1	0	0
“You were given sufficient opportunities for asking questions to the instructor(s).”	32	8	1	0	0

Furthermore, empirical observations supported these results. The instructor held informal discussions with the participants, as often as possible (either during the break time or when she met the students on campus, by chance). The students expressed their satisfaction with the course, as well as their enjoyment in participating in class activities, on numerous occasions. They often expressed these feelings even without being asked.

To summarize, some important lessons from our experience as described in this paper are as follows.

a) Active learning should be pursued in all its forms, as much as possible. In software engineering, it paves the way for an easy to achieve understanding of various concepts and allows the learners to gain experience similar to that obtained in the real world when developing a software application.

b) Collaborative learning can be very successful, in both offline and online settings. As long as an environment that facilitates collaboration between participants is ensured, collaborative learning can be implemented in either class modality, be it online or offline.

c) Perceived enjoyment and perceived usefulness play an important role in an online environment for the students. The more enjoyable and useful they feel that classes are, the more engaged and satisfied with the course they will be.

d) Multicultural classrooms provide the opportunity for students to experience work in international environments and a glimpse of global software engineering practices.

e) Fulfilling course objectives and achieving student satisfaction depend less on the class modality, and more on the student engagement strategies used by the teacher.

It is a fact that the traditional face-to-face classroom modality is preferred by many course participants (and even the instructor herself). In the case of the software engineering course, this preference does not rely on the lack of success of online classes, but rather, we suspect, on factors that have to do with human psychology. (This is a topic that can be further developed in future work.) Nevertheless, the most valuable lesson is the fact that, if necessary, online classes can

successfully substitute face-to-face classes, provided that there is constant interaction between the teacher and the students, as well as collaborative activities between the students.

VI. CONCLUSION AND FUTURE WORK

Based on the experience of teaching a graduate school software engineering course to a multicultural group of students, this paper described the approaches used by the class instructor to implement active and cooperative learning, in both the traditional face-to-face format and the sudden (imposed by the Covid-19 pandemic) online format. It highlighted the impact of switching from an offline to an online class modality and the challenges brought upon by emergency remote teaching. Our study showed that, despite all the challenges, the online classes were successful in achieving the learning outcomes, as well as achieving student satisfaction with the learning process. If the online class interactions (between the teacher and the students, as well as among students) are constant and the activities are varied, the students participate actively, even after initial reluctance. Whether the class is enjoyed by the students, and they are satisfied or not, depends more on this level of interaction rather than the class modality.

In future work, the instructor plans to make a systematic comparison between the online and offline environments from the point of view of student in-class participation, in order to discover the best strategies for making the best out of active and cooperative learning, in either type of environment.

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