


# Active Learning Activities in a Pandemic Context for a Software Engineering Course: An Experience Report

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**Abstract:** This paper reports the students' perceptions regarding active learning (AL) activities in a pandemic context and the use of AL and related tools to improve soft skills, such as critical thinking and teamwork. This work describes the active learning activities applied in a pandemic context for a Software Engineering course and presents students' survey results. Based on students' opinions, we conclude that AL and the associated tools, while promoting soft skills, also promoted motivation and student engagement for face-to-face and remote classes in the pandemic context by minimizing the negative impact it may have caused on the students.


## 1 INTRODUCTION

There is an evidence-based widespread belief that the majority of problems associated with software development are not due to technological aspects but related to people and social and cognitive elements (e.g., (Lister and DeMarco, 1987; Hazzan et al., 2020; Sonmez, 2015; Matturro et al., 2019; Oguz and Oguz, 2019; Sedelmaier and Landes, 2014)). As testified by Chamorro-Premuzic et al. (Chamorro-Premuzic et al., 2010), at least since 1998, there has been an emphasis on the importance of non-academic competencies usually referred to as "soft skills". The importance of soft skills is often present when discussing the gap between software engineering and software engineering education (e.g., Oguz (Oguz and Oguz, 2019)). As stated in the ACM and IEEE report (ACM and IEEE Computer Society, 2020, p. 29) "All computing disciplines emphasize required know-how of individual practitioners, including problem solving, critical thinking, communication, and teamwork." The report also describes thirteen elements of foundational and professional knowledge; some of them are soft skills, such as Analytical and Critical Thinking, Collaboration and Teamwork, Oral Communication and Presentation, Time Management, among others. In addition, the same report (ACM and IEEE Computer Society, 2020, p. 42) quotes a recent sur-

vey by PSI Services stating that "81% of employers in industry indicated that prospective employees lack critical thinking and analytical reasoning skills and, 75% think graduates lack adequate innovation and diversity skills".

Active learning provides opportunities for students to think about the technical content through a range of activities that help them critically understand the challenges of the industry context (Hmelo-Silver, 2004). Moreover, active learning activities "(...) help promote higher order thinking skills, such as application of knowledge, analysis and synthesis"<sup>1</sup>. Thus, active learning activities engage students in deep rather than surface learning, improving student's overall learning. Yet, this is a particularly difficult challenge in a pandemic context, where the students and teachers need to maintain social distance. This paper describes the students' perceptions regarding active learning (AL) activities in one remote and onsite/face-to-face Software Engineering course during the COVID-19 pandemic. The paper focuses on using AL to develop students' soft skills and foster students' engagement in learning, mainly in remote (online) classes. This paper is structured as follows. Section 2 describes the set of applied AL activities and tools. Section 3 describes the course and presents the used method based on quantitative analysis of a survey. Section 4 shows the results and discusses the

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findings based on: i) students' opinions on the use of AL and tools to improve their soft skills; ii) students' opinions about face-to-face and remote learning and iii) students' opinions about the effectiveness of the AL tools. Section 5 presents related work, highlighting similarities and differences with other existing works. Finally, Section 6 concludes and suggests directions for future work.

## 2 ACTIVE LEARNING (AL) ACTIVITIES AND TOOLS

In this section, we present the set of five applied active learning activities, inspired by other activities presented elsewhere (Active, nd). They were applied in a software engineering course, part of the fourth semester in a six-semester computer science bachelor's degree. The five activities, and respectively used tool, were the following:

1. "Quescussion" / Kahoot;
2. "Buzz Groups" / Mind Map;
3. "Post It Parade" and "Peer Review" / Padlet;
4. "Exercises";
5. "Exercises" / Trello.

"Quescussion" activity promotes discussion through questions presented to each student. Students are provided with a question for which they need to answer individually. This could also be done online or onsite/face-to-face (in person). Kahoot! tool (available at <https://kahoot.com/>) was used to support "Quescussion". Kahoot! is a well known game-based learning platform (app and website), where "kahoots" are multiple-choice answers to questions, among other functionalities. Some literature concludes that Kahoot! can positively affect learning performance and bring engagement and immediate feedback to students promoting classroom dynamics (Plump and LaRosa, 2017). "Buzz Groups" activity is proposed for groups. Each group internally discusses a topic for a few minutes to generate arguments, answers, or ideas. To support this activity, "Mind Map" was used as a teaching and learning tool to foster critical thinking. It can be used to brainstorm a topic and as a tool to promote student engagement (Zipp, 2011). A mind map involves thinking about a central topic and identifying new and related ideas directly or indirectly connected to that main topic. "Post It Parade" and "Peer Review" activities are proposed for individuals, pairs, or small groups. First, one or more students are provided with a question for which they need to answer. This could

also be done online/remote or onsite/face-to-face in a predefined time. Next, the students post the answer using the Padlet tool (<https://padlet.com/>) in pairs, small groups, or individually. Padlet is "a real-time collaborative web platform in which users can upload, organize, and share content to virtual bulletin boards called \*padlets\*." Then, each student reads another student's post and provides them with verbal feedback and a star classification (1-5); the students have a deadline for giving feedback. These activities promote collaboration and teamwork, oral communication and presentation, time management, and motivation.

The "Exercises" are case studies activities proposed for pairs, where the students are provided with a real-case project (as an in-class exercise) for which they need to write a report that illustrates an application of theoretical concepts that are part of the course contents. The exercises were also proposed using Trello (available at <https://trello.com/en>) to promote collaboration and teamwork, oral communication and presentation, as well as time management. Additionally, regarding remote classes, Zoom (available at <https://zoom.us/>) was used to support synchronous communication between students and instructors, as well as between students using simultaneous rooms. Next, we present how the students' perspective was recorded and summarized.

## 3 METHOD

This paper reports the students' perspective on whether active learning activities and tools improve their soft skills. Additionally, we ask students about the effectiveness of remote versus face-to-face learning and the use of active learning tools. These are used as a measure for students' motivation and engagement with the contents and learning objectives in a Software Engineering course (SE). SE is a mandatory course in the computer science degree. Regarding the pandemic context, classes were taught face-to-face and remotely, for 7.5 weeks each, in a total of 15 classes. The course is composed of theoretical and practical classes. The active learning activities and tools were applied to the classes as follows: "Quescussion" / Kahoot!, "Buzz Groups" / Mind Map are used in theoretical classes; "Post It Parade", "Peer Review" / Padlet are used in theoretical and practical classes; "Case study" / Trello are used as part of an exercise/project training in practical classes. In addition, Zoom was used to support the theoretical and practical classes remotely. Except for one case study, the proposed activities and tools were not used for as-

assessment and were all-voluntary.

Next, we present the method to obtain the answers to the following three research questions:

**Research Question 1:** How have active learning activities and tools improved students' social skills?

**Research Question 2:** What is the opinion of students about face-to-face learning compared to remote learning?

**Research Question 3:** How do the students perceive the effectiveness of the active learning tools?

At the end of the course, students were invited to participate in a survey. We opted for an online survey to elicit data and applied quantitative analysis. The survey was performed based on four criteria: (1) obtain students' profiles; (2) collect students' opinions about the activity activities/tools effect on the promotion of soft skills, namely teamwork, conflict management, time management, communication, and critical thinking; (3) collect students' opinions about face-to-face and remote classes; (4) collect students' opinions about active learning tools. The survey presented close-ended questions for criteria 2), 3), and 4). We defined different scale questions for each criterion: For criterion 2) the survey scale questions were either from "Extremely important" to "Not important at all" or from "Extremely strong contribution" to "No contribution". For criterion 3), the survey adjectives were from "Unsafe (regarding health issues)" to "Safe (regarding health issues)"; "Intrusive (relating to privacy)" to "Secure (with regard to privacy)"; "Necessary" to "Unnecessary"; from "Superficial interaction" to "Meaningful interaction"; and "Helps in solving difficulties" to "Hampers in solving difficulties". For criterion 4) the survey adjectives were "Preferred in face-to-face classes" to "Preferred in Zoom classes"; "Useful" to "Useless"; "Demotivating" to "Stimulating"; and "Friendly" to "Complicated". Open-ended questions were also asked, allowing respondents to state their views/suggestions freely. The survey was disseminated at the end of the semester using google forms and available at <https://forms.gle/3r33pAmWesfsz8xJ8>. The survey responses for criteria (2), (3), and (4) are presented in the "Results" section. Previously, the survey was applied to a small group of other students to validate the questions and avoid misunderstanding.

#### 4 RESULTS AND DISCUSSION

In this section, the survey results are presented. For easier reading, the results are grouped by Research

Question. Yet, each question has some degree of intersection with the other ones.

To find the answer to Research Question 1 (How have active learning activities and tools improved students' social skills?), we asked students about the contribution of each activity and the respectively used tool for the development of four several widely regarded soft skills: (1) teamwork and conflict management; (2) time management; (3) oral communication; (4) critical thinking. Regarding teamwork and conflict management (Fig. 1), the most popular tools were Zoom for synchronous communication and the exercises (9 in 16 recognized an "extremely strong contribution"). Most students also recognize the use of "Post It Parade" and "Peer Review" / Padlet as a strong contributor, which is not surprising considering the "Post It Parade" activity description (see section 2). Exercises with Trello is the least favored by students (3 students classified it as "No Contribution"), but most students still recognize some contribution. This perception may be because students have difficulties working in pairs, and they did not like to see these difficulties reflected in the tool.

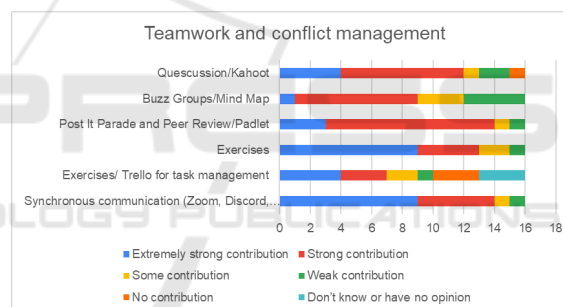


Figure 1: Active learning activities and tools contributions to teamwork and conflict management.

Regarding Time Management (Fig. 2), students (10 in 16 recognized an "extremely strong contribution") valued regular exercises as the most beneficial active learning strategy, probably due to a more obvious and stronger connection to the course contents and because those exercises were proposed mainly for pairs and to be developed in a short or long period of time. Most students acknowledged some contribution from all activities. Interestingly, even the use of Mind Map was considered by a small majority as contributing to better time management. It seems reasonable to conclude that students see all regular activities along the semester as aids for better time management.

Unsurprisingly, Zoom was the most favored tool regarding oral Communication (Fig. 3). More surprising is that Trello was equally valued, and all other activities and tools were seen as solid contributors to oral communication. The Mind Map was the least im-

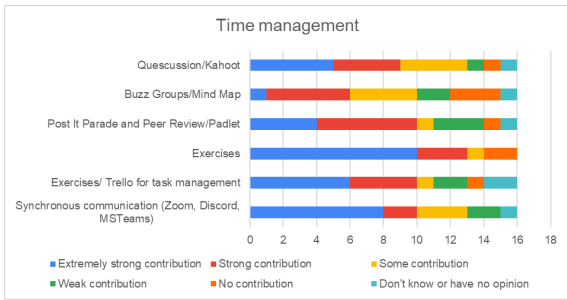


Figure 2: Active learning activities and tools contributions to time management.

portant for oral communication.

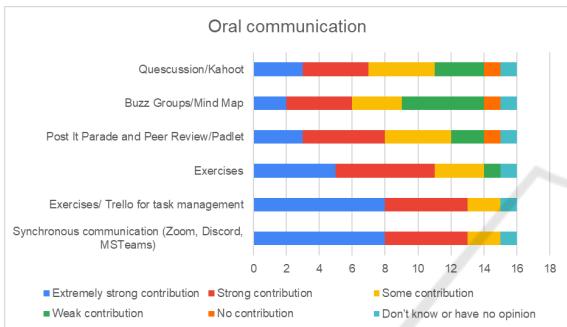


Figure 3: Active learning activities and tools contributions to oral communication.

Still, regarding the tools' contribution, students were also asked about the perceived contribution for critical thinking (Fig. 4). Exercises were the most valued (12 in 16 recognized an "extremely strong contribution"), followed by Zoom, Kahoot, and Padlet. Trello was the least valued, but still, 11 in 16 recognized some level of contribution. Notably, critical thinking has the lowest number of "No contribution" answers compared to the others. Therefore, according to students' perception, critical thinking was the most improved soft skill.

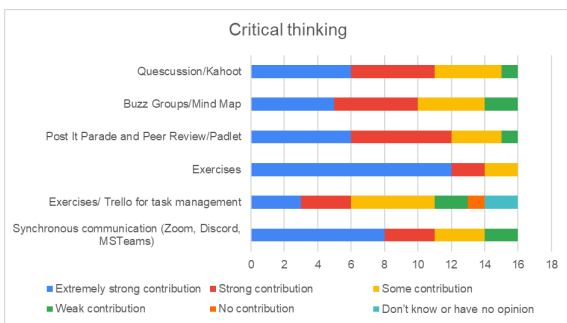


Figure 4: Active learning activities and tools contributions to critical thinking.

Most students considered that the activities car-

ried out contributed to the development of soft skills, mainly time management and critical thinking (>10 students). Moreover, students think that the less stimulated skills were oral communication and conflict management. Therefore, either the activities are not suitable to promote this soft skill, or the profile of the students can influence the answers; for example, the students think they already have this soft skill or do not like to express their opinions and knowledge aloud. Analyzing figures 1 to 3, Mind Map was the least valued activity. Even in the context of critical thinking, the Mind Map did not have a very positive contribution compared to other activities. It seems that the students found the activity very complex, probably because they needed to collect data, ask questions and analyze possible solutions, which was time-consuming as several solutions could arise.

One student denoted that Padlet, Mind Map, and Kahoot have weak contributions for her/his soft skills development, which seems reasonable considering that she/he only attended 1-4 classes. It is also worth mentioning that students regularly attended classes (>8 classes). Few students attended less than half of the classes, so it is normal to have answers as "Do not know or have no opinion".

Regarding Research Question 2 (What is the opinion of students about face-to-face learning compared to remote learning?) students were asked about five topics: (1) Safety (based on health issues); (2) Privacy (related to intrusiveness); (3) Usefulness of both types of classes (face-to-face and remote); (4) Support (each type of class helps or hampers); (5) Quality of the interaction (superficial or meaningful).

Regarding health issues, Figure 5 shows the answer of each of the sixteen students as spheres with a number between 1 (unsafe) and 7 (safe). Most students assume face-to-face classes are safe (ten students). Yet, five students seem unsure, having chosen the medium value of 4. Only one student chose a value below 4.

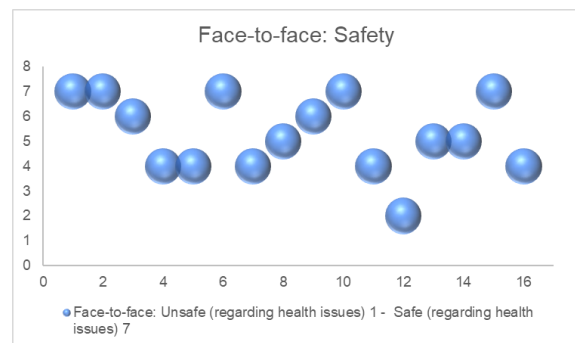


Figure 5: Students' perception regarding safety in face-to-face classes.



Only four students seem hesitant regarding privacy in remote classes, having answered with the medium value (see Fig. 6). Ten in sixteen students feel completely secure regarding their privacy during remote classes, and the remaining two still feel very at ease.

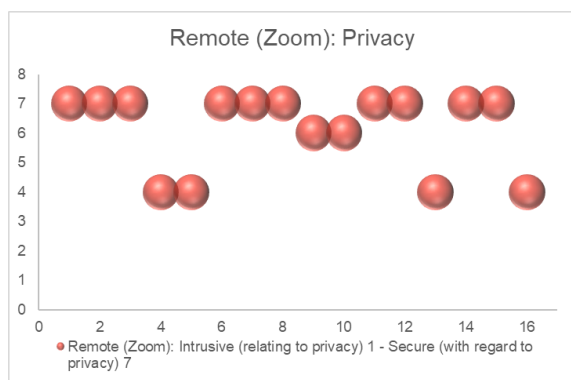


Figure 6: Students’ perception regarding privacy in remote classes.

Seven of the sixteen students feel that face-to-face classes are slightly more necessary than remote classes. The remaining nine feel that remote and face-to-face classes are equally necessary (see Fig. 7). Interestingly, no student indicated that the classes, remote or face-to-face, are unnecessary.

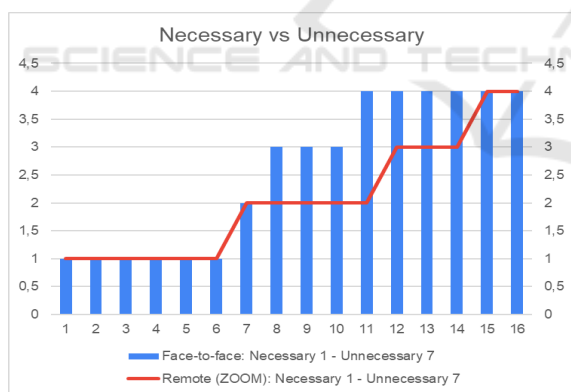


Figure 7: Students’ perception regarding the usefulness of face-to-face and remote classes.

As expected, most students (10 in 16) feel remote classes hamper solving difficulties compared to face-to-face classes (see Fig. 8). Even so, four students find no difference, and one student prefers remote classes to solve problems. One student did not answer the question regarding face-to-face, perhaps because s/he went to few classes and has no opinion.

Regarding the quality of interaction, the results are very similar: twelve of the sixteen students prefer face-to-face classes, and four find no difference

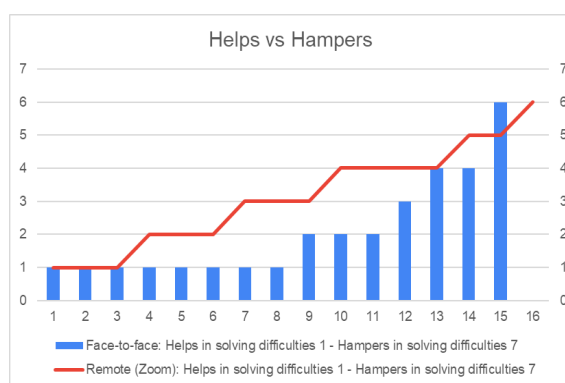


Figure 8: Students’ perception regarding support in face-to-face and remote classes.

between the two types of classes (see Fig. 9). This result could be explained by AL tools being suitable for any context, which is a positive point. Also, one student did not answer the question regarding face-to-face, perhaps because s/he went to few classes and has no opinion.

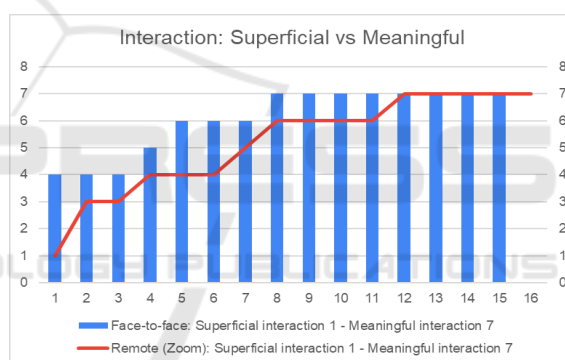


Figure 9: Students’ perception regarding interaction in face-to-face and remote classes.

The figures show that students similarly and positively enjoyed remote and face-to-face classes, despite the pandemic context. Face-to-face classes have a slight advantage of being more interactive and necessary, and remote classes have the advantage of making them feel safe.

To answer the third research question (How do the students perceive the effectiveness of the active learning tools?), we focused on the three tools more directly related to learning and motivation, leaving out the Zoom tool and the exercises: (1) Kahoot; (2) Padlet; (3) Mind map.

All, except one of the sixteen students, value the use of these three tools (see Fig. 10). All three are considered extremely or very important by more than 70% of students. Students especially value Kahoot and the Padlet. This is consistent with the results of research question 1. Considering the student who did

not appreciate the tools, it seems reasonable considering that she/he only attended 1-4 classes.

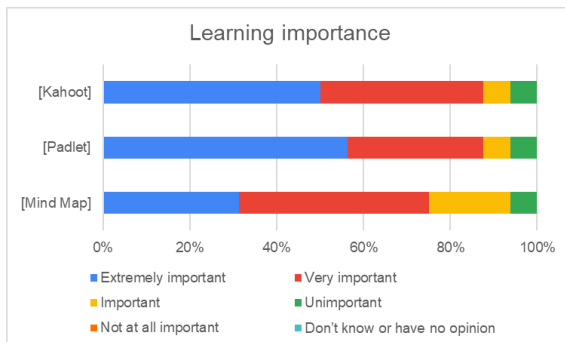


Figure 10: Students' perception about the importance of tools.

Table 1 details the students' preferences when using these tools while comparing their face-to-face vs. remote classes effectiveness. Kahoot and the Padlet are perceived as extremely useful (Kahoot with 12 and Padlet with 10) and stimulating (Kahoot with 12 and Padlet with 9). Mind map still get mostly positive scores, but students find them less useful and stimulating.

Considering the colors in the table, it seems that students have a slight preference for using tools remotely, although most indicate that it is indifferent (11 for Kahoot, 8 for Padlet).

## 5 RELATED WORK

As attested from a large number of published papers, it is easy to conclude that there is a perceived deficiency in the soft skills level of computer science students. This can be partially attributed to the relatively high prevalence of students with a diagnosis of autism spectrum disorder (e.g., (Stuurman et al., 2019)). Nevertheless, this seems to be a problem for most computer science students (e.g., (Hazzan et al., 2020; Shadbolt, 2016)).

We found no references to similar works that report the use of several active learning activities and associated tools to promote soft skills and students' engagement in a pandemic context. Nevertheless, here we briefly present some more closely related to soft skills in software engineering courses or computer science in general.

Hazzan and Har-Shai present an entire course on computer science and software engineering social and cognitive soft skills offered by the Department of Computer Science (CS) at the Technion – Israel Institute of Technology (Hazzan and Har-Shai, 2013). The

course was motivated by a call from the Israeli hi-tech industry. The authors state the importance and need to gradually learn soft skills over a period of time, based on students' engagement, active learning, and reflection. In this sense, the work presented here provides support for that progressive learning approach in the context of a SE course.

Bastarrica et al. surveyed a fifth-year software engineering capstone course (Bastarrica et al., 2017). They found that the perceived relative difficulty of soft skills grows along the course compared to that of the technical challenge, except for the negotiation with the client whose perception of relative difficulty drops significantly. They also found that the perceived relative value of correctly addressing technical challenges dropped considerably after the course and found statistically significant evidence that the perceived relative relevance changed along the course for the measured soft skills. Finally, they report that students found that planning and teamwork were more challenging than expected and realized that soft skills were much more determinant for the project's success. Although in a pandemic context, our students also perceived the importance of soft skills.

The Shadbolt review recommends improving computer sciences graduates' softer and work readiness skills (Shadbolt, 2016). It also notes that some enterprises require hard technical skills while others prioritize broader soft skills such as effective communication skills. Mainly motivated by this report, Beckingham discusses and presents some proposals to how students can develop soft skills through a variety of work experience opportunities, in-class activities, and alternative teaching approaches (Beckingham, 2018). In addition, the proposals emphasize the need to align graduate skills with the expectations and needs of employers. To that end, they recommend building partnerships with the industry to help to identify the changing priorities in the required work-ready skills. They also mention the importance of in-class activities for the development of soft skills.

Thurner and Böttcher developed a questionnaire to capture the lecturers' expectations on student non-technical competencies, which they categorize as "social", "practical and cognitive", both based on "self" competencies (Thurner et al., 2014). Their motivation was the assumption that non-technical competencies are the basis for most students' problems. A follow-up study by the same authors (Thurner et al., 2017) identified a set of competencies as highly essential prerequisites for software engineering education, lacking in a vast majority of freshmen students. These include self-organization, perseverance, will to follow instructions, ability to reflect on their be-

Table 1: Students' perceptions regarding active learning tools.

		1	2	3	4	5	6	7	
<b>Kahoot</b>	Preferred for face-to-face classes	3	0	0	11	1	0	1	Preferred for remote (Zoom) classes
	Useless	0	0	0	2	1	1	12	Useful
	Demotivating	0	0	0	2	1	1	12	Stimulating
<b>Padlet</b>	Preferred for face-to-face classes	2	0	0	8	1	1	4	Preferred for remote (Zoom) classes
	Useless	0	0	0	3	1	2	10	Useful
	Demotivating	0	0	0	3	1	3	9	Stimulating
<b>Mind map</b>	Preferred for face-to-face classes	4	0	0	5	2	3	2	Preferred for remote (Zoom) classes
	Useless	0	1	1	3	1	4	5	Useful
	Demotivating	0	0	2	4	2	5	3	Stimulating

havior, and team orientation. González-Morales et al. report positive feedback and increased motivation from computer engineering students after changing a software engineering coursework: students worked in teams of 4 or 5 to develop a project for an actual client (González-Morales et al., 2011). The motivation was soft skills improvement, but no quantitative or qualitative data is presented regarding it. It is also interesting to note that Kubota et al. argue that active learning suitability depends on the type of subject and conclude that basic subjects in information and electronics are not suitable for active learning (Kubota et al., 2017). Yet, Lehtovuori et al. noted high levels of motivation and improved learning results in electrical engineering basic studies (Lehtovuori et al., 2013).

Confronted with students' low grades and reducing face-to-face classes attendance rates along the semester, García-Holgado et al. implemented an active learning methodology based on team working in a software engineering course (García-Holgado et al., 2018). As a result, they noted a significant increase in the final exam grades and a 100% success rate in the final project developed in the groups.

Silva et al. collected the students' and instructors' perceptions regarding five different active learning activities applied to the teaching and learning of UML diagrams in four different courses in two universities (Silva et al., 2019). As a result, they identified several benefits and difficulties that influence the learning when using the tried active learning activities and some challenges reported by the instructors.

## 6 CONCLUSION

Active learning activities have been gaining prominence in computing courses, and this study shows the benefits of some of them in a pandemic context. From the analysis of students' perceptions, we could observe that some active activities and tools were more useful for students (Kahoot, for example). In contrast, others were considered more complicated and

not very useful (Mind Map, for example). In addition, the students think that their soft skills are promoted, such as critical thinking, despite the pandemic context. Regarding face-to-face and remote classes, the students agree that the activity learning activities and tools are helpful, stimulating, and necessary. Moreover, it seems that those activities and tools minimize the negative impact of remote classes and face-to-face classes in a pandemic context. Notably, no student indicated that either remote or face-to-face classes are unnecessary. Yet, unsurprisingly, most students feel remote classes hinder solving difficulties compared to face-to-face classes and show a slight preference for the latter, mainly due to the quality of interaction. All students that attended more than four classes valued the use of Kahoot, Padlet, and Mind Map with a slight preference for Kahoot and Padlet and for using all tools remotely. The main limitation of our study was the relatively small number of students. Based on our experience with these and previous years' students, we believe this group represents students' preferences and attitudes. Yet, we do not have enough data to conclude that the number was sufficient to achieve saturation. The used tools are not specific to software engineering. Hence, we believe the students' preferences we have identified are very likely transferable to other areas, especially to further computer science courses. Yet, as the study was conducted in the strict context of a software engineering course, it does not provide data to support this claim. As future work, this study will be replicated in other courses to identify the effectiveness of active learning activities and tools to promote soft skills. In addition, another study will be applied to graduate students' employers to verify if these students have the desired soft skills.

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