Activating student engagement in large videoconferencing classrooms with audience response systems during confinement

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Abstract: This paper investigates the impact of an audience response system (ARS) on student engagement and participation in online large class settings during the COVID-19 confinement period. We use interactive, quasi-participatory problem-based learning to promote active discussions, improve attention and motivation, and real-time feedback. These strategies were enhanced by adopting an ARS, aiming at combating shyness, reluctancy and reduced exposure of students during video conference-based classes. A survey was administered to higher education students to evaluate the ARS potential to improve the learning experience, participation, and involvement, socialization, and motivation. Results show that the use of ARS positively impacts these three dimensions in emergency remote instruction.

Keywords: Audience response systems, active learning, problem-based learning, videoconferencing, Wooclap

1. Introduction

Higher education institutions have shifted from face-to-face or blended instruction to fully remote instruction in the current context of global confinement due to the COVID-19 pandemic crisis to ensure education provision. As stated by Correia, Liu, and Xu (2020), without much instructional guidance, educators turned to what they felt was natural in terms of real-time communication and tried to replicate the classroom in videoconferencing virtual meetings. During this phase, the use of videoconferencing systems has increased exponentially in education. For instance, while only 10 million individuals attended Zoom meetings before coronavirus was widespread by the end of 2019, by April 2020 its usage had exploded to 300 million (Wiederhold, 2020).

Soon after, several researchers in the education field began to report the lack of student involvement in videoconferencing-based classes, namely in Zoom meetings (Castelli and Sarvary, 2021; Lin and Gao, 2020), by their unwillingness to turn on their video cameras or microphones, by faking their digital presence with the use of static photos and by dozing off during classes, among others. For the most reasonable and unreasonable motives, zoom meetings have turned into graveyards of unwilling and reluctant participators, raising severe obstacles to educational communication, active learning, and cooperation. Downsizing the expected resemblance to face-to-face classes, videoconferencing systems alone have often eliminated the possibility of teachers to build on students' body language to detect and reengage unmotivated or at-risk students, to recapture their focus, and to adjust class rhythm. Moreover, with large groups of students, these systems do not allow the teacher to visualize the entire grid of students' videos on a single screen.

In this paper, we focus on using an audience response system (ARS) as a strategy to overcome these barriers and evaluate its impact. ARS have been widely used in face-to-face settings as tools to promote large audiences' engagement during presentations and classes. We use ARS in videoconferencing-based classes together with active problem-based learning strategies to foster and monitor student verbal and non-verbal engagement while providing immediate feedback in large online classrooms to enhance both students' cognitive activities and social presence

2. Background

2.1. Student participation in video conferencing classes

Although videoconferencing systems have proven to be, in some cases, the best choice of resemblance to face-to-face learning, they have also caused unexpected downfalls. Wiederhold (2020) refers that humans use a range of precisely timed vocalizations, gestures, and movements to communicate. They rely on precise responses from others to determine if they are being understood. Videoconferencing systems can compromise this human synchrony with technological barriers because even with milliseconds' delays, subconsciously, our brain still registers the need to work harder to restore synchrony.

The authors also highlight that face-to-face communication is not actually just face-to-face. Humans read nonverbal hints to understand what other people have to say, and this is also compromised when the videoconferences frame only a person's face. Finally, it can be unsettling to have another person's enlarged face in our space. This prolonged appearance and eye contact can register as intimidating and increase stress hormones, which may be particularly unsettling for shy students.

On the other hand, lower than desired camera use by instructors and students is reported to diminish the educational experience (Castelli and Sarvary, 2021; McBrien, Cheng, and Jones, 2009). Moreover, Jeffery and Bauer (2020) state that students lost rich networks of peer communication that were detrimental to understanding and motivation to engage and persist. This study also highlighted the significance of limitations in cognitive processing, social dynamics, peer interaction, real-time discourse, and hands-on manipulation in any educational environment.

Castelli and Sarvary (2021) refer that some of the reasons why students do not turn on their cameras relate to concerns about personal appearance, concerns about other people and the physical location being seen in the background and having a weak internet connection

The very same reasons that Wiederhold (2020) refers to as having the potential to create stress in videoconferencing are the ones that several other authors refer to as beneficial to teaching and learning, namely concerning nonverbal cues. Eisenberg, Monge, and Miller (1983) refer that nonverbal responsiveness helps teachers to be more effective by detecting students' head nods, looks of confusion, boredom, smiles, frowns, etc., while students benefit from seeing their peers in collaborative activities. The use of video also promotes a more positive affective experience, fostering a warmer, closer, more comfortable and trustworthy teacher-student interpersonal relationship (Mottet, 2000), and this contributes to building stronger relationships that help reducing the loneliness that may result from remote learning and social distancing (Tsai, Tsai, Wang, Chang, and Chu, 2010). Both students and teachers demonstrate displeasure with the lack of video conferencing, referring to a general feeling of talking to self or talking to a void (Castelli and Sarvary, 2021; O'Conaill, Whittaker, and Wilbur, 1993).

Considering each student's personal settings and preferences, the trade-offs of turning on the camera in synchronous remote education may be higher or lower, enabling or incapacitating; thus, the necessary flexibility and inclusiveness must rely on the pedagogical strategies and tools to accommodate the diversity of needs. However, when implementing synchronous online learning, it is not enough to have tools that support student interaction but also tools for the teacher to support awareness of the learning environment, especially with large groups (Olsen Jennifer, Faucon, and Dillenbourg, 2020).

2.2. Active learning and audience response systems

Classroom response systems have been used to measure student understanding by having students answer conceptual questions throughout the lesson and to provide feedback in real-time. These systems enable students to enhance their interactions and engagement in the classroom, positively impacting student learning (Kay and LeSage, 2009; Olsen Jennifer et al., 2020; Wessels, Fries, Horz, Scheele, and Effelsberg, 2007), since they make student data more visible to participants by aggregating the students' answers. Engaging with large classes of students in synchronous videoconferencing requires learning strategies and tools to support real-time interactions that address the issues of social presence and awareness of students, in such a way that facilitates inclusiveness while fostering active learning.

Active learning refers to teaching methodologies that allow learners, through analysis, synthesis and evaluation, to participate in learning and teaching activities, to take responsibility for their own learning, and to establish links between ideas (Gogus, 2012). It is sometimes referred to as the Socratic Method, which consists in the introduction of a problem and directs the conversation back to critical points, to allow students to find the answers to the problems, while avoiding lecturing and promoting teacher-student and student-student engagement (Ellerman, Denning, and Hanna, 2001). It consists of a constructivist view of learning in which learners

mediate and control learning by participating in meaningful social interactions with other students and teachers; thus, it is student-centred. The role of the teacher is to promote collaboration, interaction, reflection, experimentation, interpretation, and construction (Gogus, 2012).

Audience response systems (ARS) have become very popular in education, particularly in face-to-face instruction, to enhance interaction with audiences. In education, ARS have been used to engage students who are shy and reluctant to take the risk of public failure, and this is more visible in female students who fear they might appear to dominate the discussions (Fies, 2005; Graham, Tripp, Seawright, and Joeckel, 2007). Specifically referring to shyness, Beekes (2006) states that, in general, most students are not prone to instantaneously respond to questions fearing failing to provide the correct answer. These are the "reluctant participators".

Graham et al. (2007) analysed the impact of the use of ARS in face-to-face learning. They concluded that students valued the opportunity for everyone to participate in the class and the possibility to participate anonymously. The authors also reported increased attention in class, increased motivation, and the added value of the immediate feedback, which helped students to evaluate their knowledge and performance. The value-added of mutual awareness – what/how others answer the same questions – was also pointed out as a positive outcome.

Wood and Shirazi (2020) analysed twenty studies concerning the use of ARS in large group teaching in higher education settings, focusing on the student experience. They precisely identified these related issues: engagement, interaction, anonymity, questioning, and instant feedback. The authors state that engagement is often associated with a sense of fun, generating a more positive environment in which students are more willing to participate and feeling more attentive. When used at the beginning of the class, the ARS can create anticipation and eagerness about a topic. When used punctually, it can re-focus student attention. It also emphasizes the teacher's importance in explaining and exploring the answers given by the students, as a means of feedback, particularly for incorrect answers, thus promoting deep active learning.

Interaction is increased with the use of ARS through student-student communication in the construction of knowledge, making learning feel more cooperative as students help each other by evaluating each other's reasoning and signalling each other's mistakes. Anonymity also arises as a key issue, encouraging participation while alleviating anxiety, fear of criticism and ridicule. The authors highlight the increased voice given to shy students and the inclusive and integration in the learning community.

Regarding questioning, students tend to appreciate open-ended questions or questions with several partially correct answers, as these tend to lead to verbal discussions. The students also view questioning as a valuable asset in determining the relevance of key questions and topics that may later be included in quizzes or exams. This places an emphasis on the teachers' pedagogical skills to create higher-order questions, which are demanding enough to generate discussion. Finally, the instant feedback allows students to self-assess and self-monitor their level of understanding and performance, comparing themselves to the class, as they are provided with their peers' collated responses.

2.3. Most used audience response systems

There is a great diversity of available web-based ARS, that do not require specific hardware. It is not our intention to depict the full range, as their adoption varies geographically, and the literature concerning its local adoption is scarce. To the best of our knowledge, the most used ARS in western Europe is Kahoot, Socrative, Mentimeter and Wooclap. Kahoot is a game-based student response system in which participants earn points by answering time-limited questions. It was introduced as multiple question system only, and, since 2019, the range of question types was expanded to include true or false questions, ordering, short free text, long free text, word clouds, as well as slides. Its roadmap of developments has been towards an approximation to other ARS such as Mentimeter and Socrative, and, as of 2020, Kahoot integrates with Microsoft Teams.

Mentimeter is a Swedish interactive presentation software, also aimed at audiences' real-time voting. It is specifically designed for corporate presentations and meetings, also being used in education. It allows to prepare a complete slide-based presentation with a question-based layer of interaction. The range of question types includes multiple-choice, word cloud, open-ended, scales, ranking, pin on image and grid. Some of the question types are specifically designed to address game-based presentation and stimulate competition.

Socrative and Wooclap are, among the most robust ARS, the ones designed specifically for education. Socrative is a cloud-based formative assessment management solution aimed at tracking student progress and classroom engagement. It includes public or private virtual rooms, interactive quizzes, attendance tracking, access control, and customizable reporting. The software allows users to design quizzes with multiple-choice, true or false, or short answer questions. Teachers can build personalized assessment libraries specific to their classes as well as tag, sort, search, and share quizzes.

Wooclap is a French ARS specifically designed for higher education; it has won the Innovative Start up Award in 2018 and is the most comprehensive of these systems. It is based on events, instead of presentations, and it offers 16 types of interactions: multiple-choice, poll, find on image, rating, open question, word cloud, find a number, matching, prioritization, sorting, fill in the blanks, brainstorming, script concordance test, SCT judgment, and slide and video. The system's philosophy is to design events of interactions, which can revolve more or less around content. Each event can consist of a sequence of interactions or a sequence of interactions and content (slides, videos, etc.).

One of the key aspects of this system is the emphasis on the instructional designer's role as a designer of interactions within the classroom, determining routes of attitudes, the phasing of discussions, and the capitalization of students' input. Unlike in Socrative, grading issues are made irrelevant. However, monitoring and reporting is much more robust both for teachers and students. At the end of each event, students can receive a detailed report of all their answers to close-ended questions, marked as correct/incorrect, together with a complete description of all the open-ended answers given by their peers. If slides are used in events, these are also included in the reports, reducing the need to take notes in class and making more time available for discussions.

The system also incorporates an "I'm confused" button, which students can press (anonymously) during classes to signal that additional explanations are needed during discussions; and a message wall, in which they can share their thoughts in writing at any moment. Wooclap also has an anonymous mode, a competition mode and integrates with LMS (e.g., Moodle).

3. Pedagogical underpinnings for the use of ARS in a large class

A case study was built around using the ARS Wooclap in a large group of higher education students attending a Business Ethics (BE) class. Due to confinement measures, classes were held in videoconferencing with Zoom, and, on average, 115 students participated in each class. As stated by Gokhale (2012, p. 634), "as group size increases, the likelihood of having someone in the group who can satisfactorily complete a challenging task increases". BE is traditionally seen as a predominantly theoretical subject; thus, capturing and maintaining student engagement is seen as an additional challenge for the teacher. Students are usually also less motivated to engage in theoretical topics. The class schedule consisted of one synchronous session of one hour and a half per week, from October 2020 to January 2021 (winter semester).

The curriculum was composed of four key moments: introduction to BE (unethical behaviours in organizations and human nature), unstructured ethical decision making, structured ethical decision making, and blind peer review of ethical reasoning. Wooclap was used in the first three moments (about 70% of the classes) to create lesson plans composed of sequences of interactions only or sequences of interactions alternated with content.

Wooclap events were used for scripting quasi-participatory learning interactions that were entirely dependent on the students' willingness to engage in verbal and non-verbal questioning, dialogue, reflection and discussion. According to Kollar, Fischer, and Hesse (2006), there are two broad types of scripts: macro-scripts and micro-scripts. Macro-scripts are used to create situations in which the desired interactions occur by describing groups, roles, and phases, while the emphasis of micro-scripts relies on the communication process in which students must engage and on their individual activities. The goal is to enhance the likelihood of interaction and its educational value based on higher-order thinking skills (Gokhale, 2012). This is consistent with the definition of critical thinking that "involves asking appropriate questions, gathering and creatively sorting through relevant information, relating new information to existing knowledge, re-examining beliefs, reasoning logically, and drawing reliable and trustworthy conclusions" (Gokhale, 2012, p. 634). Scripting in Wooclap consisted essentially of micro-scripting, allowing to structure interaction moments and to implement them. In the next sections, we present three examples of micro-scripts using ARS.

3.1. Introducing short key concepts

The example depicted in Figure 1 is composed of two main discussion moments, the second building on the first. A 25-second video was used to present a well-known ethical dilemma (The Trolley Problem), and students were asked how they would solve the problem before presenting a poll with two options. After the verbal discussion is generated, the poll is presented, and students are asked to compromise with a given solution (in Figure 1 it is possible to observe that most students chose option 1) while discussion is still ongoing. When discussion begins to fade, the answers are shown to all students, providing the overall picture and self-evaluation. Answers are not marked correct or incorrect.

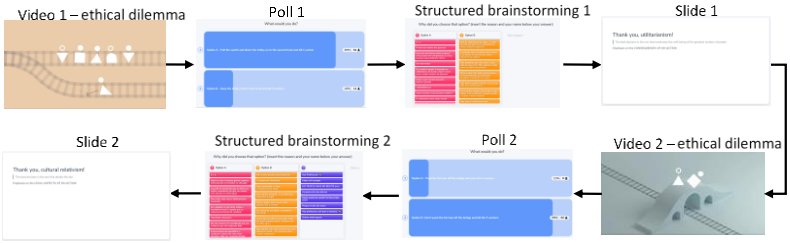

Figure 1 - Example of ARS micro-script: discussion of introductory concepts

In the following stage, students are asked to register their arguments in writing, in a structured brainstorming question (SBQ) with three categories – reasonings for option 1, for option 2, and reasonings for a possible third solution that was not included in the poll. This allows students who actively engaged in discussions to summarize their reasonings and shy or reluctant students to contribute to the debate anonymously. If new reasonings are found at this stage, the verbal discussion is recaptured, and sometimes reluctant participators feel propelled to engage verbally to explain their undiscussed points of view. A slide with a small amount of content is then used to introduce an ethical theory that summarizes and explains why most students have chosen option 1 (utilitarianism). This provides feedback, validates reasonings, self-assessment and links the discussions back to theory. It is done briefly. The script of interactions is then repeated, resuming with a 19-second video in which the circumstances of the video 1 dilemma are slightly changed. As observed in Figure 1, the students' proposed solutions and discussions shift to option 2, culminating with the introduction of the second ethical theory (cultural relativism). It is also possible to observe that, once the rhythm has been established, the students feel more comfortable interacting. The Wooclap screen from "Structured brainstorming 2" now displays a full range of interactions in the third column, but these are not related to educational content. It is a full set of social communications registered spontaneously by students, with jokes, farewell messages, and demonstrations of affection. The activity is closed with a full email report of all interactions sent to students by Wooclap.

We believe that the written interactions require students to reflect and pay attention to discussions, while decreasing the probability of disengaging from class.

3.2. Discussing a specific problem

In this example (Figure 2), the script also begins with presenting a dilemma/problem (slide) with two proposed possible solutions, but structured brainstorming is implemented before polling.

Figure 2 - Example of ARS micro-script: discussion of a specific problem

The emphasis first relies on discussing the positive and negative consequences of each proposed solution and gives room for other possible solutions to emerge. Like in the previous example, discussions are held verbally and registered in an SBQ. This stage is followed by a poll that creates awareness about the class's most common decisions. This stage creates a natural setting for the students who chose the most voted option to feel encouraged and for the remaining students to either reaffirm their arguments/convictions regarding the lest voted option(s) or to change sides completely. During this sage, any misconceptions about the presented problem (lack of understanding) also become apparent in discussions, which allows for clarification by the teacher. As some decisions may change throughout this process, the activity closes with students registering their final option and reasoning in an open question. The student's inputs to open questions can be displayed anonymously (Figure 2), not anonymously (in grid view) and in a word cloud, dynamically during class.

3.3. Covering a wide range of theoretical issues

Theoretical courses usually required dense readings and/or long content-centred lectures, which are not compatible with videoconferencing classes. The risk of student disengagement is too high, to begin with. ARS systems can be used to provide an overview of key issues contained in textbooks, creating familiarization and opening discussion around complex issues. This also facilitates the students' subsequent autonomous reading work.

Figure 3 - Example of ARS micro-script: covering a wide range of theoretical topics

In this case, game-based learning is used to measure pre-existing knowledge about a chapter of the course textbook, using a pre-test quiz focused on key issues/concepts. The questions are presented in the same order of issues in the textbook. Some questions (less than 30%) are followed by a slide with additional information or additional examples. Before presenting the solution to each question, students verbally justify their answers and discuss different points of view. We observed that during this stage, students began to open textbooks to look for the answers to questions to get higher scores. This was considered a positive side effect. Although close-ended, the questions are complex and prone to discussion, for example, “How does the text define ethics?”, “How has the theoretical debate over ethics and organizational performance changed in recent years?”, “Nalia is a millennial entering the workforce for the first time after college. If she is in the statistical majority, what will be the most important factor for her in choosing a company to work for?". Game-based learning is used to combat the common resistance to theoretical but needed discussions. After discussing each question, the podium of top players is displayed to the group and some room for social interactions is provided to students. In large classes, we found more useful to display the top 20 participants instead of the usual top 3. Students are motivated by seeing their names on the podium, and in a group of 115 students, too many would be left out.

Other scripts can be used to retain students' attention and engagement with theoretical issues. We also used the sequence: video with problem → poll with two possible solutions → poll with 16 possible reasonings gathered in literature → 20-minute theoretical exposition with slides → open question. In this case, the second poll results were not shown to students, and they were asked to memorize their response, find the corresponding theoretical framing during the theoretical exposition, and then discuss it and register it in the open question stage. This allows to capture and retain student attention directing it at a final compensation.

In the next section, we present the students' evaluation and perception of the use of the ARS in videoconferencing classes during confinement.

4. Methods and procedures

A survey was administered to Corporate Communications higher education students attending Business Ethics (BE) classes to evaluate the effectiveness and value-added of the ARS in the above-mentioned context. Students were asked about their general motivation during the winter semester of the 20-21 (during most of which they were in confinement) and how frequently they turned on their camera and microphone during the videoconferencing classes. Students were then provided with sixteen items related to the use of Wooclap during videoconferencing classes. Items were organized into three main dimensions: participation and involvement, learning experience, and socialization and motivation. Each item was presented in a labelled 5-point Likert scale anchored at 1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly agree. Higher scores represent a higher level of agreement.

5. Results and discussion

Overall, 72 valid answers were obtained (63% of the students), 41,4% male (n=30) and 58,3% female (n=42), mostly aged between 19 and 21 years old, as depicted in Table 1. Female students are, on average, four years younger than male students ($t(70)= -3,133$; $p<0,05$).

Table 1 - Sample demographics

		Gender			
		Female		Male	
		Count	N %	Count	N %
Age Group	19-21	33	78,57%	13	43,33%
	22-30	7	16,67%	10	33,33%
	>30	2	4,76%	7	23,33%
	Total	42	100,00%	30	100,00%

Concerning the overall motivation for classes during the winter semester, students felt moderately motivated ($\bar{x}$ = 3,29; min = 1; max = 5), with no significant gender differences. Regarding the use of the webcam and microphone during BE classes, students tend to turn on both "Sometimes", but the webcam is more used ($\bar{x}$ = 3,42; min = 1; max = 5; *Mo* = 3), than the microphone ($\bar{x}$ = 2,86; min = 1; max = 5; *Mo* = 2). This validates the previously explained pedagogical logic of fomenting written and verbal contributions to discussions simultaneously in de ARS, as verbal participation is not frequent for all students. However, regarding the students' perception of their own role in classes, the great majority strongly agrees that the success of classes depends on the active participation of all students ($\bar{x}$ = 4,36; min = 1; max = 5; *Mo* = 5), with no significant differences among genders.

Table 2 depicts the descriptive statistics of the sixteen items used to evaluate the pedagogical value of Wooclap. The items worded negatively were reverse coded, and results show Cronbach's $\alpha = 0.85$, indicating acceptably high internal consistency,

≥ 0.70 is considered the minimum acceptable for use in research (George and Mallery, 2003; Nunnally, 1994).

Table 2 - Pedagogical evaluation of Wooclap

		$\bar{x}$	Mo	σ	Min	Max
Participation and involvement	Wooclap allowed me to actively participate in classes	4,74	5	0,56	2	5
	Without Wooclap, I would have participated less than I did	4,43	5	0,90	1	5
	Wooclap promotes disinhibition in participation	4,53	5	0,73	1	5
	Wooclap enabled me to be more involved in class	4,72	5	0,61	1	5
Learning experience	Wooclap offered me a more positive learning experience	4,79	5	0,47	3	5
	I feel I learned better because we used Wooclap	4,43	5	0,73	2	5
	Wooclap allowed me to compare my answers and check my knowledge	4,15	4	0,90	1	5
	I find it useful to have a system that aggregates and shows the answers of colleagues in real-time	4,63	5	0,57	3	5
	The use of Wooclap made me more attentive in class	4,63	5	0,68	2	5
	In Wooclap, the focus is on the students and not the content	3,72	4	1,00	1	5
Socialization and motivation	Wooclap promoted a participative general atmosphere	4,82	5	0,45	3	5
	Wooclap promoted an interactive general atmosphere	4,85	5	0,36	4	5
	Wooclap promoted an overall fun atmosphere	4,78	5	0,48	3	5
	Wooclap enabled me to socialize better with the class	4,15	5	0,90	2	5
	Wooclap has increased my motivation for online classes in this class	4,33	5	0,90	2	5
	With Wooclap, I feel too monitored	1,65	1	1,01	1	5
Other	It should be used in other classes	4,67	5	0,61	3	5
	Wooclap should be used in face-to-face classes	4,26	5	1,02	1	5
	I found Wooclap easy to use	4,83	5	0,56	1	5

As it is possible to observe, the overall evaluation of the use of ARS is very positive for all items. Students report very high levels of agreement regarding the potential of Wooclap, with the aforesaid typology of micro-scripts. Students state that without the use of the ARS they would have participated less in videoconferencing classes, that they felt less inhibited and more involved, which is also expressed by Graham et al. (2007); Wood and Shirazi (2020). There are no significant gender

differences in this domain, except for the item "Wooclap enabled me to be more involved in class", in which the level of agreement is higher for female students (t (70) = 3,191; p<0,05).

Regarding the learning experience, students strongly agree that the ARS contributed to a more positive learning experience, with increased levels of attention and the feeling of learning better. This is particularly relevant in this context because, as stated by several authors, lower camera usage tends to diminished the educational experience (Castelli and Sarvary, 2021; McBrien et al., 2009), and the use of ARS, in this case, has served to counterbalance the low reported usage of webcams.

The self-evaluation and awareness of the class performance were also much appreciated by the ability to compare own responses to the aggregation of answers given by peers. This is referred to by Olsen Jennifer et al. (2020) as a process that supports awareness among students, and that is linked to increased motivation. The lower level of agreement in this dimension, but still high, is expressed towards the idea of the focus being the students and not the content ($\bar{x}$ = 3,72) and is mostly expressed by male students (t (70) = -3,741; p<0,05).

Socialization and motivation were also significantly improved by using the ARS. This is a fundamental aspect of the learning environments during the COVID-19 confinement because there is a natural tendency for students to feel particularly isolated and lonely (Tsai et al., 2010). The results show that, as sated by Mottet (2000), the use of ARS tends to favour positive affective experiences, and strengthen interpersonal relationships based on interactivity and cooperation.

Students highly agree that the general atmosphere was more participative, interactive, and fun. They also agree to an increase in motivation and socialization. We felt that it was important to ask students if they felt excessively monitored during classes when using the ARS since the number of written interactions was constantly being batched against the number to attendees (as a measure of control by the teacher). This could have led to students feeling overly monitored and forced to participate in writing, which does not seem to be the case ($\bar{x}$ = 1,65).

Students also highly agree that Wooclap is easy to use, that it should be used in other courses and in face-to-face classes, which is, in fact, the context in which ARS have mostly been used (Wood and Shirazi, 2020).

6. Conclusion

Due to the global confinement, the sudden move to remote instruction posed additional challenges to instructors and students, both at the technological, pedagogical, and social levels. These challenges have caused great struggles but have also opened room for the development of creative solutions that not only minimize existing problems but have the potential to benefit education in the long term.

In this paper, we have presented a successful integration of an ARS in videoconferencing large classrooms. These systems are not new in the educational field but have been mainly used in face-to-face instruction; thus, our work contributes to the emergent literature of pedagogical strategies and solutions to cope with emergency remote instruction. We have presented concrete examples of ARS micro-

scripts based on problem-solving to improve students' participation in the learning environment while combating reluctancy, shyness and disengagement from classes. Our results show that the use of ARS has excellent potential to improve the students' learning experience but also their socialization and motivation, ultimately contributing to a better disposition, wellbeing, and sense of accomplishment.

References

1. Beekes, W. (2006). The 'millionaire'method for encouraging participation. *Active Learning in Higher Education, 7*(1), 25-36.
2. Castelli, F. R., and Sarvary, M. A. (2021). Why students do not turn on their video cameras during online classes and an equitable and inclusive plan to encourage them to do so. *Ecology and Evolution*.
3. Correia, A.-P., Liu, C., and Xu, F. (2020). Evaluating videoconferencing systems for the quality of the educational experience. *Distance Education, 41*(4), 429-452. doi:10.1080/01587919.2020.1821607
4. Eisenberg, E., Monge, P., and Miller, K. (1983). Involvement in communication networks as a predictor of organizational commitment. *Human Communication Research, 10*(2), 179-201.
5. Ellerman, D., Denning, S., and Hanna, N. (2001). Active learning and development assistance. *Journal of Knowledge Management*.
6. Fies, C. H. (2005). *Classroom response systems: what do they add to an active learning environment?*
7. George, D., and Mallery, M. (2003). Using SPSS for Windows step by step: a simple guide and reference.
8. Gogus, A. (2012). Active Learning. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 77-80). Boston, MA: Springer US.
9. Gokhale, A. A. (2012). Collaborative Learning and Critical Thinking. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 634-636). Boston, MA: Springer US.
10. Graham, C. R., Tripp, T. R., Seawright, L., and Joeckel, G. (2007). Empowering or compelling reluctant participators using audience response systems. *Active Learning in Higher Education, 8*(3), 233-258.
11. Jeffery, K. A., and Bauer, C. F. (2020). Students' Responses to Emergency Remote Online Teaching Reveal Critical Factors for All Teaching. *Journal of Chemical Education, 97*(9), 2472-2485. doi:10.1021/acs.jchemed.0c00736
12. Kay, R. H., and LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: A review of the literature. *Computers and Education, 53*(3), 819-827. doi:https://doi.org/10.1016/j.compedu.2009.05.001
13. Kollar, I., Fischer, F., and Hesse, F. W. (2006). Collaboration scripts–a conceptual analysis. *Educational Psychology Review, 18*(2), 159-185.

14. Lin, X., and Gao, L. (2020). Students' sense of community and perspectives of taking synchronous and asynchronous online courses. *Asian Journal of Distance Education, 15*(1), 169-179.
15. McBrien, J. L., Cheng, R., and Jones, P. (2009). Virtual spaces: Employing a synchronous online classroom to facilitate student engagement in online learning. *International review of research in open and distributed learning, 10*(3).
16. Mottet, T. P. (2000). Interactive television instructors' perceptions of students' nonverbal responsiveness and their influence on distance teaching. *Communication Education, 49*(2), 146-164.
17. Nunnally, J. C. (1994). *Psychometric theory 3E*: Tata McGraw-Hill Education.
18. O'Conaill, B., Whittaker, S., and Wilbur, S. (1993). Conversations over video conferences: An evaluation of the spoken aspects of video-mediated communication. *Human-computer interaction, 8*(4), 389-428.
19. Olsen Jennifer, K., Faucon, L., and Dillenbourg, P. (2020). Transferring interactive activities in large lectures from face-to-face to online settings. *Information and Learning Sciences, 121*(7/8), 559-567. doi:10.1108/ILS-04-2020-0109
20. Tsai, H.-H., Tsai, Y.-F., Wang, H.-H., Chang, Y.-C., and Chu, H. H. (2010). Videoconference program enhances social support, loneliness, and depressive status of elderly nursing home residents. *Aging and Mental Health, 14*(8), 947-954.
21. Wessels, A., Fries, S., Horz, H., Scheele, N., and Effelsberg, W. (2007). Interactive lectures: Effective teaching and learning in lectures using wireless networks. *Computers in Human Behavior, 23*(5), 2524-2537. doi:https://doi.org/10.1016/j.chb.2006.05.001
22. Wiederhold, B. K. (2020). Connecting through technology during the coronavirus disease 2019 pandemic: Avoiding "Zoom Fatigue": Mary Ann Liebert, Inc., publishers 140 Huguenot Street, 3rd Floor New ….
23. Wood, R., and Shirazi, S. (2020). A systematic review of audience response systems for teaching and learning in higher education: The student experience. *Computers and Education, 153*, 103896. doi:https://doi.org/10.1016/j.compedu.2020.103896