Fostering Privacy Literacy among High School Students by Leveraging Social Media Interaction and Learning Traces in the Classroom

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ABSTRACT

With daily social media consumption among teens exceeding eight hours, it becomes increasingly important to raise awareness about the digital traces they leave behind. However, concepts of privacy literacy such as data and metadata can seem abstract and difficult to grasp. In this short research paper, we tackle this issue by designing, implementing and presenting an evaluation of a novel technology-enhanced pedagogical scenario for high school students. The scenario covers two main sessions. In a first session the SpeakUp social-media-like classroom interaction app is used to support a digitally mediated debate. In the second session, the actual learning traces from the digitally mediated debate are used as an object of study to enable students to reflect on the traces they leave behind on social media platforms. In order to enable this scenario we extended the existing SpeakUp app to the specifics of the context. The scenario was implemented and evaluated in real classrooms during a semester-long course on digital skills with 45 high school students. Our results show that the learning scenario is appreciated by students and even though non-STEM students might require more onboarding to be fully engaged in the digitally mediated debate, students from both STEM and non-STEM classes learn effectively. We discuss shortcomings and future research avenues.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; • **Social and professional topics** → **K-12 education**; Privacy policies.

KEYWORDS

classroom interaction app, SpeakUp, learning traces, metadata, social media, privacy literacy

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1 INTRODUCTION

The increasing use of social media among teenagers raises a number of concerns, from being a cause of distraction to possibly having a negative impact on school performances [16], being a source of cyberbullying [1, 12], spreading of fake news, radicalization of ideas, conspiracy theories, gender and racial discrimination. Teenagers are particularly exposed to these side effects due to their heavy usage of social media combined with their lack of awareness [37, 38]. In response, educational programs have started to integrate digital skills and privacy literacy programs into high school curricula to address this issue. However, devising engaging learning activities on topics such as privacy and metadata can be challenging, and even though some synergies have been created between universities and schools to develop and deploy learning tools to empower learners with a basic understanding of privacy [4], there is still little research on pedagogical scenarios aimed at teaching about online privacy to children and high school students [2]. Furthermore, as data and privacy literacy becomes a cross-cutting skill that should not be taught only to computer science or STEM (science, technology, engineering and mathematics) majors, research on how to reach these populations is increasing but still scarce [14]. In certain countries, such as Switzerland, where this research is conducted, students choose their majors as early as the 7th grade (12–13 years old). As such, these different disciplinary backgrounds are already present by the time students reach high school.

Incidentally, one potential avenue for teaching about social media related issues is to build active learning interventions using social media tools themselves both for their ability to support classroom engagement and for the digital traces they generate during such classroom engagement. As tools for supporting active classroom engagement, social media is widely recognized for playing an increasingly predominant role [32]. As tools to increase privacy literacy, social media provides promising opportunities for learning as it allow learners to be confronted with their own traces and learn from first-hand experience. However, it is not yet widely used. Indeed, whereas many interesting digital learning resources simulate social media traces in interactive and playful ways, social media solutions themselves are rarely directly used. One of the limitations is that mainstream social media solutions do not offer a controlled environments for learning [1, 7]. This is particularly problematic for teaching younger students and also explains why even as tools for supporting active learning, social media tools have been much less investigated below the college level [7]. Whereas many mainstream learning platforms, such as Moodle, offer the possibility to download learning traces, one additional limitation of the mainstream social media platform is the fact that much of the

activity traces are not easily downloadable by users. For instance, at the time of writing, in the Instagram activity data dump, users see that they liked or commented on another user's post at a certain time, but they do not know which post. They also do not see if their own posts were liked or commented on. Even platforms such as Reddit, which lets users access posts and comments through an open API, does not provide this type of detailed information.

In this paper we address this issue by taking a design science research methodology approach [33]. That is, after identifying the problem, we design a socio-technical artifact to address the issue and we then evaluate it. This methodology can be applied in successive incremental iterations. Here, we provide a first preliminary evaluation of the artifact that can be complemented in subsequent iterations. More specifically, this paper provides the following contributions. First, the socio-technical artifact that we design is a novel technology-enhanced active learning scenario aimed at improving privacy literacy among high school students. Second, the technical aspect of the artifact is an extension of the existing SpeakUp social-media-like classroom interaction app designed to support active learning scenarios at the university level [17, 18, 35] to fit the needs of the high school environment and to support the learning scenario. In particular, it provides the possibility for instructors (1) to avoid off-topic messages by adding the facility to moderate messages and (2) to download and inspect the learning traces of the tool in a user-friendly way. Third, we evaluate the scenario in a real classroom during a semester-long digital skills course with 45 students.

2 RELATED WORK

Here, we detail how previous work has contributed to the topic of social media tools used as a type of collaborative learning solution for active learning and privacy literacy education.

2.1 Active learning with social media

Social media is part of the culture of the younger generation, whose familiarity with these platforms facilitates their deployment in pedagogical contexts [20]. Social media provides an alternative to the traditional lecture format, mainly in terms of forums and chat rooms, enabling synchronous and asynchronous communication and stimulating students' learning process through collaborative forms of inquiry and collaborative problem-solving [6]. Social media tools are used to create virtual communities equipped with wikis, links to internet resources and discussion boards, which foster constructivism and observational learning [29], and facilitates student interaction [35], debate [28] and the sharing of resources within a group. Social media tools are also reported to support in-depth thinking, facilitating learning and long-term retention [15]. Platforms such as Twitter, WhatsApp and Tumblr enable a particular type of interaction in the form of short-text blogs. Such tools enable one to share resources among learners in an easy and time-effective manner, communication between instructors and students is enhanced, especially with shy learners [10] and in large-lecture class settings [8], and feedback can be easily collected by instructors [25].

For instance, Twitter is largely employed for backchannel conversation and as a classroom response system like clickers [9]. WhatsApp is also used more and more in pedagogical scenarios because of its popularity, its simple operation, its easy availability, and because it is free [36]. Twitter and WhatsApp enable instructors to ask for feedback and to promote interaction in a timely and resource-effective manner, regardless of class size. However, these (and other) widespread social platforms can be sources of distractions [27], privacy issues [21] and cyberbullying [1]. Indeed, a recent study on 4500 K-12 students in Israel found that around a third reported of "personal victimization from cyberbullying in their WhatsApp classmate groups".

These reasons may have led to the development of other social media solutions specifically designed for pedagogical purposes (e.g., [11, 13, 22, 24, 26, 31]). One example is Twiducate, a Twitter variation for K-12 students [26], which offers an environment whose access is limited to the classroom by means of a code, which allows instructors to share documents with students and to ask them questions. Also, contents are encrypted which addresses privacy concerns about learners. Collboard [13] is a collaborative construction space in which seventh-grade pupils can write on an interactive whiteboard. Talk Factory [24] and Group Scribbles [11] are online tools to facilitate debates of primary and secondary schools. Flinga [22] also offers an interactive whiteboard, which can be used to foster debates with high school students. Talkwall [31], formerly known as Socius [34], is a platform where learners post messages, which can eventually be made visible to the entire classroom in a specific environment called "the wall".

2.2 Privacy literacy learning experiences

Research on how to teach students about the privacy concerns online is increasing [39]. Indeed, a recent systematic review of the general literature on cybersecurity awareness and education shows that there have been at least 119 studies from 2000 to 2019, with over half of them from 2014–1019. One example is the Teaching Privacy project, which works on solutions to empower high school students to make informed choices about their privacy whenever they use social media [37]. They provide a number of freely available educational tools as well as classroom-ready lesson modules and hands-on exercises.[1] For instance, they provide a series of educational videos, called Digital Footprints, which present actions that generate traces about personal data, and how to limit their exploitation by third parties. They also developed a few apps, such as "Ready or not?", which aims to raise awareness about the risks of being localized by means of GPS metadata associated with Twitter and Instagram posts. However, the use of actual social media platforms seems mostly absent from these interventions. A recent example of the use of social-media-like intervention is Social4School [5]. With Social4School, school children join a simulation of a social network in which they see predefined posts that they can share and/or like. The goal is to view a social graph in a controlled setting and to increase privacy awareness. The results have shown that their approach was effective.

As this example illustrates, there is a trade-off between giving students with rich real-life social media experiences and providing a safe and controlled environment adequate for learning. With potential ethical imperatives of providing a safe environment for

[1] www.teachingprivacy.org/teachers-portal

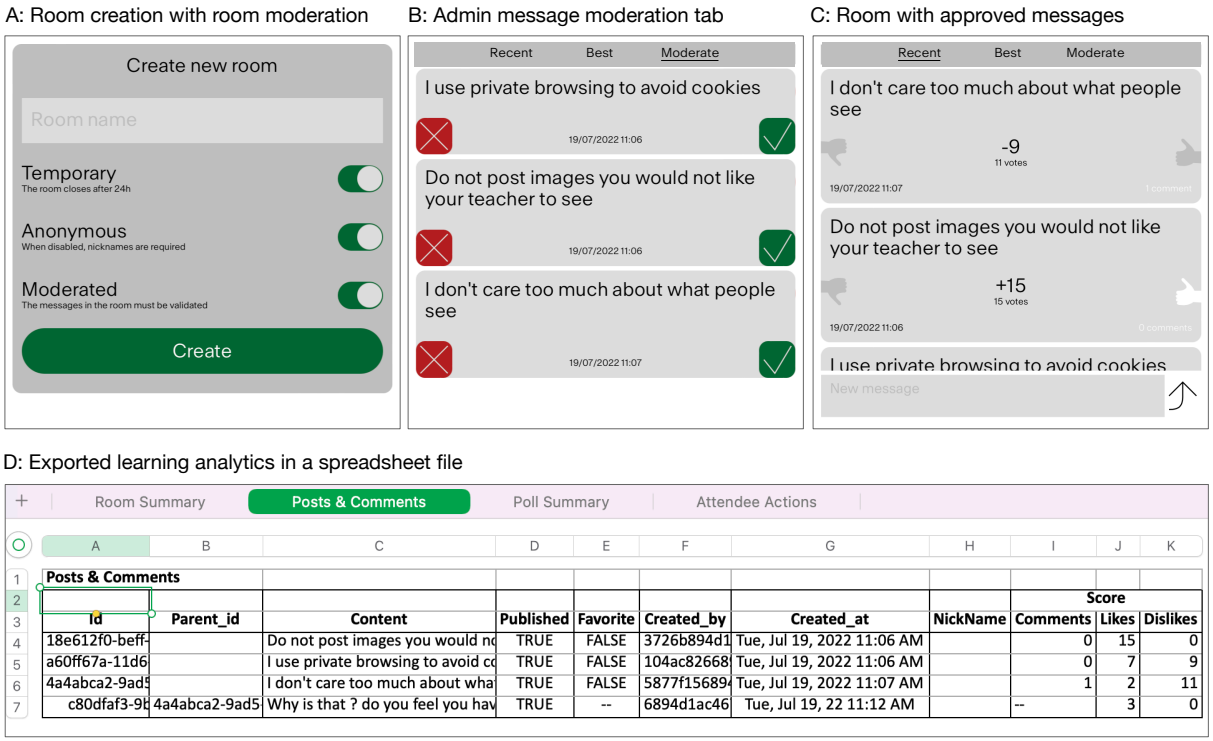

Figure 1: SpeakUp app interface

students, especially young ones, privacy literacy solutions have mostly avoided using actual social media usage traces to discuss privacy issues. Furthermore, existing social media platforms often fail to provide the required features to support the envisioned learning scenarios, which would require a combination of rich social-media-like interaction in a safe environment with the possibility of exporting learning traces.

3 THE SPEAKUP APP

To overcome the trade-off between rich real life social-media-like interaction on the one hand and a safe and inclusive digital space on the other hand, we designed an extension to an existing free open source social-media-like classroom interaction app called SpeakUp designed by group of Swiss universities (https://speakup.info [17, 18, 35]). Figure 1 illustrates its main features. The app allows instructors to create and administer rooms that can be thought of as classroom WhatsApp groups where students can post messages (anonymously or by providing a nickname). Furthermore, each message can also be voted up or down by the students, who can also add comments to each post. Moreover, instructors can add multiple choice questions into the shared room, to assess knowledge or gather opinions. In addition to these core functionalities, we extended the app with two novel functionalities for this particular scenario: message moderation and learning trace export.

First, we designed the possibility for instructors to create moderated rooms (see Figure 1.A), in which no message or comment is allowed to be displayed in the shared room until it is explicitly accepted by the instructor. When students post messages, they are at first only accessible to the instructor in the moderation tab (see Figure 1.B), where the instructor can accept or reject posts and comments. When the post is accepted, it is then visible to everyone in the shared room (see Figure 1.C).

Second, we extended the existing possibility of the app to download raw activity traces to design the possibility for instructors to extract rich learning traces of the interaction that occurs in their digital classrooms. To do so, we implemented an export feature accessible to room administrators to extract an .xlsx file containing the digital traces of the room (see Figure 1.D). These digital traces contain information about user actions, such as timestamps for each message or comment posted, alongside their content, the number of up and down votes, as well as the anonymous ID number of the user who posted the message and their nickname, if the room setting required one. As such, the traces give rich information on who posted what at what time and who voted on which post when.

4 THE LEARNING SCENARIO

The learning scenario presented here is part of a semester-long course on digital skills at the high school level. Here we present the learning scenario focused on privacy literacy, which covered two sessions of 90 minutes each.

The scenario has two main learning objectives. First, at the end of the sessions, students should be able to understand what metadata is. In particular, they should be able to discriminate between metadata and data. Second, at the end of the sessions, students should be able to evaluate how metadata can be exploited on social media. In particular, students should be able to understand that whenever they

Table 1: Learning activities of the core part of the learning scenario

Session	Duration (min)	Activity	Axis
1	60	Lecture on social media usage and privacy issues	T-K
	15	Digitally mediated debate	L-K
	15	Class discussion	T-L
2	45	Lecture on metadata and social media	T-K
	30	Trace inspection of the digitally mediated debate	L-K
	15	Class discussion	T-L

use social media services, metadata is created about their activities. Analyses of such metadata can then allow social media platforms to find patterns about user habits, and social relationships, which can be used to promote sponsored content.

Table 1 gives an overview of the learning activities in each session. Activities are classified in three categories, according to Houssaye's pedagogical triangle [19]. First, the teacher-knowledge (T-K) axis occurs when the teacher presents concepts, and students are in a listening posture. Second, the learner-knowledge (L-K) axis is when students are put into an activity to face learning concepts by themselves. Third, the teacher-learner (T-L) axis is when there is an interaction between teacher and learner to clarify tasks and to guide the learner's cognitive and metacognitive reasoning. As mentioned, the learning activity is divided into two distinct 90 minute sessions. The goal of the first session is to introduce students to social media usage and related privacy issues and to lead them to conduct a digitally mediated debate about it, using SpeakUp. The goal of the second session is to introduce the distinction between data and metadata on social media and then to inspect the traces left by the students themselves during the first session.

4.1 Session 1 – Digitally mediated debate

The first session starts with a lecture about social media usage and related privacy issues. The goal is to set the stage for the digitally mediated debate, which allows students to engage in an active learning activity. At the end of the lecture, students are instructed to log onto a computer in the classroom and access a specific shared digital room on SpeakUp. In this room, the instructor adds a set of questions about student usage of social media on the one hand (e.g., "Which social media platforms do you regularly use and what for?") and their opinion about social media issues on the other (e.g., "Give examples of concerns related to social media use?") . The instructor asks the students to reflect on the questions and provide answers in the form of comments. Students were free to post any comment they wanted (free text) in the shared chat room, where messages would be visible to all other students (as long as the instructor explicitly approved the comment). The instructor also asks students to read each other's comments and to vote on them to show their agreement or disagreement. The digital room used for the debate is set to be moderated. That is, before comments from students appear on the app for all to see, the instructor has to approve them in real time. Towards the end of the session, the instructor reviews students' contributions, and initiates a class discussion by picking one of the posts as a starting point and providing different perspectives if needed.

4.2 Session 2 – Inspecting traces left in the digitally mediated debate

The second session starts with a lecture and videos to present a theoretical introduction to the distinction between data and metadata. During this introduction, students are also instructed to identify all metadata associated with a text file and an image. Furthermore, the introduction also covers digital traces collected and exploited by social media platforms in general and messaging apps in particular. The theoretical introduction is followed by the central activity of this learning scenario, which is the inspection by the students of the actual digital traces they have themselves left during the digital debate in the first session. The activity starts with the instructor downloading the learning traces of the digital room used on SpeakUp. The instructor then shares this file with students. As shown in Figure 1, the file contains a detailed record of the data and metadata of the room (i.e. which comments have been posted at what time, by which user ID). The students are instructed to inspect the file on their own and answer a set of questions related to the learning outcomes. For instance, they have to correctly identify data and metadata on the extracted file. Furthermore, students are also expected to correctly answer questions about how some of these metadata could be exploited by social media platforms, both to know about user habits (metadata about message timestamp) and to foster user engagement (metadata about the number of likes). At the end of the activity, the instructor collects the answer sheets and initiates a classroom discussion by asking students to share their answers, and then clarifies potential remaining misconceptions.

5 RESULTS

The pedagogical scenario was implemented and evaluated in a real classroom setting with two high school classes in Switzerland (grade 10 in a K-12 education system). The students of the first class (N=23, 5 girls) followed a STEM curriculum with a focus on subjects such as math and physics. The students of the second class (N=21, 10 girls) followed a non-STEM curriculum with a focus on subjects such as business, law, philosophy and psychology. Each student had access to a computer. At the end of the semester, a student evaluation of teaching (SET) survey was conducted to gather overall feedback about the course as well as specific feedback on the user-experience of the privacy literacy sessions. In particular, usability questions (ease of use and usefulness) were asked with respect to SpeakUp.

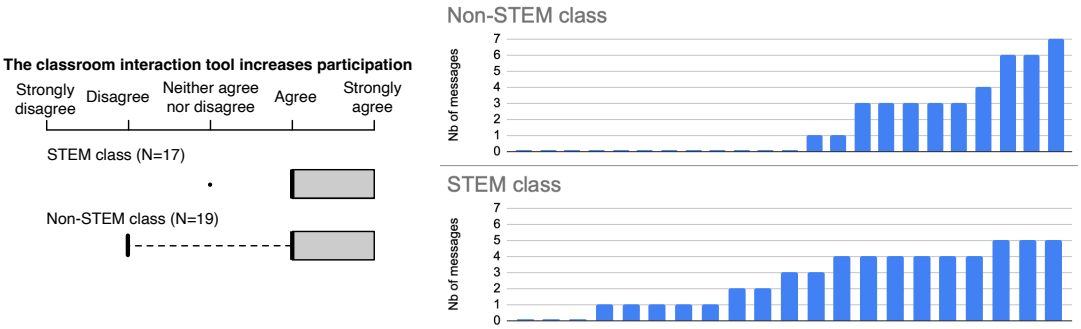

Figure 2: Left: student answers to the survey question on participation. Right: number of messages posted by each student

5.1 Digitally mediated debate engagement

During the digitally mediated debate, 99 comments were posted and 213 votes were cast. Messages were rather short, with an average number of 50 characters, ranging from 2 to 140. During the SET survey, we queried students about their engagement during the activity. In particular, we asked them how the classroom interaction app fostered participation. The results presented in Figure 2 show that around 90% of the students agree or strongly agree with the statement, with very similar results between the STEM and non-STEM classes. However, Figure 2 also shows the distribution of actual posts by students. The results show that not all students participated. While 18 out of the 21 (85.7%) STEM students wrote at least one comment, only 12 out of the 23 (55.2%) non-STEM student participated. A z-test showed that this difference (i.e., 55.2% for the non-STEM class vs 85.7% for the STEM class) is statistically significant ($z = -2.3859, p = .01684$).

5.2 Learning outcomes

Learning outcomes where measured using the test during the second session with the following questions: (1) Which columns contain data and which contain metadata (vs data)? (2) Which columns contain data that could also be accessed by WhatsApp administrators? (3) What kind of information about one's habits could be extrapolated from data contained in the column created_at? (4) How could the information about the number of "likes" for a given message, photo or video be used by social media companies to generate revenue? The learning outcome score was normalized on a scale from 0 (nothing is correct) to 1 (everything is correct) as illustrated in Figure 3. The pass level would be set to 0.6 if the test was actually graded. The results show that 80% of students reached the intended learning outcomes (9 students would have failed, 4 from the STEM class, 5 from the non-STEM class). The results also did not detect any significant difference in learning outcome between STEM and non-STEM students or between different genders.

5.3 Usability

Usability was measured using nine specific questions during the SET survey to ask about ease of use and usefulness of the class interaction app for specific in-class activities (e.g., digitally mediated debates, traces inspections). Students could answer on a five-point Likert scale. We aggregated the results into a normalized usability score from 0 (poor usability) to 1 (excellent usability) as illustrated in Figure 3. Results show that the usability of the classroom interaction app was overall very good to excellent. For instance, students widely agreed that it enabled them to better understand mechanisms of social media and metadata, therefore confirming that the tool is a valuable resource to learn about digital traces. Also, most students found the app easy to use and they would enjoy using it in other subjects as well. We did not detect any statistically significant difference between STEM and non-STEM students, or between genders.

6 DISCUSSION AND CONCLUSION

In this short paper, we presented a novel, technology-enhanced pedagogical scenario to foster privacy literacy designed for high school students. The main innovation of this scenario is to use actual social media traces left by the students themselves in order to create a first-hand experience as an active learning scenario. As most existing mainstream social media platforms, as well as custom classroom interaction apps, have shortcomings either in terms of controlled interactions (they do not prevent spam), analytics (they do not enable trace inspection) or user experience (they do not give a social-media-like feel), we designed a novel system. Specifically, we extended the existing SpeakUp app, which already provided a social-media-like experience with a simple learning trace export feature. We thus implemented a novel moderation feature to ensure controlled interaction and we improved its learning trace export feature to make it richer. This tool enabled us to design a two-session learning scenario. The first session used the app to support a digitally mediated debate. The second session then used the traces left by the students during the first session as material for studying data and metadata.

We conducted a preliminary evaluation of the learning scenario in an authentic classroom setting with two high school classes (a STEM class and a non-STEM class). Students reported that they found the classroom interaction app to be very helpful for understanding metadata, thanks to the possibility of seeing and analyzing traces of their own interaction. Our results show that the scenario was successful in achieving the learning objectives. The results did not show differences between STEM and non-STEM students, or between genders. Even though these results have inherent limitations due to the design of this preliminary evaluation (e.g., no pre- and post- measures or control group), we believe that these

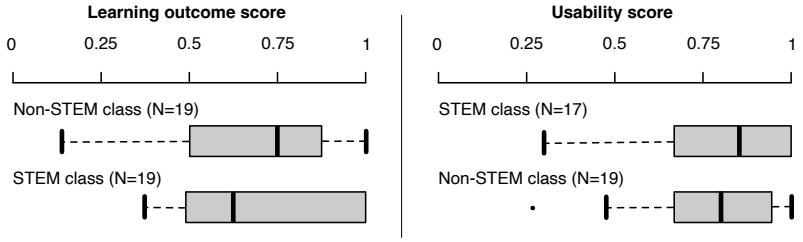

Figure 3: Learning outcome scores and usability scores. No statistical difference between STEM and Non-STEM classes

results provide an interesting contribution to the growing literature on privacy literacy education. In particular, they evaluate a novel approach to designing an active learning activity using actual social media traces as the object of study in an authentic setting with two medium size classes (N=44) with different disciplinary backgrounds. Future work is needed to confirm these results with larger samples and experimental design settings. Furthermore, future work could further refine the learning scenario to include goal-oriented learning trace inspections, such as along the lines of a detective game or a social graph design based on real data. This could extend the existing research that shows that artificial social graphs are stimulating for teaching privacy awareness [5], or that digital escape games can foster student engagement for teaching how to program [23].

The instructor who debriefed the students reported that they enjoyed posting comments and reacting to their classmates' messages, similarly to what they normally do with WhatsApp. They did not feel under pressure when taking the floor and were happy to use a chatting mode, which they were very familiar with. Students reported that they found that the classroom interaction app increased classroom interactions during the digitally mediated debate. Furthermore, students found that the system provided good to excellent usability, with no visible difference between STEM and non-STEM students. In terms of actual usage during the debate, the contributions of students who were engaged, i.e., who posted at least one message, were overall modest but adequate with an average of 3.3 messages and 7.1 votes over the 15 minute debate period. However, 15 students out of 45 did not post at all and a statistical difference was found between the STEM and the non-STEM classes. Indeed, in the non-STEM class just over half (12/23) did not post any messages compared to only 15% (3/21) in the STEM class. These students explained to the instructor, in the debriefing session, that they had not fully understood the instructions. These results add a disciplinary perspective on previous research that found that engagement in digital debates can also be influenced by the prior academic level of students [34]. These results convey the fact that instructors should ensure that all students understand the instructions and take extra steps to help less technical audiences understand how to participate. Indeed, while technology can promote inclusiveness in the classroom by removing barriers, it should be embedded in an inclusive pedagogical scenario to be fully effective. This is in line with previous research on dialogue-based learning experiences, where authors find positive outcomes but warn that "It is the pedagogy that is paramount, not the technology" [30, p.197]. Future work could further investigate how the learning scenario can be refined to foster a more inclusive environment. Potential avenues could entail the inclusion of traditional think-pair-share activity before the digital debate, where students would pair up to discuss potential answers before posting them. As it is difficult to spot students who do not participate by looking at the flow of messages on the app, a potential technical improvement to help with this issue could involve increasing usage awareness through dashboards to help instructors visualize active versus passive users.

Finally, the learning scenario was evaluated on students but its widespread usage requires that instructors adopt it first. Even though the design of the solution was informed by instructors, future work should investigate barriers to adoption among instructors and identify ideal contextual conditions to foster adoption of such pedagogical scenarios. This future work would build on previous research that established that facilitating conditions such as tutorials or pedagogical support from peers were a predictor of technological adoption in the classroom (e.g, [3]) and provide an adequate teacher onboarding plan that could move from a basic scenario with no student interaction to the full scenario.

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