Understanding the Student Experience Better: Analyzing Remote Learning Tools Through Engagement, Participation, and Liveness Concepts

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Abstract: Technologies have changed how students engage and participate during remote classes, whether by encouraging interaction via chat on platforms such as Google Meet or by using voting features such as Poll. Our research aims to better understand the role of these tools in the educational context and how their interactive features influence student experience through the lens of engagement, participation, and liveness. In this sense, we address the following question: *How can educational technologies be classified by the Engagement, Participation, and Liveness lens?* To explore the relationship between the lens and the interactive features of Mentimeter, Google Meet, and Google Presentations, we conducted a study with three independent evaluations, measuring agreement using Cohen's Kappa coefficient. Our results suggest that these interactive features can be used as a lens to understand different types of experiences and how they can be applied to promote various dynamics, such as competitive and collaborative activities. Our results expand the professor's perspective on the student experience, providing ways for professors to understand the emotional and student behavioral reactions from using interactive tools in remote learning environments.

1 INTRODUCTION

Remote teaching is a strategy for delivering educational content and facilitating communication between students and teachers without requiring physical presence (Umar, 2023). In this context, teachers face challenges when conducting their courses, such as a lack of social interactions, technical limitations, motivation, and lack of active student engagement (Ahshan, 2021). Engaging students is essential for teachers to accomplish their learning objectives.

Technologies that support the creation of interactive presentations and lessons, like Nearpod [1], for example, facilitate more interactive and participatory learning experiences in the remote context (Putra et al., 2021). Still, virtual whiteboards support students' engagement when they are trying to understand abstract concepts (Reguera and Lopez, 2021). Even simpler interactive features such as Google Meet Breakout Room influence how students learn and interact in remote online sessions (Ahshan, 2022). The use of technologies in remote learning has made it possible to explore different factors in the student experience, such as positive and negative responses to using technologies (Aguiar et al., 2022), how collaboration involves student engagement (Gopinathan et al., 2022), even interactivity and solitude (Kohnke and Foung, 2023).

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These factors help educators and researchers analyze how technologies influence student behavior and reactions, allowing them to redesign learning environments to enhance engagement and interactions (Gopinathan et al., 2022). However, there is no approach to combining different factors that help teachers and researchers understand student experiences using remote teaching tools.

Gomes et al. (2023) introduced a taxonomy to classify and explain audience experience in various events, including scientific and educational settings like conferences and lectures. This experience, when mediated by technology, can be analyzed through three key dimensions: engagement, liveness, and participation. These perspectives offer a theoretical foundation for understanding interaction in diverse contexts, from entertainment and sports to education. These perspectives can be applied to remote learning, where technological tools enhance student engagement, encourage collaboration, and support active participation in educational activities.

Considering the ways that technologies may influence student experience in remote learning, we aim to answer the following question: *How can educational technologies be classified by the Engagement, Participation, and Liveness lens?* This classification is essential to understand one or more aspects of the student experience. We understand the student experience as the emotional, cognitive, behavioral, and social experience through interacting with products, services, or systems in the educational context (Matus et al., 2021). In this sense, we observed the interactive features used in remote settings through the lens of engagement, participation, and liveness presented by Gomes et al. (2023).

To answer this question, we analyzed 3 tools – Mentimeter, Google Meet and Google Presentations– used in remote learning. As a result, we suggest that these interactive features of each tool can be used as a lens to understand different types of experiences and how they can be applied to promote various dynamics, such as competitive and collaborative activities. We also proposed a recommendation system to support the teachers in finding technologies based on student experience, helping them to promote engagement, participation, and liveness in the classroom.

2 THEORETICAL FRAMEWORK

In this section, we discuss the main concepts related to remote learning and how technological tools enhance dynamic and collaborative student-teacher interactions.

2.1 Remote Learning and Typology of Digital Learning Tools

Remote learning can be defined as a set of pedagogical practices mediated by digital platforms (Rovadosky and Agostini, 2021). Tools like Microsoft Teams, Google Classroom, Google Meet, and Zoom play a fundamental role in providing both synchronous and asynchronous interaction, allowing the continuation of the teaching-learning process, especially during the pandemic. These platforms became vital to maintaining educational activities in the global emergency caused by the COVID-19 pandemic, enabling teachers and students to stay connected even from a distance. Although remote teaching has gained prominence during the pandemic, teachers continue approaching it as a strategy for online courses (O'Connor et al., 2023).

Given this scenario, it becomes important to understand how interactions in the remote environment shape the learning process. Sims (1999) emphasizes that interactivity plays an essential role in the educational environment, allowing students to have control over the learning process, as well as enabling adaptations according to their needs. Digital tools enable different forms of communication and collaboration, promoting new interaction dynamics between teachers and students.

In this sense, Bower (2016) classifies Web 2.0 technologies for education into 37 types across 14 clusters. These tools support both real-time and asynchronous discussions, as well as content creation and sharing. Examples like Google Docs, Jamboard, and Kahoot show how they enhance collaboration and interaction. In remote teaching, these technologies are especially useful for boosting student engagement and improving communication between teachers and students.

This paper delves into the analysis of three specific technologies—Google Meet, Mentimeter, and Google Presentations—all classified according to Bower's typology and effectively employed in remote teaching.

2.2 A Taxonomy to Understand Audience Experience

The taxonomy proposed by Gomes et al. (2023) was conceived to understand audience experience using technologies in different events, such as entertainment, cultural, sport, and educational events. The taxonomy offers a perspective for analyzing technological interactions in events through three main lenses: Engagement, Participation, and Liveness.

Engagement. Engagement is an essential dimension in technological interactions, involving cognitive, emotional, and behavioral aspects. These aspects include motivation, attention, and user interactivity. The conceptual framework of engagement is divided into three units of analysis: *viewer*, *crowd*, and *audience*.

Viewer comprises an individual perspective of the spectator, and encompasses concepts such as immersion, sociality, solitude, interactivity, and immediacy. *Crowd* comprises a perspective of a large number of people together, such as in music festivals or football matches. The crowd perspective is related to the concept of *collective effervescence*, a dynamic where large groups share emotions and collective engagement in real-time. *Audience* refers to spectators or listeners in an event that does not necessarily represent a crowd. The audience perspective comprises the audience's emotional response, focusing on concepts such as arousal and valence (positivity or negativity of emotions) while using technologies.

Participation. Participation unit analysis comprises the characteristics and consequences of participation using technologies, and is related to both active and passive behaviors. This dimension is structured from four perspectives: *Time*, *Space*, *Qualities*, and *Motivation*.

Time is divided into reflective and immediate. The reflective facet reflects on the impact of the experience after the performance when the viewer processes the experience and reflects on their feelings and learnings. *Space* refers to the characteristics of the space where the audience interacts and participates, associated with the perspective. *Qualities* refer to emerging attributes or characteristics of how participants engage in interactive performance, they are classified into *constitutive*, *epistemic*, and *critical*. *Motivation* is related to the audience's intention to participate, exploring how collaboration and competition can be used to enhance participation. Motivation, in the context of interactive events, is linked to the desire to actively participate and experience new things.

Liveness. This dimension captures the sense of presence and spontaneity in an event, emphasizing the feeling of "being live". This dimension is supported by the concepts of *Flow* and *Presence*.

Flow describes the state of total concentration in an activity, where the individual feels deeply engaged and connected to what they are doing. In the context of technological interaction, this state is achieved when elements such as engagement, concentration, learning, challenge, and a shared atmosphere create an experience that resonates personally with the participant, generating an intense and fluid connection with the activity at hand.

Presence represents how effectively an event captures spectators' attention and the intensity of their engagement. The presence is related to *co-presence*, *social presence*, *sense of unity*, and *sense of belonging*.

3 RELATED WORK

Several technologies are evaluated considering the student experience through engagement and participation, such as Video Conference or Gamebased tools. Najjar et al. (2022) investigate what game-like features can be used to engage and motivate students in an online learning environment. Their findings suggest an increased level of interactivity, collaboration, and satisfaction through the game features, enhancing the student learning experience. Similarly, Nadeem et al. (2023) examine the effect of game-based learning on student engagement and motivation levels. The findings reveal the positive and negative impacts on student engagement emotions due to the competitive features.

In the literature, researchers use these tools to enhance learning during the course, aiming to improve student engagement. For example, Ahshan (2021) investigates strategies for active student engagement in remote teaching and learning during the COVID-19 Pandemic. The authors present a framework integrating technology, pedagogy, and active learning to boost student engagement in remote teaching, utilizing tools like PowerPoint, Google Meet, and Mentimeter.

While previous studies aimed to understand or improve the student experience in remote teaching, they did not examine the individual impact of interactive features. Although some authors explored isolated concepts, there is no structured approach to comprehensively analyze student experience. Our work seeks to bridge this gap by providing a framework to assess student experience and engagement through the lenses of engagement, participation, and liveness.

4 METHOD

To address the research question *"How can educational technologies be classified by the Engagement, Participation, and Liveness lens? "*, we analyzed how the concepts of engagement, participation, and liveness are incorporated into the interactive features of remote learning tools.

The analysis was structured into four main steps. In the first step, we executed an exploratory literature review, aiming to identify which technologies are used in educational remote settings. During the literature review, we identified a study (Ahshan, 2021) proposing a framework to promote student engagement for remote teaching. The study mentions 15 technologies that users could use by the framework to promote student engagement during remote class, such as Mentimeter, Google Slides, and Google Meet. We used these technologies as a base.

In the second step, we used Bower (2016)'s typology to classify the 15 technologies, aiming to understand the differences between these technologies. Bower (2016) provides a set of 14 categories to classify different learning tools, e.g., Mentimeter and Kahoot are classified as "Evaluation tools" for promoting online quiz-based dynamics. We performed a classification by aligning the category descriptions with the objectives of each of the 15 technologies. The Table 1 present the technologies classified.

Table 1: Table of technologies classified based on the typology of Bower (2016).

Tool	Classification
Moodle	Learning Management Systems cannot be classified in the typology as they are essentially a package of tools that can cover all other categories.
Mentimeter	Assessment tools
Kahoot	Assessment tools
Slido	Assessment tools
Prezi	Multimodal production tools
Google Slides	Multimodal production tools
Keynote	Multimodal production tools
Google Meet	Synchronous collaboration tools
ZOOM	Synchronous collaboration tools
BigBlueButton	Synchronous collaboration tools
Webex Meetings	Synchronous collaboration tools
GoToMeeting	Synchronous collaboration tools
Jamboard	Text-based tools Image-based tools
Google Meet Breakout Room (GMBR)	Synchronous collaboration tools
Google Chat	Synchronous collaboration tools

After classifying technologies according to Bower (2016)'s typology, in the third step, we selected one tool from each category according to theGomes et al. (2023) taxonomy lens. The sample comprises 4 tools that offer interactive features: Mentimeter (Assessment tools), Google Slides (Multimodal production tools) and Google Meet (Synchronous collaboration tools), and Jamboard (Text-based tools and Image-based tools). These tools were selected based on the authors' familiarity with them and their extensive exploration in the existing literature. However, due to product discontinuation issues, we did not analyze the Jamboard tool [2]. Therefore, we analyzed 3 tools: Mentimeter, Google Meet, and Google Presentations. The interactive features are the tools features that offer support to engagement and participation. We explain the third step in detail in Section 4.1.

In the fourth step, we developed STARS (Student Technology Advanced Recommendation System), a recommendation system prototype to support professors in deciding how to promote engagement and participation in remote classes. STARS comprises the analysis results obtained in the third step to recommend technologies based on Gomes et al. (2023) taxonomy concepts. In Section 5.1, we present more about STARS.

Table 2: Interactive features analyzed based on educational technologies.

Tool	Interactive Features
Mentimeter	Live Polling
	Word Cloud
	Quiz
	Q&A
	Presentations
Google Slides	Presentations
Google Meet	Virtual backgrounds and visual effects
	Screen sharing with other participants
	Chat
	Emoji Reactions
	Turn video on/off
	Turn microphone on/off

4.1 An Analysis of Engagement Characteristics in Remote Teaching

In this section, we explain in detail the analysis of the interactive features through Gomes et al. (2023) taxonomy. This analysis aimed to understand the role of these tools in the educational context and how their interactive features influence student engagement, participation, and liveness. Table 2 presents the selected tools and the interactive features classified.

To understand how to promote engagement, participation, and liveness in remote learning environments, we analyzed the interactive features of the tools using the Gomes et al. (2023) taxonomy. The interactive features were extracted from the exploration of the tools carried out by one of the researchers, and the main resources of each tool were identified. For each interactive feature, we pointed out the concepts related to each taxonomy lens and an explanation of how the interactive feature influences the occurrence of the factor. This process involved two researchers independently identifying the taxon-

[2] https://support.google.com/jamboard/answer/14084927?hl=en

omy concepts present in each tool. For each interactive feature, the researchers justified their perceptions without access to the others' justifications, ensuring impartiality in the analysis. In addition to the justification, the researchers assigned a value from 0 to 2 for each evaluated concept, using the following scale: 0, the interactive feature doesn't support the concept; 1, the interactive feature slightly supports the concepts; 2, The interactive feature fully supports the concepts.

In the end, the researchers discussed until they reached a consensus. A third researcher played a mediator role in discussions, ensuring that perceptions were aligned and that the analyzed concepts were interpreted coherently in the context of the tools. The third researcher also conducted an independent evaluation through the classification. As both researchers classified them independently, it was necessary to verify the degree of agreement of this classification. In this sense, we used Cohen's Kappa coefficient of agreement.

Cohen's Kappa is a coefficient to measure the degree of agreement between two judges when categorizing items into nominal categories (Cohen, 1960). The value of Cohen's kappa ranges from -1 to +1. The closer it gets to +1 indicates perfect agreement degree between the raters, and the closer it gets to -1 indicates that the agreement degree does not match between the judges.

We executed three rounds of analysis followed by a Kappa calculation. In the first round, we compared the Mentimeter-Quiz classification between the researcher's agreement, which resulted in 0.41 (Moderate). The researchers discussed the classified divergence points to get a shared sense of the classifications. In the second round, we compared the Mentimeter-Live Polling and Google Slides-Presentations, which resulted in 0.62 (Good) and 0.43 (Moderate) agreement, respectively. The researchers discussed the divergence points again and executed a new round. The third round was conducted to analyze Mentimeter-Q&A, and Mentimeter-World Cloud, which resulted in Kappa of 0.75 (Good) and 0.76 (Good), respectively. These results indicate that the interpretation between the classifications was aligned (Landis and Koch, 1977). After this, we reviewed all the interactive feature classifications, reviewed the assigned scale, and rewrote the justification-based researcher's agreement.

This collaborative approach ensured that the analysis of the interactive features of these tools was robust and accurately reflected each one's potential to promote engagement, participation, and liveness in remote teaching.

5 RESULTS

In this section, we report the result of the analysis of interactive features of 3 tools—Google Meet, Mentimeter, and Google Presentations— according to the Gomes et al. (2023)'s taxonomy lens. In Table 3, we present the results.The "X" represents when a feature was classified by some concept in the taxonomy.

By analyzing Table 3, one can notice that these interactive features are more closely tied to interaction and the exchange of information among students and professors, given that most interactive features are predominantly associated with Immersion, Interactivity, Social Presence, and Co-Presence. Other concepts, such as Collective Effervescence and Competition, were less evident. Collective Effervescence could be identified through a high volume of messages exchanged in the chat, while Competition was more noticeable when the Quiz feature was used to test student's knowledge.

We noticed that some interactive features focus more on enhancing User Experience (UX) rather than directly boosting engagement or student participation. For example, in Google Meet, Virtual Backgrounds and visual effects primarily improve UX by creating a more relaxed and friendly environment, rather than significantly increasing interaction or connection between participants.

Next, due to the paper length limitation we detail the classification of Quiz interactive feature of Mentimeter. The full results with the justification of each taxonomy concept are available in the supplementary material [3]. We chose the Quiz to present in the paper because it was one of the interactive resources that involved most of the taxonomy concepts.

Considering the Engagement lens, the Quiz was classified by the perspectives of the Audience and Viewer. From the Audience's perspective, the concepts of Arousal could be perceived when the quiz results are presented, while Valence is perceived by the attention and student willingness during the Quiz, impacting the emotions that may arise due to the quiz results. From a Viewer's perspective, we classified it as Immersion, Interactivity, and Immediacy. The Quiz can intensify the state of Immersion in the class, creating an interactive experience that could influence the energy and excitement of the viewer to win the Quiz. Interactivity is perceived when the student attempts to solve the question by interacting with interactive resources actively. The Immediacy is related to when the results are published in real-time for all students, influencing their expectations when they know their positions in the final scoreboard.

[3]https://doi.org/10.6084/m9.figshare.28225790

Table 3: Taxonomy concepts classification results through tools.

Lens		Concepts	Mentimeter					Google Meet						Google Presentations
			Live Polling	Word Cloud	Quiz	Q&A	Presentations	Virtual backgrounds and visual effects	Share screen	Turn on and turn off microphone	Chat	Emoji reactions via chat	Turn on and Off Video	Presentations
Engagement	Viewer	Immersion	X	X	X	X	X	X	X	X	X		X	
		Sociality								X	X	X	X	X
		Loneliness												
		Interactivity	X	X	X	X		X	X	X	X	X		
		Immediacy	X	X	X	X	X		X			X	X	X
	Crowd	Collective Effervescence									X			
	Audience	Arousal	X	X	X	X					X	X		
		Valence	X	X	X	X					X	X		X
Participation	Time	Reflective		X			X							
		Immediate	X	X	X	X	X			X				
	Space	Situation												
		Perspective												
	Qualities	Constitutive	X		X	X								
		Critical		X	X	X	X			X	X			
		Epistemic	X	X	X	X	X			X	X			
	Motivation	Collaboration		X					X	X	X	X		X
		Competition			X									
Liveness	Flow		X	X	X	X	X							X
	Presence	Sense o Unity						X	X	X	X	X	X	
		Sense of Belonging	X	X		X		X	X	X	X			X
		Social Presence	X	X	X	X					X			
		Co-Presence	X	X	X	X	X				X			

Regarding the Participation Lens, we analyzed Time, Qualities, and Motivation. The Quiz falls under Immediate Time since results appear in real-time. In Qualities, the Epistemic aspect emerges as students reflect on their knowledge compared to peers, while the Critical aspect depends on the quiz content, fostering deeper thinking. For Motivation, we classified it as Competitive since scores drive students to reach top positions.

Under the Liveness Lens, we examined Flow and Presence. Students may experience Flow by focusing intensely on answering questions within the time limit. Presence includes Social Presence, as students see peers' participation and results, and Co-Presence, the Quiz fosters a shared space between students and the professor.

From the other technologies' perspective, such as Google Meet, the changes in the virtual background and visual effects could change the way the students see other students in the class; the immersion occurrence can be influenced by the background changes of all the participants who participate and have the camera on. In this way, providing a sense of connection between the students who use this resource.

5.1 STARS

To aid teachers in choosing which technology to use in class, we developed STARS, a technology recommendation system to facilitate the selection of solutions tailored to the student experience. STARS recommends technologies based on the results presented in Section 5.

The recommendation process operates in two ways. The first process involves a series of seven questions structured according to the Gomes et al. (2023) Taxonomy. Each question has a predetermined option based on taxonomy concepts. Each answer aligns with one or more of these concepts, and the recommendation is determined by the frequency of answers that align with specific tools. In other words, STARS suggestion will be the one with the highest number of matches based on the provided responses. All the questions used to recommend can be seen in the supplementary material [4]. Figure 1 presents the process through the question of reaching the recommendation.

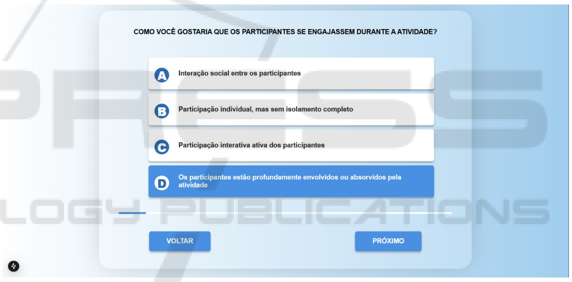

Figure 1: STARS question screens process (In Portuguese).

The second process is designed to offer a more practical option for teachers already familiar with the system and its concepts. In this process, the recommendation is made through direct concept selection, with the system displaying relevant tools in real-time when a concept is chosen. As teachers combine different concepts, the system generates compatible options to identify the solution based on their selected combination.

6 DISCUSSION

In this paper, we address the following question "How can educational technologies be classified by the Engagement, Participation, and Liveness lens?"

We answer this question by analyzing interactive features through Gomes et al. (2023)'s taxonomy and

[4]https://doi.org/10.6084/m9.figshare.28225790

proposing a tool to recommend interactive tools based on concepts to enhance student experience in remote teaching. We adopted this taxonomy as it covers key concepts of audience engagement and participation, considering that a class can be viewed as an educational event.

The interactive features classification through the taxonomy supports teachers in enhancing student engagement and participation in remote contexts. For example, teachers would decide which strategy to follow based on how that interactive feature could influence the student experience or what they want to induce. Active student engagement would be perceived by the use of features such as voting and chat (Tulaskar and Turunen, 2022). In the Epistemic concept, the values of participation are tied to gaining a deeper understanding of oneself and others present during the performance (Cerratto-Pargman et al., 2014). In other contexts, such as cooperative events, warm-up questions are used to let the audience know to find out who the people present are like by using interactive features (Salovaara et al., 2021). The use of chat could be a way to manifest information about the student or the others who participate in the experience.

Our analysis suggests that interactive features can promote various factors, such as competition and collaboration. For instance, Mentimeter's Word Cloud allows teachers to pose open questions, encouraging students to share ideas in real time, fostering collaboration and inspiration. Meanwhile, the Quiz feature can create a competitive environment, motivating students to aim for top scores, especially when rewards are involved. However, the impact depends on how teachers utilize these tools. While educators already use technology to boost engagement and participation, there is no structured approach to selecting tools based on the engagement, participation, and liveness lens.

In the literature, Ahshan (2021) developed a framework that ensures active student engagement during remote teaching. The authors investigate the strategies using tools like Google Meet, Jamboard, Google Chat, Breakout Room, Mentimeter, Moodle, and electronic writing devices. However, the authors do not consider how it impacts the student experience. Different tools can affect student engagement and participation in different ways. Our analysis highlights these ways from different perspectives. Our analysis can help researchers to study precisely these tools, helping to explore how such tools can affect the student experience. For example, Ahshan (2021) points out that Google Meet chat is an option for online interaction between students and professors. However, it is not explored how these interactions can provide different affective emotions and sentiments from experience. The analysis through the taxonomy could be used as a lens to understand different kinds of audience experiences, as proposed by Gomes et al. (2023). We propose a tool—STARS—to recommend interactive features based on taxonomy concepts, explaining how these interactive features could trigger the taxonomy concepts.

7 THREATS TO VALIDITY

Based on our analysis, there are threats and limits to our results that need to be considered. To reach our goals, we obtained a set of 15 tools used to promote engagement in remote classes. Our results are limited by our selection of tools, which may be unrepresentative. However, the selected tools are diversified by categories, each representing a group of tools with similar characteristics. We classified these tools based on a typology already known from the literature. We also classified the interactive features manually, which may be subject to different interpretations. In this sense, we validated our analysis with expert research through the Cohen Kappa, evaluating the agreement of the concepts with the use of technology in the educational context.

While our classification is based on the researchers' expertise, no evaluation with students has been conducted to validate the researchers' perceptions regarding the classification of interactive features. However, evidence from the literature supports integrating our analysis into the interactive features of remote learning tools.

8 CONCLUSION

In this paper, we analyzed Google Meet, Mentimeter and Google presentations to understand how the concepts of engagement, participation, and liveness are incorporated into the interactive features of remote learning tools to affect the student experience.

Our initial results highlight an approach to analyze interactive features using Gomes et al. (2023) taxonomy and how it can stimulate emotional and behavioral reactions due to the use of such interactive features. Gomes et al. (2023) taxonomy can support observing the student experience through the use of technologies.

In the future, we plan to integrate LLM with the taxonomy and our technology dataset to recommend tools, providing insights on their implementation and potential impact on student experience. Additionally, we aim to conduct a UX evaluation and usability test with STARS to identify key interface issues. Finally, we will carry out a study with teachers to assess STARS' effectiveness in recommending technologies for remote learning.

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