社交批注对学生在同步在线学习中参与度的影响

The Impact of Social Annotation on Students' Engagement in Synchronous Online Learning

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【摘要】 近年来同步在线学习的普及凸显了参与度不足的挑战。社交批注工具在异步学习中的协作与认知深化作用已获验证，但其在同步在线学习场景中的应用尚未充分探索。本研究拟采用准实验设计，具体为单组A-B阶段设计，将社交批注工具嵌入同步在线课堂，探究其在行为、认知与情感三个维度上对学习者参与的影响。预期成果将揭示基于社交批注的多模态交互如何重构同步在线学习参与模式，为优化在线课堂设计提供参考。

【关键词】 同步在线学习；社交批注工具；多维参与

Abstract: *The wide adoption of synchronous online learning (SOL) has exposed the ongoing challenges in learner engagement. Although social annotation tools (SATs) have demonstrated promise in an asynchronous context, their potential in SOL remains unexplored. This study proposes a quasi-experimental design, specifically a single-group A-B design, to systematically investigate the roles of SATS in reshaping behavioral, cognitive and emotional engagement in SOL sessions. Findings are expected to provide empirical evidence for optimizing instructional design in technology-enhanced SOL environments.*

Keywords: Synchronous online learning, Social annotation tools, Multidimensional engagement.

1.Introduction

The rapid adoption of synchronous online learning (SOL) enhances the accessibility of learning, yet persistent challenges in engaging learners are identified due to its lack of flexibility in time, pace, and duration (Park & Bonk, 2007; Wang et al., 2023). This condition is further aggravated by the emotional disconnect caused by the loss of physical interaction. Additionally, thinking and verbal interaction could remain superficial resulting from inappropriate pedagogical designs, such as long-time lectures. Thus, learner engagement is counted as the key to the success of SOL (Baxter & Hainey, 2022). Social annotation technologies (SATs) have demonstrated considerable promise in asynchronous online learning (AOL), effectively supporting collaborative learning, critical thinking, and community formation. Nonetheless, their application in SOL remains mostly unexamined. SATs possess several theoretical advantages owing to their real-time, content-specific, and multimodal interactions, which indicates their potential to address the engagement challenges in SOL. The existing research landscape is deficient in empirical evidence concerning the efficacy of SATs in SOL. To fill this gap, this research proposal aims to explore the potential of SAT-mediated learning for enhancing student engagement in the SOL context through a quasi-experimental study.

2.Literature Review

2.1. Engagement Challenges in Synchronous Online Learning (SOL)

SOL facilitates real-time interactions through digital platforms like Zoom, allowing instant dialogue via audio, video, and text, and mirroring some of the dynamics of traditional classrooms (Martin et al., 2017; McArthur, 2022). Despite its advantages, SOL poses significant engagement challenges critical to the effectiveness of online learning (Baxter & Hainey, 2022; Chiu, 2023). Engagement is defined as a psychological investment in and effort directed toward learning, understanding, or mastering (Newmann, 1992). Fredricks et al. (2004) expand on this by categorizing engagement into three critical dimensions: behavioral, cognitive, and emotional. Each plays a vital role in influencing students' learning outcomes. Studies have shown that the unique settings of SOL influence how students engage in learning behaviorally, cognitively, and emotionally (Bedenlier et al., 2020), thereby making the challenge of engagement more severe in this context. First, by providing less supervision, SOL demands a higher level of self-regulation, which not all students possess (Bedenlier et al., 2020; Chiu, 2023; Ryan & Deci, 2020). Therefore, online instructors need to adopt alternative strategies that are better suited to the SOL context (Heilporn et al., 2021), and design appropriate content that satisfies learners' personal needs and learning goals (J. Lee et al., 2021) to engage learners both behaviorally and cognitively. Second, being physically separated and lacking body language may reduce opportunities for informal interactions, as well as weaken the sense of connection among students, increasing feelings of isolation and lowering engagement (Bedenlier et al., 2020; Chiu, 2023; Wang, 2024). Such emotional disengagement is particularly detrimental as it directly affects students' attitudes towards the learning process and their satisfaction with learning experiences. Third, verbal-centered interaction privileges native speakers, while discouraging engagement among students facing language barriers (Park & Bonk, 2007) or with an introverted personality. Fourth, cognitive and emotional engagement is less observable in the SOL context due to the lack of face-to-face communication (Bedenlier et al., 2020), preventing instructors from recognizing disengagement and intervening in time. Moreover, research on emotions in online learning remains relatively scarce (Hsu et al., 2019). These multifaceted challenges underscore the necessity for SOL designs and pedagogical strategies that consider and address the specific engagement challenges inherent to this learning mode.

2.2. Social Annotation Technologies (SATs) as Engagement Interventions

SATs are typically web-based platforms that enable students to collaboratively share written comments and highlights directly with peers and instructors (Lazzara & Clinton-Lisell, 2024). At its core, annotation is a dialogic process—a way for readers to engage with, critique, and apply knowledge from texts (R. H. Kalir & Garcia, 2021). Consequently, SATs serve as an effective means of enhancing learner engagement in online courses (Bjorn, 2023). Compared to traditional annotation methods, SAT is particularly dynamic due to its integrated social functions (Brown & Croft, 2020). Students interact through upvoting, tagging, and emoji-based reactions (Li & Li, 2023), thereby fostering a vibrant and participatory learning community. These interactions not only strengthen connections among learners but also help mitigate the isolation often felt in online courses (J. H. Kalir et al., 2020). Beyond fostering social bonds, SATs support cognitive

engagement through peer scaffolding and structured communication, which enhances motivation and learning outcomes (Razon et al., 2012). By allowing students to highlight and link specific parts of a text to discussion, SATs anchor conversations in a shared context, enabling deeper, more focused dialogue (Sun & Gao, 2017). Additionally, SATs capture students' in-process thinking (Adams & Wilson, 2020), creating a visible record of their cognitive engagement. Existing studies have consistently shown that SAT application enhances student engagement, attention, and interaction, fostering advanced cognitive skills and reading comprehension (Bjorn, 2023; Hwang et al., 2007; Johnson et al., 2010; Razon et al., 2012; Yang et al., 2013).

While most existing studies focus on the use of SATs in AOL, their potential in SOL remains unexplored. In SOL, interactions tend to be dominated by real-time instructor-led communication. Integrating SATs offers a promising intervention to enrich all three key forms of interaction: learner-content, learner-instructor, and learner-learner (Moore, 1989). First, by enabling students to annotate and discuss specific parts of learning materials, SATs enhance learner-content interaction (S. Lee et al., 2023). It serves as the foundation for other interactions, as it drives cognitive processing (Moore, 1989; Xiao, 2017). This approach supports transforming learning from passive reception of information to active knowledge construction. Second, learner-learner interaction is strengthened through replies, upvotes, and emotive reactions (Allen & Randall, 2023). These interactions can increase the sense of community and enhance collaborative learning. Third, learner-instructor interaction can be diversified, as instructors gain access to learners' in-process thinking through annotations. Therefore, instructors could provide immediate and contextual feedback. Furthermore, integrating SATs expands communication channels and extends the temporal boundaries of live sessions. Text-based communication helps create a more inclusive environment, which is especially meaningful for learners who feel less comfortable with verbal expression in SOL. Meanwhile, the annotation records enable post-session review and encourage deeper cognitive engagement. In sum, SATs hold theoretical potential to engage students in synchronous sessions. However, empirical evidence remains limited, calling for further research.

3.Research Questions (RQs)

RQ1: What are the differences in learners' behavioral interactions between SAT-enabled and non-SAT synchronous contexts?

RQ2: Do SATs influence students' cognitive engagement in synchronous settings?

RQ3: Do SATs influence students' emotional engagement in synchronous settings?

4.Methodology

4.1. Research Design

A single-group A-B design will be employed to explore the impact of SATs on student engagement. By comparing the same group of learners before and after the intervention, this design minimizes between-group variability and provides clear observation of the changes associated with the introduction of SATs within an authentic instructional setting. The study will consist of two phases, each containing three sessions. Phase 1 will serve as the control condition, where instruction will be delivered solely through Zoom. In Phase 2, SAT (Perusall) will be integrated into the teaching

strategy. The instructor will upload slides to Perusall and share the interface via screen sharing. Students can annotate slides, ask questions, reply to peers, share emojis, and upvote others' annotations in real time via Perusall. Meanwhile, students can still use Zoom. They can engage through annotations, chat messages, or voice messages. This design provides multiple interaction methods and fosters authentic learning practices. It also enables instructors to observe shifts in students' natural behaviors within a realistic context.

4.2. Participants

The study will be conducted at a teacher training institute. Approximately 30 undergraduate students specializing in education will be recruited for the study. Before the study begins, students will be asked to provide their written consent to participate. This emphasizes voluntary participation and the anonymization of the collected data.

4.3. Data Collection

All Zoom sessions throughout the study will be recorded and the annotated slides in Phase 2 will be preserved. In Phase 1, the data will include the number and content of chat messages and verbal contributions during Zoom classes. At the end of Phase 1, a survey will be conducted to collect both quantitative and qualitative data about learners' self-perceived depth of thinking, and emotional experiences. The survey (Survey 1) consists of 10 five-point Likert scale items (from "5: Strongly agree" to "1: Strongly disagree") and one open-ended question (see Appendix A). Cognitive and emotional dimensions each contain 5 items to capture learners' self-perceived engagement. The open-ended questions aim to collect additional information not covered by the Likert-type items. In Phase 2, the same data will be collected from Zoom interactions. Then, data about the number and content of annotations will be collected from the Perusall log files. After the Phase 2 sessions, another survey (Survey 2) will be administered. Its quantitative section and the first open-ended question mirror Survey 1, while a second open-ended question is added to explore students' perceptions of the embedded SAT (see Appendix B). To ensure data validity, the survey instruments will be self-developed based on established engagement constructs (Fredricks et al., 2004) and will be reviewed by two experts in educational technology to assess item clarity, relevance, and alignment with theoretical definitions. Reliability will be supported through a pilot test involving five non-participant students, followed by internal consistency checks targeting a Cronbach's alpha greater than 0.70. For coding qualitative data, a predefined rubric will be employed. 20% of the data will be independently coded by two researchers. Inter-rater reliability will be assessed using Cohen's kappa ($\kappa \geq 0.70$).

4.4. Data Analysis

For RQ1, we will focus on the total interaction frequency and modality distribution across the phases to investigate varying behavioral patterns. The total interaction in Phase 1 encompasses chat messages and verbal contributions via Zoom. In Phase 2, the total quantity of Perusall annotations will be added. We will then compare the total interactions through paired *t*-tests or a non-parametric Wilcoxon signed-rank test. In addition, the modality distribution (text, language, annotations) will be analyzed through Chi-square tests. For RQ2, we will perform paired *t*-tests (or Wilcoxon tests for non-normally distributed data) on the composite cognitive depth scores measured by Survey 1 and 2. Meanwhile, all interaction data (Zoom chat transcripts, verbal transcripts, Perusall annotations) will

be coded into two cognitive categories: basic (e.g., restatement of facts, simple questioning) and deep (e.g., critical analysis, synthesis of ideas). A predefined coding scheme will be applied, and inter-rater agreement will be checked through independent coding. A Chi-square test will then be used to assess whether the proportion of deep cognitive interactions has increased significantly. For RQ3, the emotional composite scores obtained from Survey 1 and 2 will be compared via paired *t*-tests or Wilcoxon tests. Additionally, we will thematically analyze the responses to the first open-ended question in both phases to identify recurring emotion themes (e.g., pleasure, frustration). Moreover, the responses to the supplemental open-ended question in Survey 2 will be systematically coded into three predefined categories: behavioral (e.g., interaction modality shifts), cognitive (e.g., critical thinking triggers), and emotional (e.g., tool-related stress or motivation). A consensus-based coding rubric will be employed, with two researchers independently coding to ensure reliability. Emerging themes will then be mapped to quantitative findings to explain how SAT tools influence engagement. This analysis aims to provide mechanistic insights, thereby enriching the interpretation of the results across all RQs.

5.Limitations

Firstly, the findings are based on a single course, which may restrict the generalizability of the results to other disciplines. Secondly, the reliance on self-reported data could introduce bias and oversimplify the emotional experiences of participants. Thirdly, the relatively short intervention period of three sessions may not be sufficient to observe long-term patterns of engagement. Fourthly, the use of a single-group A-B design limits the ability to infer causal relationships. Changes in engagement might also be influenced by maturation, novelty effects, or other external variables. Future studies should consider randomized controlled trials or crossover designs to strengthen causal inferences.

6.Expected Contributions

Firstly, this study aims to provide empirical evidence for SATs' potential in live sessions and offers practical insights for educators to design more flexible, interactive, and learner-centered instruction in SOL. Secondly, this study introduces a framework for capturing silent but active engagement through annotation analysis, providing conditions for longitudinal tracking of cognitive and emotional trajectories in SOL. Thirdly, this study investigates how adopting emerging technologies can facilitate the creation of alternative interaction methods. Thus, learners can make meaningful contributions according to their individual preferences in a more equitable and inclusive learning environment.

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Appendix A
Phase 1 Survey
Cognitive Engagement (5-point Likert scale, 1=Strongly Disagree, 5=Strongly Agree)
The session content prompted me to think deeply.
I actively connected the material to my prior knowledge or experiences.
The instructor's questions encouraged me to reflect on my understanding.
I could explain the key concepts in my own words.
I identified gaps in my knowledge during the session.
Emotional Engagement (5-point Likert scale, 1=Strongly Disagree, 5=Strongly Agree)
I felt motivated to participate in class discussions.
The learning environment felt safe for expressing ideas.
The pace of the session made me feel stressed. *(Reverse-scored)*
Interactions with peers increased my motivation.
I felt satisfied with the overall session experience.
Open-Ended Questions
Describe a moment in the session where you felt particularly engaged or frustrated. Explain why.

Appendix B
Phase 2 Survey
Cognitive Engagement (5-point Likert scale, 1=Strongly Disagree, 5=Strongly Agree)
The session content prompted me to think deeply.
I actively connected the material to my prior knowledge or experiences.
The instructor's questions encouraged me to reflect on my understanding.
I could explain the key concepts in my own words.
I identified gaps in my knowledge during the session.
Emotional Engagement (5-point Likert scale, 1=Strongly Disagree, 5=Strongly Agree)
I felt motivated to participate in class discussions.
The learning environment felt safe for expressing ideas.
The pace of the session made me feel stressed. *(Reverse-scored)*
Interactions with peers increased my motivation.
I felt satisfied with the overall session experience.
Open-Ended Questions
Describe a moment in the session where you felt particularly engaged or frustrated. Explain why.
Did Perusall affect your learning experience? Please describe specific features or interactions that stood out to you (positively or negatively).