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An fsQCA-based Configurational Analysis of Factors Impacting Student Engagement in Blended Learning

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Abstract

This study employs fuzzy-set Qualitative Comparative Analysis (fsQCA) to examine how critical thinking, self-regulation, peer interaction, sense of belonging, and teaching presence collectively influence student engagement in blended learning among Chinese higher education learners. The findings reveal that no single factor alone is sufficient to predict engagement; rather, three distinct configurations of these variables highlight the complex interplay of cognitive, social, and structural supports required for effective engagement. The study underscores that multiple pathways can lead to high student engagement, offering guidance for designing and facilitating effective blended learning environments.

Keywords

Student Engagement, Blended learning, fsQCA, Configurational analysis

1. Introduction

The advancement of technology has significantly transformed the educational landscape characterized by its flexibility, efficiency, personalization. Incorporating technology into teaching environments can diversify students' learning experience (Ahmed & Opoku, 2022), providing more opportunities for student interaction and information exchange, leading to enhanced educational quality (Timotheou et al., 2023). Fully online learning limits social interaction, affects health, and hinders assessment (Pikhart et al., 2023). In contrast, blended learning (BL), combining face-to-face and online modes, is seen as a transformative force in higher education (Garrison, 2016). More and more instructors and practitioners embrace BL, which has become a prevailing trend in higher education worldwide (Anthony et al., 2022). BL is an approach that requires students to choose their learning resources, acquire knowledge

at their own pace, and select learning methods according to their preferences (Rasheed et al., 2020). It is regarded as a fertile ground for fostering students engagement in their learning process (Cleveland-Innes & Wilton, 2018). Nevertheless, doubts remain about whether students truly learn when placed in front of a computer. Hence, researchers keep exploring factors that may influence student engagement in BL (Alemayehu & Chen, 2023; Borup et al., 2020).

Student engagement, a key factor in learning success, is highly related to learning continuity, academic satisfaction, performance and completion (Fredricks, 2023). It is regarded as the "holy grail of learning" (Sinatra et al., 2015). Although there is no agreed-upon definition of student engagement due to differing conceptualizations and terminology (Hazel et al., 2013), researchers agree that it is a complex, multifaceted, and malleable construct (Ben-Eliyahu et al., 2018). With ongoing research, the number of sub-components of engagement has grown, with cognitive, behavioral, and emotional (affective) engagement regarded as three widely accepted meta-dimensions (Alrashidi et al., 2016). Besides, the current technology-supported learning environment has complicated this learning process (Bond & Bedenlier, 2019). As indicated by Community of Inquiry framework, cognitive presence, social presence, and teaching presence are essential to a meaningful learning experience (Garrison et al., 2000). It provided clear structure to identify contributors to student engagement in BL. Moreover, Garrison and Vaughan (2008, p. 19) stated that "overlap does not have to be symmetrical. Emphasis can be any one of the presences". Therefore, the asymmetrical relationship among variables related to student engagement remains to be explored.

However, previous studies tend to explore the net effect of individual variables, overlooking the combined effects of multiple variables within social context (Denovan et al., 2020). The interaction of multiple variables requires an analytical approach to explore their combined impact. Hence, this research employs the fsQCA method to explore the combined role of critical thinking, peer interaction, sense of belonging, teaching practice, and self-regulation in student engagement in BL. The fsQCA method (fuzzy-set Qualitative Comparative Analysis) (Ragin, 2014) allows researchers to examine "the varied connections between causal combination and the outcome" (Ragin, 2008, p. 190). It has been widely applied to analyze relationships between theoretical concepts (Rasoolimanesh et al., 2021). Whereas conventional quantitative analysis, based on assumptions of symmetry and linearity, demonstrates average effects across factors, fsQCA identifies specific configurations of conditions within each dimension and reveals multiple pathways leading to the same outcome (equifinality) (Woodside, 2013). This study holds the potential to deepen the theoretical development and offer empirical evidence that informs educators to design and optimize learning environments.

2. Literature Review

2.1 Critical Thinking and Student Engagement

Critical thinking, encompassing analysis, synthesis, and evaluation to reach reasoned conclusions, is regarded as one of the desirable learning outcomes in higher education (Elder & Paul, 2020). Learning

activities that involve critical thinking are significant to student engagement (Aliyu et al., 2022). Students tended to be most engaged in learning when they are involved in higher-order thinking (Nkomo et al., 2021), as it is a process involved cognition and metacognition (Al Mamun, 2023).

Critical thinking is an essential component of cognitive presence in BL (Garrison & Kanuka, 2004). "Cognitive presence is defined as the extent to which learners are able to construct and confirm meaning through sustained discourse in a critical community of inquiry" (Garrison et al., 2015, p. 1), which is the key to the success of distance learning (Al Mamun & Lawrie, 2023). Cognitive presence is achieved through sustained reflection and inquiry, where learners actively engage in discussion, analyze different perspectives, and critically evaluate their understanding (Garrison & Kanuka, 2004). The stronger the cognitive presence, the higher the ability of learners to construct knowledge, which in turn, positively influences their engagement (Chi, 2023). Studies found positive relationship between cognitive presence and engagement in BL (Doo et al., 2023). Notwithstanding those findings, Chi (2023) found cognitive presence has the least impact on student engagement in BL than teaching presence and social presence.

Critical thinking is also perceived as a powerful driver for student engagement (Murawski, 2014). When students are motivated to engage in effortful thinking, critical thinking is activated at the right moment, signaling genuine learning (Kuh, 2009). Positioned as critical thinkers, students participate in meaningful intellectual work (Elder & Paul, 2006). However, despite their own efforts, students often attribute their progress to the contributions of peers or teachers (Zheng et al., 2023). Student engagement is a multifaced construct, involving not merely cognition process (Bond et al., 2020). Cognitive presence is necessary for meaningful learning but not sufficient alone for student engagement (Garrison, 2015).

2.2 Peer Interaction and Student Engagement

Peer interaction with others plays a pivotal role in maintaining and enhancing student engagement in technology-supported learning (Dixson, 2012). Research suggests that interaction with peers is associated with student perceptions of learning (Richardson & Swan, 2003). According to Wu (2023), interaction in technology-supported learning is complex, as it lacks physical presence, yet media-based interaction can still foster a sense of social community among physically distant learners.

Human needs for affiliation and self-esteem are considered as important as fundamental physiological needs like food, water, and shelter, which can be satisfied only through interaction (Rourke et al., 1999). Garrison et al. (2000) supposed that social-emotional interaction and support are important and essential for a meaningful and worthwhile educational experience. Students create trust and connect with others via interpersonal interaction (Garrison & Vaughan, 2008). Interaction is an important means of enhancing social presence which contributes to affective goals by enhancing appealing, engaging, and rewarding group interactions (Rourke et al., 1999), thus increasing the quality of the learning experience in terms of course persistence, completion, and satisfaction (Pozzi & Persico, 2011). Studies have validated the significant effect of social presence on student engagement in BL (Doo & Bonk,

2020; Doo et al., 2023; Wu, 2023).

2.3 Sense of Belonging and Student Engagement

Mendoza and Venables (2023) suggest fostering a stronger sense of belonging to enhance students' learning experiences in BL. As it helps strengthen students' cognitive engagement (Kahu et al., 2020). Peer-to-peer relationships, socialization, collaboration, and interaction in BL are critical factors to student engagement (Palmer et al., 2017). Students' sense of belonging can be fostered through ice-breaking activities and mutual comments on each other's work, which can lead to enhanced emotional and cognitive engagement (Heilporn et al., 2021). However, students without friends may experience social isolation, yet still perform well academically if they remain committed to their learning (Christenson et al., 2012). That is to say, a sense of belonging might be replaced or supplemented by other factors in certain cases.

2.4 Teaching Practice and Student Engagement

Instructional designs that incorporate active learning, grouping strategies, and authentic tasks are central to shaping the learning experience in BL (Fisher et al., 2018). Student engagement can be optimized when teachers carefully design connections and continuity between asynchronous and synchronous components, as well as select appropriate teaching and learning activities. Topic-related activities and professional practice-based learning promote students' cognitive and emotional engagement, while assessments foster cognitive and behavioral engagement (Heilporn & Lakhal, 2021). The quality of teaching contents, methods, and tutoring are vital to encouraging their cognitive engagement in BL (Tuiloma et al., 2022). The structural model confirmed that the relevance of activities, content, and resources, along with maintaining a steady course pace, significantly influence student engagement in BL (Heilporn et al., 2022). Similarly, Wang (2022) found that assessment, technological support, course design and organization, discourse facilitation, and direct instruction contribute to student engagement—explaining 45.3% of behavioral engagement, 34.3% of cognitive engagement, and 40.9% of emotional engagement, all of which are components of teaching practice.

2.4 Self-regulation and Student Engagement

Self-regulation is a significant predictor of student engagement. Students with higher levels of self-regulation tend to demonstrate stronger engagement, whereas those with lower levels often struggle to engage effectively in BL (Kara et al., 2024; Rasheed et al., 2020). Empirical studies further highlight this relationship. Lai et al. (2016), in an experiment on flipped classrooms, demonstrated that self-regulated learning effectively enhances learning outcomes. To address challenges such as social loafing and disengagement, Rasheed et al. (2021) proposed a peer-learning self-regulation strategy for BL. Similarly, Park and Kim (2022) found that students with stronger self-regulation are more likely to engage in co-regulation with peers, and that both self-regulation and co-regulation positively influence behavioral engagement. Van and Elen (2023) extended this line of inquiry by proposing an instrumentalized framework with seven attributes to support self-regulation in BL, and confirmed its positive impact on students' overall learning experience.

2.5 Theoretical Background and Conceptual Model

Student engagement is often considered a malleable state that can be increased by fostering better social and academic context (Fredricks et al., 2016). Scholars conceptualize engagement based on different perception, but most assume that engagement and motivation are close linked. Engagement represents motivation in action, with motivation serving as its underlying driver (Skinner & Raine, 2022). Self-determined Theory (SDT) suggest that autonomy, competence, and relatedness are three universal and psychological needs possessed by all individuals that drive people's motivation to act (Deci & Ryan, 1985; Deci & Ryan, 2000). When learners' needs of autonomy (feel in control of behaviors), relatedness (feel connected), and competence (feel competent) are satisfied, they are more likely to experienced intrinsic motivation, which means they are more likely to engage with a sense of interest, enjoyment, and personal value (Deci & Ryan, 2000). Autonomy-supportive teaching, where educators offer meaningful choices and avoid controlling behaviors, promotes higher levels of student engagement (Niemiec & Ryan, 2009). Within educational context, students who feel competent are more likely to engage, as they believe they can succeed in their tasks. Positive relationships and a supportive social environment enhance engagement by fulfilling students' need for relatedness (Sökmen, 2021).

SDT provides a strong theoretical foundation for understanding how student engagement can be enhanced through the fulfillment of psychological needs. Students who feel they have control over their learning environment are more inclined to think critically. Positive interactions fostering a sense of belonging satisfy the need for relatedness. Self-regulated learners are better at controlling, monitoring, and adjusting their learning. When they feel more autonomous and competent, they become more motivated and engaged. Given that, this study posits that there is a synergy among critical thinking, peer interaction, sense of belonging, teaching practice, and self-regulation skills in student engagement. We assumed that those are vital variables lead to student engagement, and can be matched into different and effective configurations to function jointly rather than one optimal configuration. Hence, a configurational model is proposed as follows (see Figure 1):

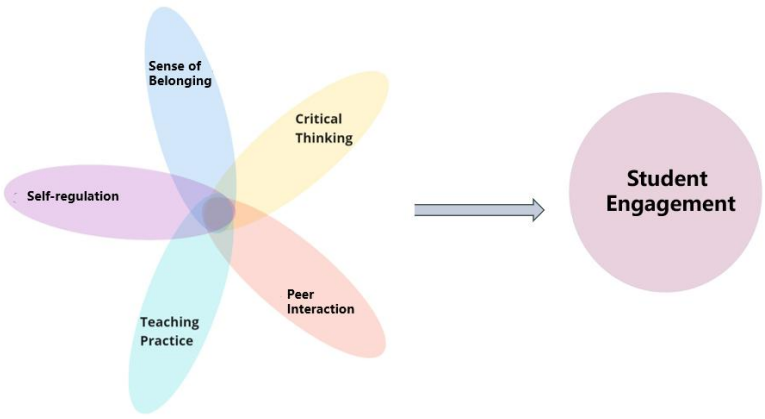

Figure 1. Configurational Model

On the left are five chosen conditions: critical thinking, peer interaction, sense of belonging, teaching presence, and self-regulation. The overlapping area illustrates that these conditions may combine to produce student engagement, shown on the right. Since configurations can involve different combinations of causal conditions, two propositions must be examined.

Proposition 1: The presence or absence of individual conditions—critical thinking, peer interaction, sense of belonging, teaching presence, and self-regulation—may contribute to effective student engagement, depending on how they combine with other causal conditions to form a configuration.

Proposition 2: No single configuration of these five conditions is sufficient to explain student engagement in blended learning. Instead, multiple, equally effective configurations of causal factors can lead to the same outcome.

Therefore, the research question this study aims to address is: What configurations of critical thinking, peer interaction, sense of belonging, teaching presence, and self-regulation lead to student engagement in the blended learning context?

3. Methodology

3.1 Sample

The target respondents for this study were students from one university in central China. This university has been implementing blended learning for 5 years with 30%–70% of courses delivered online. Some learning management systems (LMS), such as Chaoxing Learning Platform and Dingding Platform are used blended learning. Students are required to review learning materials uploaded by teachers, or search for related learning materials independently before class.

The questionnaire was made through Wenjuanxing, a popular survey tool in China, and distributed via WeChat to students who were were informed of the objectives of the study in advance. The anonymity and confidentiality of the data collected were also ensured. A total of 135 students responded to the survey in the end. After excluding questionnaires with identical responses or unusually short completion times, 70 valid questionnaires were retained (51.85%). Of the respondents, 55.1% were male and 44.8% were female; 68.2% were postgraduate students and 31.8% were undergraduates. Participants represented diverse disciplines, including economics, computer science and technology, and anthropology.

3.2 Data Collection

The questionnaire consisted of two sections. The first gathered demographic information, including gender, grade, and age. The second comprised five separate scales measuring the conditional variables respectively: critical thinking, peer interaction, sense of belonging, teaching presence, and self-regulation, using a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). All scales were adapted from established instruments and back-translated to ensure validity and reliability within the research context. Student engagement was assessed through self-evaluation on a 5-point scale

Critical thinking. The critical thinking scale was adapted from NSSE (2020), with several items revised

to better align with the research context. This section contained six items and demonstrated high reliability (Cronbach's α= 0.934). The KMO value was 0.778, and Bartlett's test of sphericity was significant ($\chi^2 = 739.081$, df = 15, $p < 0.001$).

Peer interaction and sense of belonging. This section was adapted from Rover's (2002) Classroom Community Scale, which originally included two factors: feelings of connectedness and perceptions of interaction within the community to construct understanding and achieve learning goals. To align with the objectives of this study, three items for each factor were adapted and translated into Chinese. All items showed factor loadings above 0.8. The peer interaction scale demonstrated strong reliability and validity (Cronbach's α = 0.887; KMO = 0.733; Bartlett's test of sphericity: $\chi^2 = 213.885$, df = 3, $p < 0.001$). Similarly, the sense of belonging scale showed good reliability and validity (Cronbach's α = 0.815; KMO = 0.716; Bartlett's test of sphericity: $\chi^2 = 129.025$, df = 3, $p < 0.001$).

Teaching presence. The teaching presence scale was adapted and translated into Chinese from NSSE (2020). It involved 5 items in total showing high reliability (Cronbach's α=0.896), with the KMO value 0.782, and Bartlett's test of sphericity being significant ($\chi^2 = 414.211$, df = 10, $p < 0.001$).

Self-regulation. The self-regulation scale was adapted and translated from Barnard et al. (2009). The original instrument consisted of 24 items across six sub-scales: goal setting, environment structuring, task strategies, time management, help seeking, and self-evaluation. For the purposes of this study, the sub-scales of goal setting and task strategies, comprising six items, were adapted. The scale demonstrated excellent reliability (Cronbach's α = 0.945). Principal component analysis (PCA) indicated strong factor loadings ranging from 0.777 to 0.896. The KMO value was 0.894, and Bartlett's test of sphericity was significant ($\chi^2 = 716.072$, df = 15, $p < 0.001$). Composite reliability (CR) was also assessed, yielding values of 0.878 for goal setting and 0.865 for task strategies, both exceeding the recommended threshold of 0.70 and confirming good internal consistency.

3.3 Data Calibration

Calibration of variables is a key step in fsQCA analysis, involving the transformation of variables into sets and assigning membership scores to samples. The data collected in this study utilized a Likert scale format. To apply the fsQCA method, it is necessary to convert sample data into membership scores ranging from 0 to 1. Based on the characteristics of the sample data and drawing on Ragin (2008) research, this study adopts the direct calibration method. The calibration points for full membership, the crossover point, and full non-membership for causal and outcome variables are set at the 95th, 50th, and 5th percentiles of the sample data, respectively. When the calibrated variable value is exactly 0.5, it is adjusted to 0.501 to avoid case loss.

4. Results

4.1 Analysis of Necessary Conditions

Following the research steps of the fsQCA method, it is first necessary to examine whether the presence or absence of a single condition serves as a necessary factor in determining student

engagement, before analyzing the combined effects of multiple conditions. A condition is considered essential to the outcome if its consistency exceeds 0.9 and its coverage is greater than 0.5 (Ragin, 2008). Otherwise, a condition cannot reliably determine the result on its own, and must be analyzed in combination with other relevant factors. The results are shown below in Table 1:

Table 1. Necessity of Conditions for Student Engagement

Conditions	Student engagement	
	Consistency	Coverage
critical thinking	0.636	0.692
~ critical thinking	0.684	0.697
self-regulation	0.640	0.736
~ self-regulation	0.641	0.622
peer interaction	0.578	0.647
~ peer interaction	0.698	0.691
sense of belonging	0.628	0.672
~ sense of belonging	0.691	0.715
teaching presence	0.665	0.704
~ teaching presence	0.630	0.658

Note. "~ " means "absent".

The results in Table 1 show that the consistency values for all five condition variables are below 0.90, indicating that no single condition is necessary for student engagement. This suggests that, in the context of blended learning, engagement emerges from the combined effects of five variables: critical thinking, self-regulation, peer interaction, sense of belonging, and teaching presence.

4.3 Analysis of Sufficient Conditions

After the analysis of necessary conditions, a sufficiency analysis was then carried out to find out the possible causal configurations contributing to student engagement. The analytical logic of fsQCA dictates that the frequency threshold should be set based on the sample size. For small to medium-sized samples, the frequency threshold is typically set to 1, whereas for larger samples, it should exceed 1. Considering the sample size and the distribution of the truth table in this study, a frequency threshold of 1 was adopted. The consistency threshold was set at 0.9, and the PRI (Proportional Reduction in Inconsistency) threshold was set at 0.7 (Ragin, 2008). A sufficiency analysis of the configuration conditions was conducted (see Table 2), yielding the parsimonious solution, intermediate solution, and complex solution.

Table 2. Conditional Configuration Analysis of Student Engagement

Conditional Variable	Solution		
	1	2	3
Critical thinking	●	⊗	⊗
Self-regulation	⊗	●	●
Peer interaction	⊗	⊗	⊗
Sense of belonging		⊗	●
Teaching presence	●	●	⊗
Consistency	0.908	0.919	0.941
Raw Coverage	0.323	0.309	0.292
Unique Coverage	0.09	0.06	0.07
Overall Solution Consistency	0.909		
Overall Solution Coverage	0.484		

Note. "●" indicates the presence of a condition, and "⊗ " indicates its absence. Larger circles are core conditions, and the smaller ones mean peripheral conditions. The blank space indicates "don't care" conditions. Each column in the table represents a distinct configuration.

This study primarily focuses on analyzing the intermediate solution, using the parsimonious solution to determine whether a variable is a core condition. Variables present in both the parsimonious and intermediate solutions are identified as core conditions, while those appearing only in the intermediate solution are classified as peripheral conditions (Greckhamer et al., 2018). The analysis yielded three configuration results. As shown in Table 2, a total of 3 configurations were identified. The overall solution coverage rate is 0.484, the overall consistency is 0.909, indicating that the degree to which the three configurations of conditions get proper results was high, as the consistency value is higher than 0.8.

In Solution 1, when peer interaction and self-regulation were absent, critical thinking and teaching presence lead to better student engagement in BL. In Solution 2, when critical thinking, peer interaction, and sense of belonging were absent, teaching presence and self-regulation can be combined to lead to student engagement. In Solution 3, when teaching presence, peer interaction, and critical thinking were absent or at a very low level, their self-regulation and sense of belonging can lead to student engagement.

5. Discussion

The results in Tables 1 and 2 indicate that none of the factors, on their own, function as necessary conditions for determining student engagement in blended learning; rather, they must be configured in combination to influence learning outcomes. In essence, student engagement in BL arises from the interplay of both internal and external learner factors.

Solution 1 provides strong evidence for designing blended learning with an emphasis on facilitating critical thinking and ensuring robust teaching presence, especially for students who may lack intrinsic motivation or social scaffolding. Students with low peer interaction and low self-regulation lack both external social stimulation and internal control mechanisms. However, the combination of critical thinking (students' ability to analyze, evaluate, and synthesize information) and teaching presence (teacher's active facilitation and instructional design) can compensate for these deficiencies, effectively fostering student engagement. This aligns with what the Community of Inquiry framework emphasizes, where critical thinking and teaching presence are considered to be crucial elements. Critical thinking compensates for the lack of peer interaction by allowing students to independently reflect, question, and build upon their learning experiences without relying on social scaffolding. It also partially mitigates the absence of self-regulation by engaging students intellectually and keeping them mentally involved in the learning process (Elder & Paul, 2020). The findings substantiates the idea that teaching presence should be expanded in providing external support and structure in blended learning, particularly when students need more support for self-regulation (Shea & Bidjerano, 2010). This finding supports the idea that teachers can design and facilitate activities that explicitly guide students' critical thinking processes by providing detailed instructions, posing thought-provoking questions, or scaffolding complex tasks to foster engagement (Lai, 2011). Moreover, increased teacher support helps sustain engagement, extending the findings of Means et al. (2013), who emphasized that students with varying levels of motivation and self-regulation require alternative instructional models.

In Solution 2, when critical thinking, peer interaction, and sense of belonging are absent, teaching presence and self-regulation can be combined to predict student engagement. The absence of critical thinking, peer interaction, and a sense of belonging suggests that in blended learning, when social and cognitive conditions are absent or weak, student engagement relies more on teacher support and students' intrinsic motivation to compensate for these deficiencies, thereby effectively fostering learning engagement. Teaching presence, through external guidance, helps reduce the confusion that may arise from limited social interaction in blended learning and provides students with encouragement. This result also supports the view that students with strong self-regulation skills, even in the absence of a sense of community, can remain focused on their own learning and still demonstrate high levels of engagement (Deci & Ryan, 2004). In blended learning, teaching presence, through clear instructional design, guidance, and feedback, provides students with a strong sense of direction (Garrison & Vaughan, 2008).

Solution 3 shows that when teaching presence, peer interaction, and critical thinking are absent or at

very low levels, self-regulation and sense of belonging can still predict student engagement. This finding supports previous research suggesting that in online learning, when teaching presence is lacking, self-regulation and sense of belonging remain key predictors of engagement (Sun & Rueda, 2012). This aligns with the idea that successful online learners are self-regulated and actively engage both cognitively and affectionately (Shea & Bidjerano, 2010). Chiu (2022) found that relatedness is the most critical factor for student engagement, highlighting the importance of establishing online peer support groups. Similarly, fostering a sense of belonging helps build a learning community that reduces the risk of dropout (Rovai, 2002). Within such communities, the social obligations of participation and attendance enhance motivation, interaction, and group cohesion, which in turn support engagement and increase the possibility of deep and meaningful learning (Cleveland-Innes & Wilton, 2018).

6. Conclusion and Implication

This study employs a fsQCA method to explore how critical thinking, self-regulation, peer interaction, sense of belonging, and teaching presence collectively shape student engagement in blended learning among Chinese learners in higher education. The results indicate that none of the antecedent factors alone play a decisive role in predicting student engagement. Regarding the pathways to effective engagement, three distinct configurations of these factors are identified, offering novel insights into the complex interplay among critical thinking, self-regulation, peer interaction, sense of belonging, and teaching presence. Collectively, these pathways demonstrate that student engagement in blended learning can be achieved through multiple combinations of cognitive, social, and structural supports.

These findings have important implications for practitioners of blended learning. For educators, it is crucial to establish a strong teaching presence in blended courses by employing strategies such as video explanations, timely responses, and personalized guidance to enhance engagement. Proactive teacher intervention is particularly important when students have limited peer interaction. Maintaining active communication with students helps sustain teaching presence, especially in the online component of blended learning. Clear instructions and well-defined goals for each activity ensure that students understand expectations. Given the independent nature of online learning, educators can also leverage adaptive learning technologies to personalize learning paths, support student autonomy, and foster a community of practice through small-group collaboration and peer mentoring.

However, this study did not examine the distinct dimensions of student engagement in depth. Future research should explore how different configurations of variables influence cognitive, emotional, and behavioral engagement.

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