Environment and Social Psychology (2025) Volume 10 Issue 9
doi: 10.59429/esp.v10i9.3878
ISSN: 2424-8975 (O)
2424-7979 (P)

RESEARCH ARTICLE

Empowering learning engagement in higher education with active learning experiences in STEM classrooms

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ABSTRACT

Students often feel disengaged in class discussions due to ineffective teaching methods, such as passive lectures and over-reliance on learning materials, which lack interactive elements like group work or open discussions. Repetitive, simplistic content further diminishes interest by failing to challenge them. Uninspired teaching attitudes and outdated, irrelevant learning materials undermine motivation and fail to connect studies with real-world applications. This paper explored how active learning experiences in classrooms encourage students to participate in class activities and discussions. Fifteen science, technology, engineering and mathematics (STEM) college students were purposely sampled for this study. Their experiences in learning STEM-related subjects were explored through one-on-one interviews, allowing for the collection of detailed narratives. The findings revealed that several active learning strategies effectively engaged students in the learning process. The relevance of learning materials to real-world contexts significantly enhanced engagement, as students valued instructors who connected theoretical concepts to practical applications and current events. The flipped classroom approach also emerged as a powerful method, enabling students to transition from passive learning to active participation through discussions and hands-on activities during class presentations. Teachers' energy and passion for the subject not only enlivened even challenging or monotonous material but also inspired students to engage more actively, which transforms the classroom dynamic into one of motivation and intellectual curiosity. Timely and constructive feedback was essential in maintaining student engagement, as it guided

ARTICLE INFO
Received: 7 July 2025 | Accepted: 5 September 2025 | Available online: 16 September 2025

CITATION
Legarde MAA, Mundo MD, Chavez JV, et al. Empowering learning engagement in higher education with active learning experiences in STEM classrooms. *Environment and Social Psychology* 2025; 10(9): 3878 doi:10.59429/esp.v10i9.3878

improvement, encouraged reflection, and supported a collaborative learning atmosphere. Rather than passively receiving information, students actively engage through activities such as discussions, problem-solving, hands-on tasks, and group projects.

Keywords: Academic boredom; active learning; instructional attitude; student engagement; teacher enthusiasm

1. Introduction

Active learning, a method centered on engaging learners directly in the educational process, demands that students critically reflect on their actions and their implications [2]. Unlike traditional classrooms—where teachers present concepts through demonstrations, followed by passive student practice—active learning requires intellectual, social, and physical participation to construct knowledge collaboratively [1].

The multidimensional engagement facilitated by active learning creates a more enjoyable and impactful experience for students while simultaneously addressing essential academic content. Research indicates that active learning enhances performance, boosts motivation, and cultivates interest in science, technology, engineering and mathematics (STEM) fields [1, 4]. These benefits stem from the integration of intellectual, social, and physical aspects of learning, all of which contribute to students' ability to understand and apply ideas [3].

Active learning is associated with the cultivation of metacognitive abilities, self-reflection, learner autonomy, skill acquisition, and the collaborative construction of understanding among peers [9]. It empowers students to take ownership of their education by making decisions and applying self-regulation strategies throughout the process [8]. This method actively engages learners, encouraging them to utilize their cognitive capacities and critical thinking skills to navigate and internalize the material being taught. For example, the "learning by doing" approach emphasizes experiential learning, which prioritizes hands-on practice over theoretical instruction, enabling students to develop knowledge and skills through real-world application [7]. This approach highlights the importance of integrating knowledge with transformative experiences to encourage meaningful learning [5–6]. Unlike traditional theoretical learning, which can disengage students and result in diminished retention, learning by doing actively involves learners at every stage, making education both engaging and impactful.

This paper analyzed how active learning experiences in classrooms develop learning engagement and mitigate students' academic boredom among STEM students. Academic boredom is increasingly recognized as a complex achievement-related emotion involving interwoven affective, cognitive, physiological, expressive, and motivational dimensions [13]. It is typically characterized by negative emotions, such as disinterest or dissatisfaction, cognitive disengagement, including inattention and procrastination, low physiological arousal, and lethargy, all of which culminate in a desire to escape the learning environment [11–12]. This emotional state often arises when learners perceive their activities as lacking challenge or relevance, failing to provide any meaningful incentive, whether positive or negative [10].

In the theoretical research context of cognitive/motivational mediators between emotion and learning achievement, boredom weakens students' motivation, consequently impairing their academic performance [13]. Some scholars have identified a relationship between academic boredom and various motivational variables for learning, and academic achievement [14].

In addition, the majority of active learning studies have focused on cognitive processes, while giving less attention to the social dynamics that shape students' emotional experiences. From a social constructivist perspective, learning is co-constructed through peer interaction, teacher enthusiasm, and the contextual relevance of materials. Control-Value Theory further explains how these social processes shape students' appraisals of control and value: when materials feel relevant, value is enhanced; when instruction scaffolds participation, control is increased. Low value and low control, by contrast, generate boredom. By explicitly integrating CVT with social constructivism, this study frames boredom not as an isolated psychological state but as the outcome of socially mediated classroom processes, thereby clarifying how active learning strategies can be designed to counteract disengagement. Control-Value Theory [15] provides a complementary lens by explaining how emotions emerge from appraisals of control and value. From a constructivist standpoint, these appraisals are not formed in isolation but are socially constructed through teacher enthusiasm, peer interaction, and the perceived relevance of materials. Integrating CVT with constructivism therefore clarifies how external social processes shape emotional experiences like boredom.

While prior research on active learning has emphasized cognitive outcomes, fewer studies have examined the emotional dimension of student engagement, particularly boredom. Existing work has noted the benefits of collaborative activities [15] and guided exploration [16], but has not explicitly connected these practices to students' achievement emotions. This study addresses that gap by integrating social constructivist principles with Control-Value Theory to analyze how classroom processes influence boredom.

2. Literature review

Raffaelli, Mills and Christoff[17] pointed out the inconsistencies in the concept of boredom, pointing out that a unified operational definition has yet to be agreed upon. However, studies that analyzed the literature have begun to clarify the conceptual framework linking antecedents, experiences, and consequences of boredom [21], albeit with a broader and more generalized application. Academic boredom is a complex negative emotional state characterized by feelings of low arousal, discomfort, and repetition during learning tasks [19–20]. This state leads students to disengage, feeling excessively fatigued and viewing learning activities as dull or monotonous (Dagoy THS, Ariban AI, Chavez JV, et al., 2924). The developmental stage of adolescence exacerbates this issue, as young learners are often less equipped to identify and manage academic boredom effectively [18].

As the predominant emotional experience in the context of learning, academic boredom has significant ramifications for student outcomes, impacting attention, motivation, and overall satisfaction [24]. High levels of boredom tend to correlate with disengagement, demotivation, and decreased academic performance [23]. It can also contribute to negative behaviors such as peer violence and emotional and behavioral problems [22].

The review of antecedent factors influencing academic boredom is categorized into three primary groups: demographic factors, including variables such as gender, age, and grade level [26], psychological factors, particularly cognitive appraisals like self-efficacy, task values, and emotional regulation [20], external factors, such as perceived teacher support, autonomy support, and teaching creativity [25]. This paper focused on external factors, particularly on the context of classroom dynamics and instructional strategies.

Research on the antecedent factors influencing academic boredom among students has largely overlooked several significant variables that may have a substantial impact. These include academic buoyancy [33], teacher enthusiasm [32], teacher immediacy and professional dedication [31], self-compassion [30], and psychological capital [29]. Given how social psychology impacts the learning perceptions of students, this paper believes that active learning could stimulate students into engaging in classroom discussions. There is a major shift from traditional lecture-based instruction, often criticized as passive, toward more engaging and interactive pedagogies, such as problem-based learning, small-group activities, and design projects [27–28].

Freeman et al.[34] analyzed 225 studies in STEM disciplines and revealed that active learning significantly improved exam performance, increasing scores by nearly half a standard deviation, while reducing course failure rates by 55%. Theobald et al.[35] focused on underrepresented groups in STEM and found that active learning reduced achievement gaps in exam scores by 33% and passing rate disparities by 45%. Earlier, Hake[36] demonstrated the superiority of interactive engagement over traditional lectures in physics education, reporting average gains nearly two standard deviations higher for active learning methods.

Active learning emphasizes a student-centered approach, where learners actively participate in classroom activities rather than passively absorbing information. This pedagogical method rests on the premise that learning success hinges on students constructing new knowledge through active involvement in their educational processes [39]. However, active learning experiences are not widely applied in most countries. For example, in many Indonesian high schools, teaching is characterized by teacher-initiated interactions, where students are primarily limited to answering questions rather than engaging in substantive dialogues or collaborative activities [38]. This teacher-centered approach perpetuates a hierarchical interaction structure, contrary to the participatory ethos of active learning. Scholars have noted that such practices align with cultural norms that value student passivity, with classroom participation occasionally perceived as disruptive [37].

3. Theoretical review

In constructivism, Paulo Freire proposed that education should focus on learning rather than teaching. He emphasized that learning should be a process where individuals construct knowledge both individually and socially [42]. In constructivist classrooms, the emphasis shifts from teaching to understanding students' behaviors and their learning processes [40–41]. While teachers continue to play an essential role, their functions evolve, transitioning between expert, guide, and facilitator. Constructivist environments are designed to encourage intrinsic motivation in students, encourage self-directed learning, and provide continuous support, context, and feedback from instructors.

In such environments, students are encouraged to build on prior knowledge, engage in critical thinking, and present their ideas both independently and collaboratively. Assessment also shifts from traditional grading to self-assessment and peer evaluations, encouraging intrinsic motivation and fostering self-directed learning over time [41, 43–45]. This approach moves away from extrinsic measures of success and instead focuses on fostering long-term motivation through more personal, reflective engagement with content.

Braxton, Milem and Sullivan[46] identified four key active learning behaviors in classrooms: class discussions, group work, higher-order thinking activities, and exam questions focusing on knowledge level. Effective classrooms should engage students in both action and reflection. Class discussions promote critical engagement with course content, while group work develops collaborative thinking and problem-solving. Higher-order thinking activities challenge students to apply deeper cognitive processes, in contrast to fact-based exam questions, which are deemed counterproductive for active learning as they encourage surface-level understanding [47]. Together, these behaviors reflect faculty efforts to develop an interactive and reflective learning environment, supported by evidence of their face validity as measures of active learning.

Active learning is also linked to social integration, a critical factor in student persistence. Although Tinto[48] original propositions do not explicitly include social integration as influenced by faculty teaching behaviors, subsequent research has highlighted the role of faculty-student interactions and active learning in promoting institutional commitment and reducing dropout rates [49]. Expanding Tinto's framework to include active learning and related teaching practices can deepen our understanding of the mechanisms driving student persistence. Specifically, faculty who employ active learning strategies may enhance students' sense of belonging and institutional commitment, paving the way for revised theories that emphasize the broader dimensions of teaching performance in supporting student engagement.

The control-value theory posits a cognitive-motivational mediation model where achievement emotions such as boredom affect academic engagement and achievement through a series of self-regulatory processes including interest, cognitive resource allocation, and effort regulation [55]. Environmental theories of boredom emphasize that constraints on individuals' autonomy and actions [54] can increase the likelihood of experiencing boredom [53]. Functional theories of boredom suggest that boredom serves as a signal of wasted time, indicating that the current activity does not maximize psychological well-being relative to alternatives [21, 51–52]. Further, attentional theories focus on the role of cognitive resources in regulating attention as a key determinant of boredom experience [50]. Essentially, individuals are more likely to find tasks boring when they perceive them as lacking intrinsic value or when they have attractive alternative activities available. These theories suggest that boredom occurs when an individual fails to focus attention or engage with a task, due to a limited capacity to process information and prioritize relevant details.

4. Objectives

This paper explored the experiences of STEM students in learning, the causes of academic boredom, and how active learning experiences encouraged them to participate in classrooms. This paper analyzed how learning experiences shaped the emotional state of college students towards positive academic participation. Below are the specific research questions answered in this study.

1. What are the causes of academic boredom among STEM students?
2. What active learning experiences in classrooms encouraged students to participate?

5. Methods

5.1. Research design

This paper explored how STEM students feel about having academic boredom, how this impacted their productivity and learning enthusiasm. This paper also explored active learning strategies that encourage students to be engaged in the STEM learning processes. Exploratory studies aim to gain an initial understanding of phenomena that are not well-documented or have limited prior investigation, making them especially relevant for addressing emerging issues [59, 64]. These studies focus on identifying patterns, generating insights, and recognizing key themes rather than testing hypotheses or confirming established theories [62–63]. They often serve as a precursor to more structured research by employing flexible and predominantly qualitative methods such as interviews, observations, and open-ended surveys. These methods enable researchers to explore the nature of social or psychological phenomena in depth [15, 62]. This approach allows for the identification of general patterns and provides the data needed for hypothesis development, which can guide more rigorous investigations [60–61]. Although sometimes criticized for perceived lack of scientific rigor, exploratory studies are widely valued for their efficiency in gathering preliminary data and offering new perspectives [59]. In social sciences, these studies are characterized by systematic planning to thoroughly examine questions arising from phenomena, thereby contributing to a more comprehensive understanding of underexplored areas [56, 58]. Emphasizing flexibility and participant engagement, exploratory designs clarify the scope of a phenomenon and encourage active contributions from study participants, which generates knowledge in fields that remain largely unexplored [56–57]. This paper answered two critical questions in learning: (1) how students experience academic boredom? and (2) what active learning experiences could encourage students to engage in class discussions? This paper was expected to frame the scope of active learning and understand its role in reducing students' academic boredom, especially in the context of STEM.

5.2. Participants and sampling

Sampling in exploratory research is characterized by a deliberate, focused approach that prioritizes depth of understanding over broad generalizability [71]. Purposive sampling enabled researchers to select participants who have specific characteristics, knowledge, or experiences directly pertinent to the research question, thus ensuring the richness and relevance of the data collected [58, 70]. Emmel[65] highlights that in qualitative research, the value of cases lies in their quality rather than quantity, making smaller, strategically chosen samples particularly effective for uncovering patterns and themes. Purposive sampling aligns with the purpose of exploratory research, which seeks to identify emerging trends and refine preliminary concepts without the constraints of hypothesis testing. Further, the flexibility of this method allows researchers to adapt sampling criteria as new ideas and insights surface during the data collection process, which is especially advantageous in exploratory studies [58, 69]. In this study, purposive sampling was employed through online methods [68], utilizing preliminary open-ended questions to explore participants' learning experiences. Three primary sampling criteria were established: (1) enrolled in the Academic Year 2024-2025, (2) takes a STEM course, (3) experiences academic boredom. Out of the 81 STEM students who responded to the online survey, only 15 were selected for interviews based on these criteria. Although smaller samples may be critiqued for their limited scope, they help in developing adaptable concepts and contextualizing phenomena, making them indispensable in exploratory research frameworks [64, 66–67]. **Table 1** provides a summary of the information collected from the interviewed participants.

Table 1. Summary information of 15 sampled students

Participant Name	Sex	Age	STEM Course	Experiences in Academic Boredom
Alex	Male	20	Engineering	Frequently loses focus during lectures.
Casey	Female	22	Statistics	Finds the subject repetitive and struggles with motivation.
Jordan	Male	21	Mathematics Education	Often distracted during class due to lack of engagement.
Taylor	Female	19	Computer Science	Feels overwhelmed by the complexity of coursework.
Jamie	Male	23	Biology	Finds lectures boring and prefers hands-on learning.
Morgan	Female	20	Chemistry	Tends to daydream during lectures.
Riley	Male	21	Engineering	Gets easily frustrated with theoretical concepts.
Dana	Female	22	Statistics	Frequently misses classes due to disinterest.
Sam	Male	19	Mathematics Education	Struggles to connect with the subject matter.
Drew	Female	23	Computer Science	Experiences mental fatigue after long hours of coding.
Quinn	Male	20	Biology	Finds it hard to stay engaged in lectures.
Leslie	Female	21	Chemistry	Often feels overwhelmed by course material.
Blake	Male	22	Engineering	Frequently skips classes due to boredom.

Participant Name	Sex	Age	STEM Course	Experiences in Academic Boredom
Taylor	Female	20	Mathematics Education	Struggles with motivation in class.
Morgan	Male	21	Computer Science	Feels disengaged during lectures.

Table 1. (*Continued*)

5.3. Instrumentation

A semi-structured interview guide was developed to gather the responses from the students. This type of guide integrates structure with flexibility, allowing researchers to direct the conversation towards critical themes while simultaneously enabling participants to express their narratives and insights freely [76]. The process begins with a clear understanding of the research context, objectives, and relevant literature, which serves as the foundation for designing preliminary questions that address the core themes of the study [75]. These initial questions are carefully crafted to initiate discussion and gather pertinent information, ensuring clarity and minimizing ambiguity [74]. The semi-structured format is designed to minimize biases, such as social desirability, by using structured themes while allowing open-ended questions that encourage participants to provide detailed narratives [73]. These interviews are not rigid scripts but adaptable tools that enable interviewers to explore responses, clarify information, and explore emerging themes [72]. Pilot testing the interview guide was a critical step to identify potential issues related to clarity, language, and scope . This phase allowed researchers to refine the questions based on feedback, enhancing the guide's reliability and accessibility. Expert input further enhances the guide's alignment with the research goals, ensuring it can capture comprehensive responses . After a thorough examination, pilot testing, and expert validation, the final interview guide is presented in Table 2, with the adjustments made to optimize its effectiveness in eliciting meaningful data and facilitating a discussion with participants. This ensured that all critical topics were addressed while creating space for participants to express themselves fully, which developed the richness of the data collected and minimized biases.

In practice, the semi-structured interviews lasted between 30–50 minutes (M = 42). All interviews were conducted face-to-face, audio-recorded with consent, and transcribed verbatim. Transcripts were checked against recordings for accuracy. While transcripts were not returned for member-checking due to time limitations, saturation was observed by the 13th interview, as no new themes were emerging. To enhance credibility, two coders independently reviewed an initial subset of transcripts, resolving discrepancies through discussion, and an audit trail of coding decisions was maintained. Although formal intercoder reliability was not calculated, reflexive discussion and consensus ensured analytic consistency.

Table 2. Interview guide questions

Research Questions	Guide Questions	Thematic Markers
What are the causes of academic boredom among STEM students?	a. What causes academic boredom in your classes? Explain an example. b. What are the effects of academic boredom in terms of your learning pace? Explain how it happens. c. How do you describe your productivity when you experience academic boredom? Elaborate the process.	Causes of Academic Boredom Effects on Learning Pace Impact on Productivity
What active learning experiences in classrooms encouraged students to participate?	d. Why is academic boredom going to reduce the enthusiasm of the learners? Explain further. e. What can instructor do in terms of classroom management, to reduce academic boredom? Narrate some of your experiences with your teachers. f. How should a student respond to academic boredom to	Instructor's Role in Classroom Management Student Responses to Academic Boredom

Research Questions	Guide Questions	Thematic Markers
	continue learning? Explain some self-discovered strategies.	

Table 2. (*Continued*)

5.4. Data gathering procedure

Semi-structured interviews are particularly effective in capturing personal narratives and facilitating in-depth engagement with participants, allowing them to express their lived experiences and perspectives in a detailed manner [82]. This is particularly suitable for phenomenological research, which seeks to explore the subjective meaning individuals assign to their experiences comprehensively [81]. Researchers can maintain the necessary flexibility to explore key themes while adapting follow-up questions to the participants' responses Elhami & Khoshnevisan, 2022; Seidman, 2006). Interviews lasted 30–50 minutes (M = 42). Sessions were recorded, transcribed verbatim, and checked for accuracy. Transcripts were not returned for member-checking, but saturation was observed by the 13th interview. To ensure a systematic and effective interview process, the study adhered to established qualitative research protocols. These included clearly articulating the research objectives, selecting participants with relevance to the study, and providing clear communication regarding the study's purpose, as well as assurances of confidentiality and appropriate data usage [58, 80]. The use of thematic questions guided the discussion, helping maintain focus on key topics while allowing for exploration of emergent ideas as they surfaced during the conversation [79]. To encourage meaningful responses, language barriers were addressed by allowing the participants to use a preferred language/dialect [78]. Audio recordings, with participants' consent, were utilized to ensure accurate data record, while preliminary notes assisted in organizing key points for subsequent analysis [77].

5.5. Data analysis

Reflexive thematic analysis was carried out to analyze the narrative data from one-on-one interviews. This approach is especially suited for exploring shared experiences and the embedded meanings within participants' narratives, providing an in-depth understanding of lived experiences [84]. The flexibility inherent in reflexive thematic analysis allows it to adapt to various research contexts, facilitating the emergence of themes organically as researchers engage with the data, reflecting on the participants' perspectives [15, 89]. The coding process in reflexive thematic analysis is multi-layered, which often starts with descriptive coding then integrates to more interpretive analyses [85, 88]. Reflexive thematic analysis acknowledges the active role of the researcher in shaping interpretations, recognizing that the researcher's values, experiences, and assumptions can significantly influence findings [83]. It requires researchers to maintain a critically reflexive position, continuously examining how their perspectives might impact the analytic process [87]. To ensure methodological rigor while maintaining flexibility, an inductive approach was adopted in this study. This method allows themes and patterns to emerge directly from the data, grounded in the content and context of participants' responses, without being restricted by pre-existing theories or hypotheses [86]. Braun and Clarke[83] proposed the six phases of reflexive thematic analysis (**Figure 1**) which include: (1) familiarization with the data, (2) generation of initial codes, (3) identification of themes, (4) refinement and review of themes, (5) definition and naming of themes, and (6) production of the final report. This iterative process enabled the researcher to transition systematically from basic descriptive coding to advanced interpretative analysis, ensuring that the themes captured both explicit and implicit dimensions of the data [84–85]. While Braun & Clarke's thematic analysis provides transparency, it is limited in capturing processual dynamics. For this study, it suffices, but future research may employ grounded theory or discourse analysis.

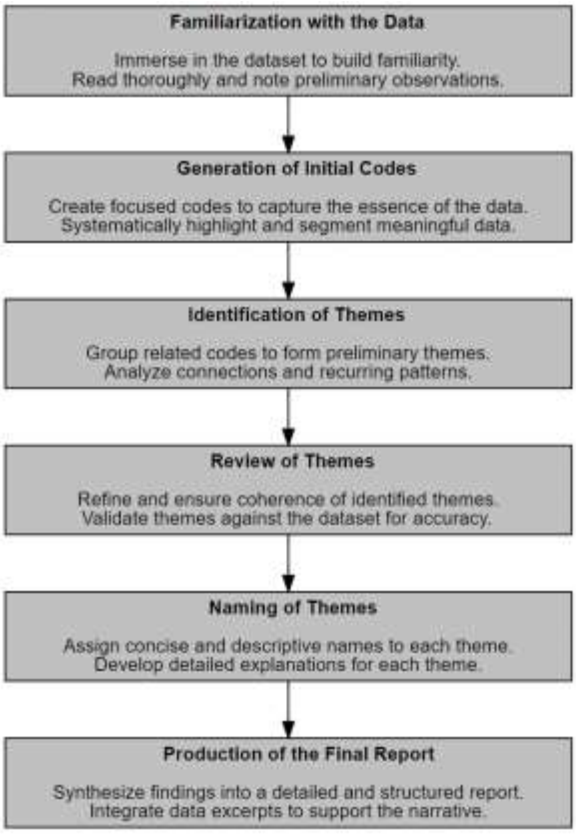

Figure 1. Workflow of data analysis

6.Results

Research Question 1: What are the causes of academic boredom among STEM students?

The findings reveal key factors contributing to academic boredom among STEM students, emphasizing the relation between teaching methods, instructor behavior, and the quality of course materials. A recurring theme was the dissatisfaction with ineffective discussion methods, where students reported disengagement due to passive lecture formats, over-reliance on reading PowerPoint slides, and a lack of interactive activities. The monotony of repetitive or overly simplistic content further exacerbated their lack of focus and motivation, leaving students feeling unchallenged. Another significant factor is the teacher's attitude, wherein students argued on the critical role of instructor enthusiasm and energy in an engaging learning environment. A perceived lack of passion or effort to diversify teaching strategies led to a diminished sense of importance and value in the classroom experience. Lastly, the quality of learning materials emerged as a major concern. Students reported disengagement when faced with outdated, irrelevant, or impractical content that failed to align with modern advancements or their personal aspirations. The absence of meaningful connections between course material and real-world applications further contributed to their lack of interest.

Theme 1: Ineffective Discussion

Ineffective discussion reflected students' dissatisfaction with lecture-based teaching approaches that lacked interactive and engaging elements. Students expressed frustration with teaching methods that primarily involved *reading directly from PowerPoint slides* without incorporating opportunities for *active participation or meaningful discussion.* This one-sided delivery of information often led to a lack of engagement and a sense of monotony, as students felt that lectures lacked *variation or effort to make the content relatable* to their academic or personal interests.

> "The most boring classes I've had were the ones where the professor just reads off PowerPoint slides."
>
> "There's no interaction or room for discussion."
>
> "I don't mind reading textbooks or doing assignments on my own, but I want to feel engaged during class. If it's just lecture after lecture with no variation or effort to make the content relatable, it feels like a waste of time."

Further, the absence of interactive learning strategies, such as *group work, problem-solving activities, or open discussions,* was highlighted as a significant barrier to maintaining their focus and motivation. Students described feeling *uninvolved* in the learning process, which often resulted in them *zoning out* or becoming disengaged during class. This disengagement, in turn, led to difficulties in retaining critical information during lectures, subsequently requiring *additional self-study time* to revisit and relearn missed concepts.

> "I prefer classes where we can work in groups, solve problems together, or have open discussions. Otherwise, I just zone out. When I don't feel involved, my focus disappears."
>
> "I stop paying attention to what the professor is saying, which causes me to miss important points. This not only makes it harder to keep up during lectures but also makes my self-study sessions longer because I have to go back and relearn the material I missed."

The lack of opportunities for *dialogue, hands-on application, or peer interaction* diminished their overall educational experience, causing them to perceive such classes as *unproductive and unmotivating.*

> "I always find it frustrating when the professor just reads from the slides without asking us to do anything."

Students felt that classes often focused excessively on *relearning material they already understood,* which created a sense of stagnation in their learning experience. While they acknowledged that *repetition could be beneficial* in reinforcing knowledge, they found it counterproductive when this approach was overextended, leading to diminished focus and engagement.

> "In some of my classes, I feel like I'm relearning things I already know."
>
> "It feels like the professor is just repeating basic concepts without moving forward or providing new insights. I understand that repetition can be helpful, but when it goes on for too long, it's hard to stay focused."

This lack of learning integration hindered students' ability to connect with the material and undermined their motivation to actively participate. They expressed a strong preference for instruction that incorporated *more complex ideas, real-world applications,* and *updated examples* aligned with current trends and advancements in their field of study. The absence of such elements left students feeling disengaged, as they struggled to see the relevance or value of the repetitive content in achieving their academic or career goals. They believed that the failure to offer *varied, intellectually stimulating material* not only reduced their interest in attending classes but also contributed to a perception of wasted time and missed opportunities for meaningful learning.

> "It's frustrating when professors spend weeks on topics that feel too easy or basic, and there's no deeper exploration."

> "I want to see more complexity, real-world applications, or even updated examples that reflect current trends in the field. If I'm hearing the same introductory ideas every week, it's hard to stay motivated to continue attending class."

Theme 2: Teacher's Attitude

Students recognized the profound influence of a teacher's attitude on the learning experience, with *a lack of passion and enthusiasm* emerging as a significant detriment to classroom engagement. Students consistently observed that *professors who appeared disinterested in the subject matter* inadvertently conveyed a sense of monotony and disengagement, which discouraged active participation. The absence of *energy and excitement* in teaching not only made the classes feel laborious but also undermined the students' motivation to engage with the content.

> "I've had professors who don't seem passionate about the subject they teach."

> "It's hard to stay interested when the person leading the class doesn't seem enthusiastic about the topic themselves. Their lack of energy makes the whole class feel like a chore."

A perceived lack of interest from the instructor often resulted in students feeling *disconnected from the material,* creating a ripple effect that hindered their focus and participation. *Monotonous teaching approaches* and *an apparent lack of investment in pedagogical practices* diminished the overall learning experience, making students feel undervalued as active participants in their education.

> "I think professors underestimate how much their energy influences the class. If they seem disinterested, it's easy for students to check out as well."

> "I've had professors who don't make an effort to vary their teaching methods or even show excitement about the content, which makes the class feel dry and unimportant."

Theme 3: Quality of Learning Materials

Students also believed that the *quality and relevance of learning materials* played a crucial role in sustaining their engagement and motivation in academic settings. Students expressed dissatisfaction when course materials were perceived as *outdated or irrelevant* to their personal goals or future career aspirations. This disconnect hindered their ability to see the *practical applications* of the content, resulting in a diminished interest in the learning process.

> "When the course material feels outdated or irrelevant to my life or career goals, I struggle to stay enthusiastic."

The absence of *relevance and relatability* in the learning materials was identified as a barrier to engagement. Students emphasized the importance of *understanding the purpose and value of their studies* in relation to their broader educational and professional objectives. Without this connection, the learning experience was perceived as lacking significance, contributing to feelings of disengagement and wasted effort.

> "If it's not something I can relate to, it's hard to get excited about learning. I need to see the purpose behind what I'm studying, or else it just feels like a waste of time."

> "Some of the content feels outdated, especially in fields where technology and research evolve so quickly."

A recurring sentiment highlighted the expectation for *up-to-date materials,* particularly in fields characterized by *rapid advancements in technology and research.* When educational content failed to reflect *current trends and innovations,* students found it challenging to remain invested, perceiving the material as disconnected from the realities of modern academic and professional environments. This lack of alignment between course materials and contemporary developments led to a sense of frustration, as students felt that the resources did not equip them with the *knowledge and skills necessary to succeed* in their chosen fields.

> "Learning material that's no longer relevant or up-to-date makes it hard to get excited about the course."

> "In today's fast-paced world, I expect the information I'm learning to be current, and when it's not, I can't help but feel disengaged."

Research Question 2: What active learning experiences in classrooms encouraged students to participate?

Active learning experiences highlighted several key themes that were deemed effective in developing active participation and deeper engagement in the learning process. Learning relevance emerged as a critical factor, with students expressing a preference for instructors who connected course material to real-world examples and current events. The flipped classroom approach was noted as beneficial as it shifted the focus from passive learning to active participation, allowing students to engage more deeply with the material through discussions and hands-on activities. Instructors who displayed a positive attitude and enthusiasm towards the subject were found to significantly influence student engagement, creating a motivating and supportive learning environment. Finally, timely and constructive feedback was recognized as a crucial element in maintaining student engagement, encouraging self-improvement, and promoting a collaborative learning atmosphere.

Theme 1: Learning Relevance

Students consistently emphasized the value of instructors who *bridge the gap* between theoretical concepts and practical scenarios. Students encountered those who are adept at *linking course material* to real-world examples and current events. This approach not only made the learning process more *relevant* but also helped students see the broader implications of the theories they were studying. Rather than merely presenting information from textbooks, this professor actively demonstrated how these ideas applied to *daily life* and the larger world context.

> "Some teachers were great at connecting the course content to real-world examples and current events."

> "Instead of reading from a textbook, he would show us how the theories applied in our lives or the world around us. That made me want to learn more because I could see the value of the material outside of just getting a grade."

For instance, when discussing economic theories, he would relate them to contemporary issues such as *market crashes* or financial trends, which indicated the applicability of the material. This method enabled students to move beyond *rote memorization* and engage in a deeper understanding of the subject matter. It was perceived as not just about acquiring knowledge for grades but about having an appreciation for the *relevance* of the content in real-world scenarios.

> "I had a professor who was great at tying course material to current events. For example, when we studied economic theories, he would bring up examples from the news, like market crashes or the latest financial trends."

> "It helped me see the direct application of what I was learning and kept me engaged. It wasn't just about memorizing concepts; it was about understanding how they play out in the real world."

> "I think incorporating real-world examples that relate to what we're learning makes it more interesting and easier to understand. When teachers connect lessons to practical applications, we feel more involved."

Theme 2: Flipped Classroom

The *flipped classroom* approach was frequently highlighted as an effective method for engaging students in an active learning environment. Participants described a professor who implemented this approach by *posting lectures online before class*, which allowed students to engage with the content at their own pace and come prepared for in-depth discussions and problem-solving exercises during class time. This shift from a passive to an *active learning process* was noted as particularly beneficial, as it enabled students to engage more deeply with the material.

> "I had a professor who flipped the classroom. She'd post lectures online before class, and then use class time for discussions and problem-solving exercises."

> "This way, we could engage deeply with the material, ask questions, and really work through the concepts together. The class wasn't about passively listening to lectures anymore but actively engaging in the learning process."

In one programming class, the *flipped classroom* model required students to respond to the instructor's questions and perform hands-on tasks in real-time during class sessions. This practical application of knowledge not only *enhanced critical thinking skills* but also prepared students to handle unexpected problems they might encounter in real-world scenarios. Another example involved individual reports, where students were tasked with conducting experiments and explaining each step of the process. Such *hands-on activities* not only reinforced theoretical concepts but also connected them to practical applications.

> "There was a time in our programming class, we need to answer our teacher's question in front of the class while also having our hands-on. It helped me develop my critical thinking skills especially when encountering unexpected problems."

> "Our teacher asked us to report in front of the class individually. He gave us topic. We need to conduct the experiment and explain each process we had."

> "Hands-on activities help us be engaged in the learning process and expose us to applications of theoretical ideas."

Theme 3: Positive Attitude

Participants frequently highlighted the *importance of a positive and enthusiastic instructor demeanor* as a critical element of student engagement. They recounted experiences with professors who were visibly *passionate about the subjects they taught*. These educators were described as having the ability to make even dry material more engaging through their *contagious enthusiasm*. They *utilized storytelling* and *posing intriguing questions* to bring the content to life and encourage deeper student involvement. Such approaches *transformed the classroom atmosphere* from a passive learning environment to an interactive one, where students felt more motivated and willing to participate actively.

> "I've had professors who were visibly passionate about the subject they taught, and it made a huge difference."
>
> "Even if the material itself was dry, their enthusiasm was contagious. They found ways to make the class exciting by sharing personal stories or asking intriguing questions. When the instructor's energy is high, it's hard not to feel engaged."
>
> "There was a professor who always came to class with high energy and a positive attitude."

This attitude persisted even on *challenging days*, when *difficult assignments or exams* were given. The professor's *enthusiasm never wavered*, creating a supportive and positive classroom environment that *motivated students to engage fully* in the learning process. The positive example set by the instructor encouraged students to *take ownership of their learning* and align their efforts with the professor's commitment to the subject. This sense of motivation was particularly effective in *cultivating a proactive learner mindset* among the participants.

> "Even on tough days when we had difficult assignments or exams, his enthusiasm never wavered, and it created a positive atmosphere in the classroom. It was motivating because I could see that if he cared so much, I should care too."

Theme 4: Feedback

Participants emphasized that feedback was not merely a component of the educational process but a *vital element* that influenced their motivation and active participation. Immediate feedback, *whether in response to an assignment or during class discussions*, was seen as particularly effective in keeping students engaged and focused on their learning objectives.

> "When teachers give us immediate and constructive feedback, it motivates us to do better and stay engaged in the lesson."
>
> "I feel more involved when teachers encourage us to reflect on our work and discuss how we can improve."

Feedback provided clear guidance on areas of improvement and allowed for quick adjustments to their study strategies. This kind of feedback was perceived as *constructive but not overly critical*, which develops an environment where students felt comfortable making mistakes and learning from them without undue anxiety.

> "Providing feedback in a way that's constructive but not overly critical makes us more open to learning and improving."
>
> "I think timely feedback is crucial. If it's delayed, I forget what I did, and it feels less meaningful to my learning."

Similarly, involving students in peer feedback activities allowed them to gain new perspectives, learn from each other's strengths and weaknesses, and cultivate a collaborative learning environment. This approach not only deepened understanding but also contributed to the development of critical thinking skills and interpersonal communication abilities.

"Teachers who involve us in peer feedback activities make it easier to learn from each other and see different perspectives."

7. Discussion

This paper described active learning as an instruction that engages students directly in the learning process by requiring them to participate actively rather than passively absorbing information. Active learning has emerged as a prominent approach in higher education, reflecting a shift towards more interactive and engaged teaching methods [90]. Numerous studies highlight the effectiveness of active learning in enhancing student learning outcomes and performance [35].

To expand the discussion about active learning, this study believed that exposing students to active learning experiences enables them to feel engaged in learning, which in turn, reduces the incidence of academic boredom. Active learning is a pedagogical approach that involves engaging students through activities such as answering questions, solving problems, discussing content, or teaching peers individually or in groups, as opposed to passive listening [34].

In practical terms, evaluating the effectiveness of flipped classroom strategies requires measurable indicators. These may include changes in attendance rates, improvement in assessment scores, engagement statistics from learning management systems, and student satisfaction surveys. Embedding such measures would allow educators to monitor whether interventions truly mitigate boredom and increase participation.

As per the control-value theory of achievement emotions [92], academic boredom arises from the relation of students' perceived control over achievement activities, the value they assign to these activities and outcomes, and their personal investment in performing well. STEM students supported this, explaining that "…[it's] frustrating when the professor just reads from the slides without asking us to do anything." Specifically, individuals may experience boredom when they feel they have limited control over their learning activities and when they do not place high value on the associated outcomes [93].This highlighted the reasons STEM students may experience boredom, particularly when educators exhibit a negative attitude toward teaching, fail to connect learning content to real-life applications, rely on outdated instructional materials, or deliver discussions that lack integration. Fundamentally, boredom influences academic engagement and achievement through a cognitive-motivational mediation model, involving self-regulation, cognitive resources, and the strategic use of different learning environments [92]. When students experience boredom in the classroom, their level of engagement in discussions diminishes significantly, often leading to disengagement, zoning out, and a lack of active participation. This state not only hinders their ability to absorb and process information but also negatively impacts their critical thinking and problem-solving skills [91]. For them, it is *"...hard to stay interested when the person leading the class doesn't seem enthusiastic about the topic themselves."*

Figure 2. Thematic word cloud

Figure 2 presents the prominent codes observed in the narratives of participants. Essentially, active learning student participation, engagement, and the practical application of knowledge through dynamic methods. Key elements of this approach include linking course content to real-world examples, ensuring that learning is relevant and applicable beyond the classroom. Active participation, such as problem-solving exercises and real-time feedback, promotes critical thinking and the application of concepts in practical contexts. Instructors' positive attitude and enthusiasm further motivate students, fostering a collaborative and supportive environment. The flipped classroom model shifts from passive listening to active participation, encouraging students to engage with content before class and apply it through discussions and hands-on activities. Collaborative learning and peer feedback broaden students' perspectives, deepen understanding, and encourage critical thinking. Timely and constructive feedback guides students' progress, encourages reflection, and enhances self-improvement. Finally, active learning also promotes student responsibility, autonomy, and proactive engagement, reinforcing participation and knowledge retention. Continuous interaction with the material through activities like storytelling and problem application helps maintain student engagement and reinforces learning.

Active learning could potentially reduce the impact of boredom to students' learning engagement, as it is broadly characterized by its emphasis on student activity and engagement in the learning process. It typically involves methods such as problem-based learning, small group activities, and design projects, and is frequently proposed as an effective alternative to the traditional lecture format often associated with passive learning [27–28, 35]. Similarly, this study observed that active learning experiences teach relevance of learning the subject, oftentimes exposing students to real-life applications, hands-on activities, and problem-based learning. For example, in programming, students who were exposed to hands-on activities while doing in-class presentations believed that "…it helped develop critical thinking skills especially when encountering unexpected problems." This type of active learning experience exposes students to activities that demand strong thinking skills, enabling them to engage in learning more effectively than passive teacher discussions. Active learning, at its core, should help students "…be engaged in the learning process and exposed to applications of theoretical ideas." Consequently, this counteracts academic boredom as it arises when individuals are unable to effectively direct, sustain, or remain engaged with an activity [94]. Attention, regarded as a finite cognitive resource, allows individuals to selectively process and prioritize certain information while disregarding irrelevant stimuli. Incorporating interactive and stimulating learning experiences prevents the stagnation associated with boredom by maintaining students' focus on relevant and meaningful activities.

Further, this study noted that active learning also needs a positive instructional attitude and constructive feedback from teachers. Instructional strategies should incorporate and convey positive emotions from teachers, particularly when addressing the needs of students facing academic challenges. Students often regard their relationships with teachers as one of the most vital aspects of their educational experience. Geng et al.[95] argued that teachers who uphold high expectations and exhibit positive dispositions foster more conducive learning environments and significantly enhance student performance. Teachers' positive instructional attitude was an essential component of effective active learning strategies. For example, one student believed that when teachers show enthusiasm "…even if the material itself was dry, their enthusiasm was contagious. They found ways to make the class exciting by sharing personal stories or asking intriguing questions." Turner and Christensen[96] note that both educators and students recognize the critical role of classroom activities in promoting instructional effectiveness and nurturing prosocial behaviors. Similarly, Durgungoz and Durgungoz[97] assert that these interactions are essential for establishing a strong social presence within the learning environment. Empirical evidence further highlights the influence of the frequency, quality, and nature of classroom interactions on the development of social presence. Adopting active learning experiences becomes more effective when complemented by positive teacher attitudes and strong teacher-student relationships. These factors enhance student engagement in the learning process and help mitigate the occurrence of academic boredom. In alignment with this perspective, Pennings et al.[98] demonstrate that regular and constructive classroom interactions significantly enhance the depth and quality of social engagement, thereby enriching the overall educational experience. One example of effective teacher-student relations was the use of feedback in learning. Students believed that "[providing] feedback in a way that's constructive but not overly critical makes us more open to learning and improving."

The findings have significant implications in teaching STEM programs in higher education. Engaging students directly in the learning process through activities that require active participation encourages understanding of the content and develop critical thinking [99]. This approach involves active exploration and application of knowledge, enhancing their ability to analyze, synthesize, and evaluate information effectively. In a psychological sense, when teachers demonstrate enthusiasm and invest in developing a constructive emotional climate, they contribute to an engaging and enriching learning experience. This is particularly important for students who may struggle academically or have diverse learning needs. The implications of such a supportive environment are far-reaching, affecting not only student engagement but also their overall academic success and well-being. Having community-building extend beyond individual learning outcomes—they contribute to the development of a positive classroom culture where students feel motivated to engage and participate actively.

8. Conclusion

This study explored academic boredom among STEM students through the lens of Control-Value Theory and social constructivism. The findings reveal that boredom was primarily influenced by teaching methods, instructor behavior, and the quality of learning materials. Ineffective discussion formats, disinterested teaching, and outdated or irrelevant content emerged as persistent drivers of disengagement. By contrast, teacher enthusiasm, relevant course materials, timely feedback, and active learning strategies such as flipped classrooms and real-world problem-solving activities helped sustain motivation and participation.

These results highlight the importance of socially mediated classroom processes in shaping students' perceptions of control and value, thereby influencing their emotional engagement.

The practical implications point to the need for educators to integrate active learning practices into STEM programs while maintaining high-quality feedback and supportive teacher–student relationships. When instructors make learning interactive, relevant, and emotionally constructive, students are more likely to remain motivated and engaged, even when facing challenging content. The sample was not only small but also concentrated in engineering and computer science programs within a single institution. This disciplinary skew introduces sampling bias, as experiences of students in other STEM fields (such as biology, chemistry, or mathematics) may differ substantially. This bias is a common limitation in single-institution studies and underscores the need for replication across diverse academic contexts.

At the same time, these findings should be interpreted cautiously. The sample was drawn from a single institution and disproportionately represented engineering and computer science students, which limits generalizability across the broader STEM landscape. The small sample size and qualitative design mean that the study is best understood as exploratory. Moreover, while thematic analysis provides transparency, it is less suited to capturing the processual dynamics of social interaction; future research may benefit from grounded theory, discourse analysis, or mixed-method approaches. Incorporating observational data, performance indicators, or triangulated measures would also strengthen validity and help connect students' subjective accounts with objective outcomes.

In sum, this study contributes to the understanding of how academic boredom in STEM is shaped by both emotional appraisals and social classroom processes. By integrating Control-Value Theory with constructivist principles, it underscores the need for pedagogical strategies that foster both perceived value and perceived control. Although bounded in scope, these insights provide a foundation for future research and practice aimed at reducing boredom and enhancing engagement in higher education STEM contexts.

Conflict of interest

The authors declare no conflict of interest.

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