WIP: The Responses of Engineering College Students with Attention Deficit and Hyperactivity Disorder (ADHD) to Instructional Practices

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Introduction

The evolution of instructional practices in higher education reflects the need to enhance student engagement and learning outcomes. Lecture-based instruction is a teacher-centered approach [1] [2], while active learning is a student-centered teaching approach [3]. Active learning outperforms lectures in developing critical thinking, problem-solving, and deeper understanding while improving attitudes, achievement, retention, and persistence [4] [5]. However, it also presents challenges, including the need for foundational knowledge, resource intensity, and implementation difficulties in large classes [1]. In engineering education, traditional instructional practices—such as lectures and individual assignments—continue to shape classroom experiences [6]. These traditional instructional practices often do not align with the learning preferences and strengths of students who have ADHD [7]. Students with ADHD face the challenge of navigating barriers and obstacles to achieve success [8] . While student-centered teaching approaches have been shown to support diverse learners and foster critical thinking skills [9], there is little known about how neurodivergent students respond to these methods. Understanding these responses is particularly important in engineering settings, where rigorous coursework and varied instructional approaches significantly impact students' academic success.

This work in progress emphasizes on how engineering college students with ADHD respond to various instructional practices, including traditional lecture-based and active learning environments. For this work in progress, our research question asks: *How do engineering college students with ADHD respond to various instructional practices?* This study seeks to explore insights into how these students navigate different instructional approaches, aiming to inform more inclusive instructional practices that foster academic success in engineering.

Conceptual Framework

Our conceptual framework is grounded in Terenzini and Reason's College Impact Model [10]. In our work [11], we view the individual student experience (i.e., classroom experiences, academic adjustment, and students' sense of belonging) as a critical element of the students' success. In this work-in-progress, we focus on the students' classroom experiences, exploring the relationships between *instructional practices* (lecture-based and active learning), *student attitudes and feelings,* which include positive and negative feelings and emotional reactions [12]; *student engagement*, how involved or interested (cognitively, emotionally and/or behaviorally) students are in their learning process [13]; *classroom interactions,* both with instructors and peers, significantly shape students' sense of belonging and academic achievement [14]; and lastly, understanding instructors' expectations, which is students' understanding of course demands and shape their responses to instructional strategies.

Methods

Participants and Data Collection

After receiving approval from the University Institutional Review Board (IRB), we recruited engineering college students with ADHD at a research-intensive institution located in the Midwestern United States. We emailed a random sample of 1,800 of the 11,104 currently enrolled engineering students, inviting them to attend a focus group or interview if they had previously received a formal ADHD diagnosis. We also collected participants' demographic information (gender identity, pronouns, age, class level, major, and race/ethnicity) using an in-take survey. A total of 26 students participated in nine focus groups and six individual interviews, exploring experiences with lecture-based and active learning instruction. Four focus groups focused on lectures, five on active learning, and six interviews on both. Focus groups (90 min) were held in person or via Zoom, while interviews (30–60 min) were conducted on Zoom. Separate protocols guided both formats, each covering four main sections [11]. At the start, we provided a handout defining key terms and framing the student experience. Using a semi-structured approach, we explored three key aspects of their experience and concluded with an open-ended reflection.

Data Analysis

We transcribed all focus groups and individual interviews verbatim, anonymized them, and analyzed them using MAXQDA24[15]. In the first round of coding, we used a deductive approach [16] to develop a codebook based on pre-defined codes from our conceptual framework. Specifically, four researchers independently coded the transcripts, collaboratively refined the codebook (Appendix Table 1), and reviewed the codes to ensure inter-coder reliability. In the second round of coding, we adopted an inductive approach to identify and categorize emerging themes (Appendix Table 1). This second part of the analysis involved three researchers.

Preliminary Findings

In this paper, we present preliminary findings from two of the nine focus groups—one addressing lecture-based instruction and the other addressing active learning. Each session included four engineering college students with ADHD, respectively, and we present demographic information about the participants in Appendix Table 2. In Appendix Table 1, we present sample quotes for each student's response to instructional practices.

Students' attitudes and feelings

Students expressed mixed feelings towards lecture-based classes, often highlighting challenges such as maintaining focus, staying accountable, and effectively absorbing content. **Maria** valued note-taking and shorter, frequent lectures to help her stay interested but found extended sessions overwhelming. **John** noted how slides-based lectures made it easy to lose track despite his efforts to listen attentively. Similarly, **Ana** emphasized the difficulty of staying on top of material in non-interactive lectures, often leading to cramming before exams, particularly when attendance wasn't mandatory. **Sofia** questioned the value of attending lectures, as she often felt she could learn independently at home. While students acknowledged the necessity of lecture-based teaching for certain subjects, they expressed a preference for integrating active learning elements to enhance accountability and engagement.

Students shared how active learning instruction positively shaped their feelings and attitudes toward classroom experiences. **Samuel** appreciated collaborative learning and immediate feedback, which helped him practice skills effectively. **Emily** found that being active in class helped her stay attentive and process content better, describing how engaging classes made her feel excited to learn. **James** emphasized that participation, such as answering questions or solving problems, kept him engaged and deepened his understanding of the material. **David** contrasted lecture-based classes, where he often felt lost, with a flipped classroom model that allowed for more interaction and clarity.

Student engagement

Engagement in lecture-based classes varied depending on the course structure, the instructor's teaching style, and how well the content was understood. Students like **Maria** and **John** noted that active elements within lectures, such as writing on the board or requiring detailed note-taking, helped sustain their focus. However, they reported a decline in engagement when lectures relied heavily on slides or progressed too quickly for them to follow. **Ana** emphasized the role of interest in the subject matter, explaining that engaging content made it easier to stay focused, while confusion or difficulty understanding led to decreased participation. They all found it easier to stay focused when the content was engaging but reported reduced participation when they struggled to understand the material.

Students highlighted how active learning fosters engagement through teaching methods, professor behavior, and classroom dynamics. **Samuel** noted that group work and collaborative experiences significantly enhanced his participation. He also emphasized the importance of the professor's energy and pacing, contrasting an energetic lecture that facilitated learning with a less engaging class that included clicker questions. **Emily** shared how interactive activities, such as making paper airplanes to illustrate processes and management styles, created a dynamic and memorable learning experience, allowing her to connect with peers and stay engaged. Similarly, **James** emphasized the value of active participation and noted that a professor's tone and enthusiasm are vital in maintaining engagement. He highlighted the role of teaching assistants in large or professor-led classes, explaining that multiple TAs can help sustain student focus and foster a stronger feedback loop. These insights underscore the importance of interactive elements, energy, and classroom support in promoting engagement in active learning environments.

Classroom interactions

In lecture-based classes, students described limited interactions with instructors, particularly in large classes. **Ana** noted that unless she took the initiative, there was little opportunity for engagement due to the size of the class. Similarly, **Sofia** mentioned that she never interacted with the instructor, and assignments were graded by a TA. **Maria** appreciated the structure of lectures but highlighted the importance of interactive elements like writing on the board to stay engaged. Peer interactions were minimal, with **Ana** and **Sofia** observing that engagement usually occurred with known peers or during group assignments. In contrast, active learning environments were seen as fostering more meaningful peer connections, as **John** shared how group work and problem-solving helped break up the monotony of lectures and encouraged engagement.

In active learning classrooms, students experienced more direct and meaningful interactions with both instructors and peers, which enhanced engagement and learning. **Samuel** appreciated how his instructor interacted with students during independent work, making the class feel more dynamic.

Emily highlighted the personalized support she received, with the instructor walking around and providing tailored feedback. **David** and **James** emphasized the importance of rapport-building between instructors and students, noting that it helped foster a more engaging learning environment. Peer interactions were also enhanced, as **James** mentioned that students often helped each other understand challenging material, contributing to a supportive and collaborative classroom atmosphere. Group activities and collaborative elements were key to promoting peer engagement and building a sense of community.

Understanding instructors' expectations

In lecture-based classes, students emphasized the significance of clear expectations, structured assignments, and effective teaching strategies to enhance engagement and understanding. While most students did not struggle with understanding the expectations themselves, **Ana** noted that her ability to meet them depended on the clarity of the content and course structure. She stressed that clear syllabi were important, but the key was ensuring the expectations were manageable and aligned with the material. **Sofia** critiqued the independent learning model in lecture-based classes, expressing a preference for group-based learning where more active engagement could occur. She suggested that professors need to facilitate effectively, rather than relying solely on group work, to maintain student engagement and ensure success. Despite these critiques, students acknowledged that active learning methods, when well-facilitated, could better support understanding of expectations and course material.

In active learning environments, students described a more flexible and sometimes ambiguous approach to understanding instructors' expectations. **Emily** highlighted the contrast between traditional lecture-based classes and active learning settings, noting that expectations in the latter were more individualized and varied. She mentioned, "Expectations were flexible, opposed to a lecture-based class that are more uniform," and while she didn't fully understand the expectations, the interactive nature of the class allowed for a more personalized approach to learning. **David** also observed that in flipped classrooms, the expectations were less clear, which, though not detrimental to his learning, led to some challenges. The attempt to blend traditional lecture-based expectations with the interactive format sometimes created confusion and a less structured experience. Despite these challenges, students generally found the flexibility in expectations beneficial, as it allowed for a more tailored learning process.

Summary

This study explores how engineering college students with ADHD respond to traditional lecture-based and active learning instructional practices. Preliminary findings suggest that lecture-based environments were often disengaging, with students struggling to maintain focus, particularly in larger classes. In contrast, active learning settings fostered engagement, as students appreciated the opportunities for direct interaction with peers and instructors. Lecture-based classes had limited interaction due to class size and passive teaching, while active learning environments facilitated meaningful engagement through group work and discussions. While expectations were generally clear in lecture-based classes, students found it difficult to meet them. In active learning, flexibility was appreciated but sometimes created ambiguity. This study offers insights for improving instructional practices to support students with ADHD in engineering education and calls for further research on strategies to enhance engagement and clarity.

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Appendix

Table 1. Codebook for engineering college students with ADHD responses to instructional practices.

Themes	Descriptions	Examples
Students' attitudes and feelings	Participants' emotional reactions, feelings, attitudes, and perceptions about classroom teaching practices.	*"I feel like having a good time in class per se for me is if I can sort of come out of the class saying like, I learned what was intended to be taught to me…"*
Classroom interactions	Interaction between the instructor and students and amongst the students in the classroom, whether in face-to-face or online learning environments.	*"She [the instructor] interacts with everybody. It was a small class so the feeling was more familiar, the professor will walk around answering questions, one on one giving strategies."* *"When I'm in class, I do not interact with my peers unless it's like, sit together and, and discuss this or whatever."*
Student engagement	The extent to which students are involved in purposeful classroom activities.	*"Yeah, kind of it's just a saying, it's, kind of feast or famine I guess it's either it's not engaging me, so I'm zoning out, or it's way too fast, and I mean, I guess I'm technically engaged, but not processing, um so yeah."*
Understanding instructors' expectations	Students' beliefs about what anticipated requirements, applied abilities, and expected behaviors should be considered/involved.	*"It was pretty clear what the professor's explanations, or expectations were for me."*

Table 2. Participants demographic information

Focus group	Participants	Gender identity (pronouns)	Age	Enrollment level	Major	Race/Ethnicity
Active learning	Samuel	Male (he/him)	21	Senior Undergraduate	Computer engineering	

	Emily	Female (she/her)	18	Freshman Undergraduate	Chemical engineering	
	James	Male (he/him)	20	Junior Undergraduate	Biomedical engineering	
	David	Male (he/him)	24	1st Year Graduate	Material Science and Engineering	Hispanic or Latino
Lecture based	Maria	Female (she/her)	18	Freshman Undergraduate	Chemical engineering	White
	John	Male (he/him)	20	Junior Undergraduate	Robotics engineering	Asian
	Ana	Female (she/her)	20	Junior Undergraduate	Computer engineering	
	Sofia	Female (she/her)	20	Sophomore Undergraduate	Aerospace Engineering	