BOARD # 282: NSF IUSE: Project Update: Academic Success of STEM College Students with ADHD and the Role of Instructional Practices

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Abstract
This NSF-funded Division of Undergraduate Education (DUE) Improving Undergraduate STEM Education (IUSE) project involves three studies using mixed research methods to understand the academic success of STEM college students with ADHD. Study 1 is a quantitative analysis examining the relationships between pre-college factors, college experiences, and the academic success of college students with ADHD. Study 2 is a scoping literature review exploring the individual student experiences of STEM college students with ADHD. Study 1 and Study 2 are complete. Study 3 is an ongoing qualitative investigation studying the effects of instructional practices (including lecture and active learning) on the individual student experience. In this project update, we present a summary of Studies 1 and 2 and share some preliminary results from Study 3. Next steps include synthesizing the findings of all three studies and providing comprehensive suggestions to better support engineering instructors and educators.

Introduction

Pursuing higher education in engineering is a transformative and complex journey for many students; and for neurodiverse students, it often comes with distinct and multifaceted challenges [1]. Neurodiversity is a concept that acknowledges and values the natural variations in how people's brain's function, viewing these differences as strengths rather than deficits. It includes but is not limited to individuals with autism, dyslexia, and attention deficit hyperactivity disorder (ADHD) [2]. ADHD is characterized by persistent difficulties with inattention, hyperactivity, and impulsivity, affecting various aspects of an individual's day-to-day personal and social life [3].

ADHD is a common disability among college students, with at least 25% of students receiving disability services diagnosed with the condition, a figure that continues to rise [4]. Additionally, 2% to 8% of the overall college population reports having ADHD [4]. These statistics highlight the growing need for research to better understand the challenges students with ADHD face and to develop effective interventions that support their academic success [4].

One of the key challenges faced by students with ADHD in the college setting is that traditional instructional practices impose specific challenges and barriers that are incompatible with the learning preferences of students with ADHD [5]. For example, most engineering classes follow a lecture-based format [6], which research has shown to be particularly challenging for students with ADHD due to difficulties in maintaining focus [6]. Other challenges for students with ADHD include instructors' limited knowledge of neurodiversity and the prevalence of assignments that don't incentivize creative thinking [7, 8]. Proactively addressing the needs of specific student groups, such as those with ADHD, is essential for fostering the academic success of all learners [5]. Using instructional practices that support diverse students may be one approach. However, there is a notable gap in research about the impact of various instructional practices on students with ADHD, and our project seeks to address this gap. Our project consists of three studies that aim to explore how instructional practices impact the college experience of engineering college students with ADHD.

Study 1, which is complete, is a quantitative analysis examining the relationships between pre-college factors, college experiences, and the academic success of college students with ADHD.

Using structural equation modeling and mediation analysis, we conducted a statistical study of a secondary, longitudinal dataset from the Higher Education Research Institute [9]. The data comprised records from over 45,000 undergraduate students, more than 2,000 of whom had been diagnosed with ADHD [10, 11]. It also matched responses from students entering college with their responses at the end of their first year. [10, 11]. The study found that the relationship between an ADHD diagnosis and first-year grades was partially mediated by academic adjustment. On average, students with ADHD reported lower rates of adjustment to college than their peers without ADHD. In addition, students with ADHD earned slightly lower grades, and thought of themselves as more creative than their peers without ADHD.

Study 2, which is also complete, is a scoping literature review exploring the individual student experiences of STEM college students with ADHD. We synthesized the key findings and major themes from 39 articles. For each article, we analyzed its contribution to understanding the college experience of students with ADHD, its identification of gaps in the literature, and its insights into opportunities for future research. We also noted aspects in each paper including the definitions of relevant terms, the frameworks and theories utilized, and the academic outcomes discussed. Finally, we noted how many articles examined the three sub-elements of the individual student experience that we were investigating: classroom experiences, academic adjustment, and sense of belonging.

Study 3 is an ongoing qualitative investigation studying the effects of instructional practices (including lecture and active learning) on the individual student experience. This update presents preliminary results which reveal insights about the classroom experiences of engineering college students with ADHD who participated in our study.

Methods

Study 3 explores participants' perceptions of various instructional practices and their associated classroom experiences. To recruit participants, we emailed a random subset of engineering students at a research-intensive institution in the Midwest. Students were invited to participate in either a focus group or an individual interview if they had previously received a formal ADHD diagnosis. Because not every engineering college student necessarily experiences both lecture-based instruction and instruction featuring active learning, we designed separate focus group protocols for the two types of instruction: 1) lecture-based instruction (i.e., "a class in which the instructor relied solely on lecture to convey class material") and 2) active learning instruction (i.e. "a class that instructors engage students with course material by clicker questions, group discussion, or problem solving"). We designed the interview protocol to elicit student perspectives about one or both types of instruction.

We conducted nine focus groups and six individual interviews, with a total of 26 unique engineering college students with ADHD. Each session followed a semi-structured protocol which included questions that invited participants to share their 1) classroom experiences, 2) sense of belonging, and 3) academic adjustment.

To analyze students' classroom experiences, academic adjustment, and sense of belonging, we used inductive and deductive coding approaches. Our deductive codebook was created based on our framework, which was adapted from Terenzini & Reason's (2005) College Impact Model. We used MAXQDA24 to label codes, guided by our codebook. After the interviews and focus groups were conducted, we transcribed and anonymized the responses. In the first round of

coding, we applied a deductive approach to label codes and refine the codebook. To establish inter-coder reliability, four research independently coded each transcript, then discussed as a group and modified our codes as necessary after an agreement was reached. We coded 1,001 segments as classroom experiences (with sub-categories of instructional practices and student response), 268 segments as academic adjustment (with sub-categories of academic transitions and study skills), and 214 segments as sense of belonging (with sub-categories of classroom belongingness and engineering belongingness). In the second round of coding, we used an inductive approach to allow emerging themes and sub-themes within each sub-category and identify the underlying patterns. To reach inter-coder agreement, three researchers independently coded each transcript and then discussed until agreement was met.

Project Findings

Here, we present an overview of our preliminary results. To identify our preliminary results, we reviewed the codes assigned to each interview and conducted a thorough analysis to identify the major themes and patterns within each category in our codebook.

Classroom Experiences

Classroom experiences was divided into two categories: instructional practices and student responses. Three subcategories emerged in the theme of instructional practices: teaching method, class format and policy, and instructor behaviors [12]. Participants described most lecture-based classes as large (~100+ students), with professors primarily lecturing from slides or writing on a board, while active-learning classes were characterized by student-peer interactions and student-instructor interactions through group work or collaborative problem solving. Across both class types, participants discussed exam formats, attendance policies, and homework flexibility. Instructor responsiveness and ability to create engagement were key factors discussed in both class types as well.

Four subcategories emerged in the theme of student responses: students' attitudes and feelings, student engagement, classroom interactions (with the professor and with their peers), and students' understanding of instructors' expectations. Students felt lecture-based classes, which relied on slideshows, were unhelpful, and favored classes where instructors used the whiteboard and effectively answered questions. Active-learning classes, with more group work and instructor interaction, were seen as more effective, despite some students feeling pressure to perform. In contrast, the lack of pressure in lecture-based courses led to lowers motivation to participate.

Regarding *student engagement*, students largely reported that it was hard to stay engaged in lecture-based classes. Students felt engaged in active learning classes because they could interact with peers and because they were doing interactive activities during class, instead of only listening and taking notes. With respect to *classroom interactions* with the professor and with peers, students reported that interactions were more likely in active-learning classes than in lecture-based classes because of the prevalence of group work.

Students reported that they *understood instructor expectations* fairly well in both lecture-based and active learning classes. Students found it helpful when instructors provided regular announcements; kept syllabi, course slides, and assignments up to date; and maintained a consistent course structure. They noted that having a clear rhythm to the course, such as homework assignments being due at the same time each week, made it easier to understand and meet instructor expectations.

Academic Adjustment

In analyzing students' academic adjustment, we identified two main themes: adaptation to *academic transitions* (e.g. undergraduate to graduate) and their perceptions of three types of study skills: *time management and organization, note-taking*, and *test preparation*. Regarding *academic transitions*, students mostly mentioned adjustments they needed to make to their current academic environment if it was significantly different from what they were used to at their previous institution. For example, students reported challenges in adapting to the flexibility of graduate school, particularly when transitioning from the structured deadlines and familiar expectations of their undergraduate experiences.

Regarding *time management and organization*, students generally found courses with strict and fixed deadlines to be more helpful than courses where flexible and constantly adjusting ones. Some students also shared that active learning classes tended to be less structured than lecture-based ones in the sense that classroom activities often had a greater variety of activities from week to week in active-learning classes, which could make time management more challenging.

Students also generally agreed that *note-taking* during lecture-based classes helped them process the information, and allowed them to pinpoint any areas of confusion. Finally, regarding *test preparation* in lecture-based classes, students mentioned that having lots of resources to study with (e.g. practice exams, lecture recordings) was helpful. In lecture-based classes, students mostly attributed their success with test preparation to more personal factors, like motivation, rather than instructional practices. Some students also perceived test preparation to be easy in active-learning classes because instructors tended to clarify what exactly would be tested, and class content was aligned with what was tested.

Sense of Belonging

Two subcategories emerged in the theme of sense of belonging: *classroom belongingness* (students' sense of belonging in their classrooms) and *engineering belongingness* (students' sense of belonging in their engineering major). In terms of *classroom belongingness*, participants reported little sense of belonging in lecture-based classes, which they attributed to the lack of peer interaction and the one-sided nature of instruction. Conversely, they felt a strong sense of classroom belonging when the instructor used active learning, owing to the increased student-peer connections. Participants also shared that if the instructor was approachable and took the time to get to know them personally, they felt a stronger sense of belonging. It diminished participants' sense of belonging if the instructor devalued student contributions or did not create an inviting environment for questions.

Regarding *engineering belongingness*, students shared that active learning classes fostered their sense of belonging in their engineering major by providing opportunities to connect with peers in their major. Additionally, participants experienced a greater sense of belonging when instructors took the time to understand their accommodations due to ADHD and made necessary adjustments to support them. Similar to classroom belongingness, if the instructor made an effort to get to know their students and their backgrounds, participants reported an increased sense of belonging in engineering.

Conclusion and Future Work

Our findings offer valuable insights into how various instructional practices affect the academic experience of engineering college students with ADHD. Future work includes synthesizing results and providing comprehensive suggestions to better support engineering instructors.

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