# Board 355: Project Update: Academic Success of STEM College Students with ADHD and the Role of Classroom Teaching Practices

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# Project Update: Academic Success of STEM College Students with ADHD and the Role of Classroom Teaching Practices

## Abstract

This project investigates the academic success of college students in science, technology, engineering, and math (STEM) with attention deficit and hyperactivity disorder (ADHD), a growing but understudied population. The overarching project goals are to identify factors and teaching practices influencing the academic success of STEM students with ADHD, understand the role of classroom teaching practices, explore the college experience, and disseminate actionable recommendations to higher education stakeholders. Guided by the social model of disability, we are conducting three sequential studies. Study 1 analyzes the relationships between pre-college factors, college experiences, and academic success. Findings reveal that academic adjustment partially mediates the relationship between an ADHD diagnosis and first-year grades, suggesting instructors recognize and support first-year students' differences in academic adjustment. Study 2 is a scoping literature review of the college experiences of students with ADHD. It examines 2,589 articles, resulting in 40 fully examined and coded articles. Analysis is underway, but preliminary findings of the 40 articles indicate a wide range of definitions and study types, limited application of theory, and considerable inconsistencies in outcome variables. They also highlight important future directions for study. Study 3 is an interview-driven investigation. We are currently conducting focus groups and interviews of engineering students who have ADHD, after which we will transcribe the data and begin analysis. Findings of our three-study project can inform policies and practices aimed at fostering inclusive educational environments, support STEM students with ADHD, and enhance educational outcomes. This paper provides updates on the progress and findings of the three studies.

## Introduction

Pursuing higher education is a transformative journey, offering students the opportunity to acquire knowledge, cultivate critical thinking, and shape their future careers [1]. Students who choose the path of science, technology, engineering, and math (STEM) education are often driven by a profound passion for their fields, and an innate curiosity [2]. For a subset of these aspiring STEM professionals, their higher education journey is marked by unique and multifaceted challenges stemming from neurodiversity experiences. Neurodiversity emphasizes understanding neurodivergence as a natural variation in individual brain function and behavioral traits not to be devalued [3]. It includes various neurological differences such as autism spectrum disorder, attention deficit and hyperactivity disorder (ADHD), and dyslexia. ADHD is acknowledged as a neurodevelopmental condition characterized by persistent difficulties maintaining attention, regulating impulses, and managing executive functions [4], [5]. According to one study, college students with ADHD comprise 11% of college undergraduates in the U.S. [6]. Higher education instructors, staff, and administrators can best promote the academic success of all students if they are cognizant of the experiences of specific groups of students, such as students with ADHD, and how these experiences influence their academic success [7]. In spite of their growing college presence, little is known about the academic success of students

with ADHD [8], and even less is known about these students' experiences and academic success in STEM [9].

Students with ADHD have the burden of needing to overcome barriers and obstacles to succeed in college in and outside of the classroom [10]. Traditional pedagogical methods, coursework, and assessments in STEM higher education do not align with the learning preferences and strengths of students who have ADHD [11]. For example, college students with ADHD may experience difficulties in a lecture-only (the overwhelming style of instruction [12]) due to the need to stay focused during lectures [12]. Further, they may be inadvertently placed at a disadvantage when completing class assignments that do not value creative and divergent thinking [13] . Students with ADHD also commonly face the obstacle of instructors unfamiliar with ADHD and instructional practices that promote students' academic success [14]. These barriers can negatively impact the recruitment and retention of students who have ADHD in engineering programs, thereby compromising diversity efforts in the field [15].

Identifying institutional and systematic barriers that have impacted the collegiate academic experience and academic success of college students with ADHD is critical to creating equitable learning environments [16]. Scholars have proposed that instructional methods can significantly impact the academic achievement of college students with ADHD [11], but few studies have delved into how neurodiverse students are affected by STEM learning environments or instructional approaches. Gaining insight into the strengths and challenges experienced by students with ADHD in the classroom can shed light on how instructional practices facilitate or obstruct academic success. Our three-pronged study aims to explore the relationship between college experiences and academic success and the role instructional practices play in the academic success of STEM college students with ADHD.


**Conceptual Frameworks**

*Social Model of Disability*

The Social Model of Disability, created by people with disabilities [17], [18], supports the view that people who have disabilities face barriers resulting from the way the system and society operate, not resulting from the impairment itself [17]. It differs from the medical model, which focuses on what people with disabilities are not able to do because of their impairment [19]. According to the social model of disability perspective, impairments are seen as biological differences, whereas disability is not an inherent attribute of an individual but is rather a result of societal barriers, prejudices, and systemic shortcomings [20], [21]. It centers on identifying and removing systemic and environmental barriers and fostering inclusivity, enabling individuals with disabilities to participate fully in society.

In this study, we apply this model by focusing on ways we can address and dismantle barriers encountered by STEM students with ADHD in higher education. We first focus on gaining a comprehensive understanding of the unique college experiences of these students will inform the development of inclusive teaching practices and the creation of equitable environments for diverse learners [22]. Second, we focus on understanding the challenges and successes of students with ADHD in the college setting, which serves as a framework for advancing diversity.

Aligned with the social model's principles, our aim is to challenge educational norms, foster equality, empower individuals with disabilities, and contribute to the cultivation of a more inclusive and just society.

*Terenzini and Reason's College Impact Model*

In our study, we employ a conceptual framework (Figure 1), grounded in Terenzini and Reason's [23] extension of Astin's Input-Environment-Output (I-E-O) college impact model [24], to investigate the academic success of students with ADHD and various elements within their collegiate experiences. Astin's original I-E-O model serves as a theoretical lens for examining students' outcomes in college, positing that both input factors (e.g., demographic characteristics) and environmental influences (e.g., students' college experiences) collectively shape student outcomes such as learning and persistence. Expanding on that model, Terenzini and Reason proposed a model to account for multiple interrelated factors affecting student outcomes. Their model also includes four salient factors: precollege characteristics and experiences (i.e., sociodemographic traits, prior academic preparation and performance, and student dispositions) and the remaining three comprise the student college experience: organizational context, the peer student environment, and the individual student experience (including curricular, classroom, and out-of-class experiences). For our study, we included neurodiversity in pre-college characteristics and experiences, and introduced other factors that may be particularly relevant for students with ADHD such as creativity, having close friends, and short-term motivation, time management and study skills [25].
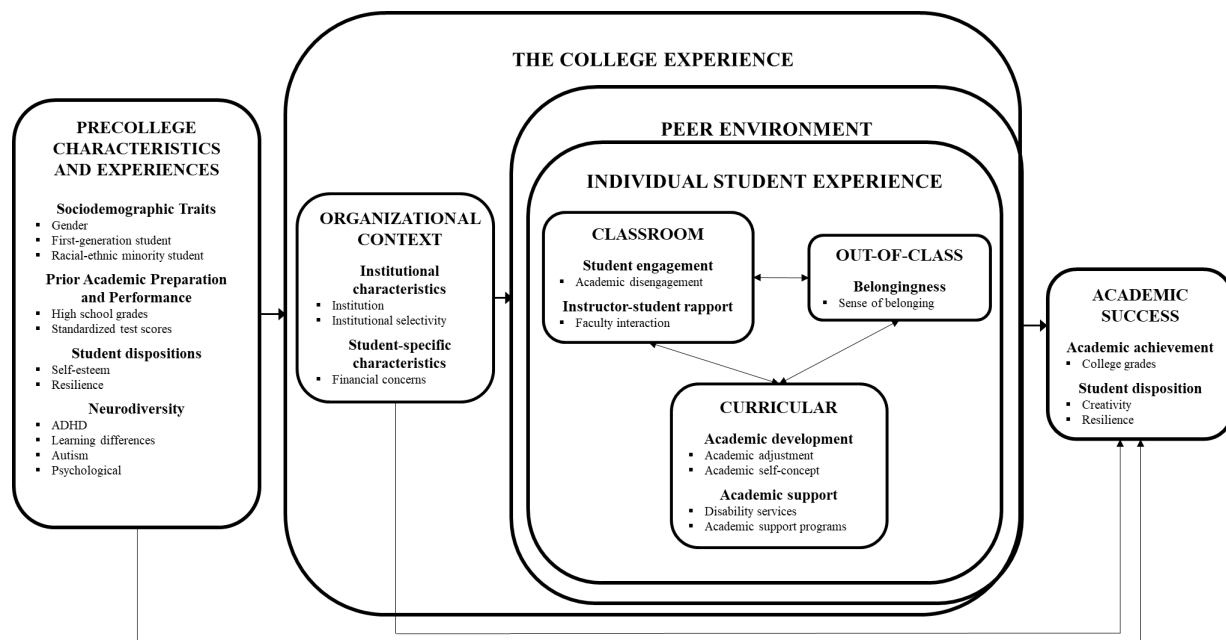


*Figure 1. Our conceptual framework [26]*

**Project Overview**

Our project involves three sequential studies. Study 1 is a quantitative analysis investigating the relationship between pre-college factors, college experiences, and academic success of college students with ADHD. Study 2 is a scoping literature review of the college experiences of these students, and Study 3 is a qualitative study focusing on the role of teaching practices in the college experience as a precursor to academic success.

**Study 1**

This study is a statistical analysis of a secondary, longitudinal dataset from the Higher Education Research Institute [27]. The dataset comprises data from approximately 45,000 first-year students, including over 2,000 students with ADHD [26] [28]. Study 1 aims to answer the question: *How does the college experience mediate the relationship between pre-college student characteristics and experiences and academic success for students with and without ADHD?*

We investigated the relationships between pre-college factors, college experiences (i.e., academic adjustment, faculty interaction, and sense of belonging), and the academic success of college students with ADHD (Figure 3) using structural equation modeling and mediation analysis [29]. We specified our structural equation model (SEM) based on the work of Bowman and coauthors [30], and estimated an SEMs for the academic success measures of first-year grades. We then conducted mediation analyses using latent college experience variables as mediators for academic success outcomes of first-year grades to identify aspects of the college experience (academic adjustment, faculty interaction, and sense of belonging) that mediate the relationship between the pre-college characteristics of ADHD and first-year grades.
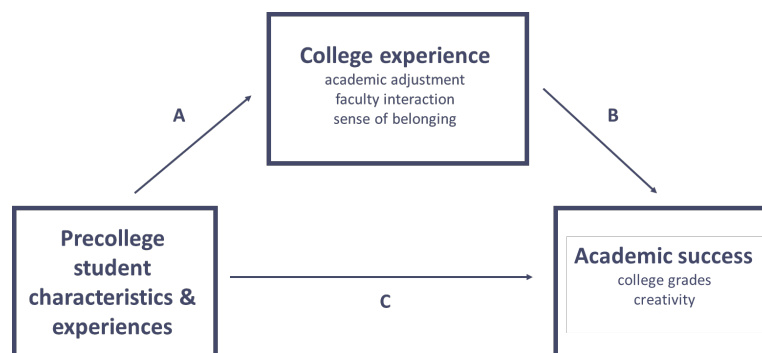


*Figure 2. Schematic of the mediation model [26].*

Our findings indicated that, on average, students with ADHD rated their adjustment to college academics (predictive of their understanding professors' expectations, time management skills, and study skills) lower than their peers without ADHD [29]. Students' academic adjustment was. Additionally, model estimates indicate students with ADHD earned slightly lower grades, averaging a one-fifth grade change lower than their peers without ADHD. Only one of the college experiences (i.e., academic adjustment, faculty interaction, and sense of belonging) had a substantial mediating role. Academic adjustment or the ease of adjusting to college academics

partially mediated (around 33%) the relationship between a previous ADHD diagnosis as an incoming first-year student and first-year grades.

We also modeled a second academic success outcome, creativity, specifying a model based on Terenzini and Reason's work [23]. We found students with ADHD were more likely to perceive themselves as highly creative (above average or in the top 10% of their peers) compared to peers without ADHD; however, the first-year college experience (measured as faculty interaction and sense of belonging) had little impact on students' self-rated creativity [25].


**Study 2**

This study is a scoping literature review that aims to gain insight into the academic success of STEM college students with ADHD by exploring the role of college experiences (i.e., classroom experiences, academic adjustment, and sense of belonging). We use Arksey and O'Malley's framework [31], comprising a six-stage process, as a guide to conduct scoping literature reviews.

*Stage 1 Identify the research questions.*

For Study 2, we define three research questions. (1) *What is known about the college experience (academic adjustment, classroom experiences, sense of belonging) of students with ADHD?* (2) *What are the gaps and opportunities in the literature about the college experience of students with ADHD?* And (3) W*hat approaches are being used to understand the college experience of students with ADHD?*

*Stage 2 Identify relevant studies.*

In this stage, we conducted a systematic search. Following our conceptual framework (Figure 2), we developed a search protocol with seventeen (17) total keywords in four categories: classroom, out-of-class, curricular, and academic success. We used a total of seven (7) databases: Scopus, Education Abstracts, Web of Science, Overton, Engineering Village, ERIC ProQuest, and IEEE Xplore. These searches yielded 3,493 studies and 2,589 unique studies after removing duplicates.

*Stage 3 Select studies*

We guided the screening process by a set of screening questions based on the inclusion and exclusion criteria. The principal objective of the screening process was to include articles that align with the conceptual framework and address the research questions. The process consisted of three steps: (1) the abstract screening, (2) full-text screening, and (3) full-text eligibility. Three (3) reviewers participated in this comprehensive evaluation of 2,589 unique articles, reviewed following the established inclusion criteria. A total of 3 articles met the inclusion criteria (as shown in the PRISMA diagram of Figure 3), and those proceeded to be analyzed.

**Identification**

Records identified through

| Scopus n = 975 | Engineering Village n = 105 | ERIC Pro n = 463 | Web of Science n = 1,661 | Education Abstracts n = 219 | IEEE Xplore n = 4 | Overton n = 66 |

March 2022 – April 2022

**Screening**

Records before duplicates removed: 3,493 → Duplicates removed: 904

May 2022

Abstract screening: 2,589 → **Records excluded by abstract screening: 2,497**
- Medical symptoms, intervention, malingered presentation, other populations: 2,279
- College experience or academic outcomes: 21
- Academic adjustment, classroom experiences, or sense of belonging: 193
- Peer-reviewed journal or conference paper: 4

June 2022 – August 2022
Exclusion
September 2022 – October 2022
Inclusion
July 2023

Full-text screening: 92 → Records excluded by full-text screening: 53

November 2022 – March 2023
July 2023

**Eligibility**

Full-text eligibility: 39 → Records excluded by full-text eligibility: 0

April 2023
July 2023

Coding: 39 → Records coded: 39
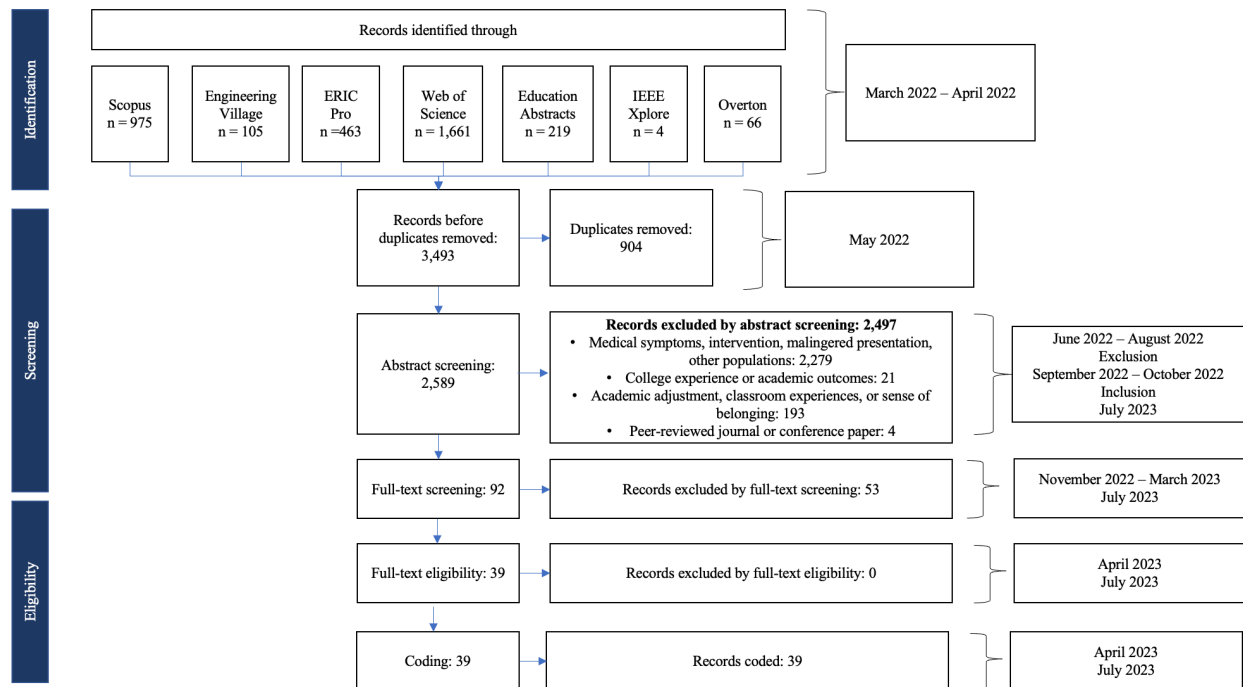
April 2023
July 2023

*Figure 3. Preferred Reporting Items for Systematic Reviews (PRISMA) flow diagram demonstrating the search and screening process of studies to be included in this review.*

## Stage 4: Chart the data

In this stage, we aimed to extract key information from the 39 articles identified in Stage 3. To do this, we developed a coding rubric aligning with our framework, covering themes like definitions, frameworks, study types, demographics, academic fields, approaches, and collegiate experiences. Two reviewers independently applied the rubric, followed by joint discussions to ensure consistency. We also analyzed and recorded findings and limitations from the studies.

## Stage 5: Summarize and report the results

Our scoping literature review examined 39 articles emphasizing the college experiences of students with ADHD. Among the 39 articles examined, 19 articles specifically address issues related to academic adjustment, two articles delve into classroom experiences, 17 articles explore multiple elements of the collegiate experience, encompassing classroom experiences, a sense of belonging, and academic adjustment, and one is a comprehensive review. In this section, we present answers to our three separate research questions from Stage 1 and we structure the findings using the variables of our framework (Figure 1).

*What is known about the college experience (academic adjustment, classroom experiences, sense of belonging) of students with ADHD?* To answer this research question, we systematically examined data classified as study information. The information was aimed at providing details on definitions of concepts of interest (i.e., ADHD, classroom experiences, academic adjustment, sense of belonging), frameworks or theories, type of study (i.e., qualitative, quantitative, mixed methods), participants, and academic outcomes.

***Definitions:*** ADHD and academic adjustment were explicitly defined in 15 and eight articles, respectively. However, formal definitions for classroom experiences and sense of belonging within the collegiate context were not provided in the 39 articles.

***Frameworks/Theories:*** Altogether, 11 of the 40 articles explicitly describe the use of a framework or theory. Only four of the 19 articles emphasizing academic adjustment mentioned the use of theoretical or conceptual frameworks. One of the two articles centered on classroom experiences employed a dual framework approach to investigate factors that support or hinder the self-advocacy of college students with ADHD and learning disabilities (LD). Six articles of the 17 that emphasized more than one collegiate experiential element implemented a framework or theory. And the comprehensive review article did not use a framework.

***Study Types:*** Among the 39 articles, the methods varied. Twelve were qualitative, 25 were quantitative, one was a mixed-methods study, and one was a literature review.

***Participant Demographics***: The majority of studies (36 out of 39) indicated that 100% of their participants were undergraduates. In addition, two other articles reported including both undergraduates and graduate students. The remaining study did not specify this information.

***Academic Outcomes:*** The 39 articles addressed various academic outcomes, including GPA (11), academic success (10), creativity, persistence (3), self-confidence, and post-graduation plans. Additionally, other academic outcomes such as motivation (12), self-determination, attitudes and perceptions, academic and social adjustment, test anxiety, retention, social skills, self-esteem, college adjustment, self-advocacy, study skills/habits, and coping strategies were widely considered.

*What approaches are being used to understand the college experience of students with ADHD?* To explore the college experience of students with ADHD, we conducted a thorough analysis of various methodologies, aiming to understand the factors considered and the measurement approaches employed.

***Academic adjustment:*** 19 of the 39 articles investigated academic adjustment, using varied instruments, including the Student Adaptation to College Questionnaire (SACQ), Freshman Year Survey (TFS), and Your First College Year Survey (YFCY). These tools provided a comprehensive assessment that encompassed not only academic but also social and personal/emotional adjustments.

***Classroom experiences:*** Three articles examined classroom experiences. These delved into attitudes, learning themes, and self-advocacy, and identifying external factors significantly impacting students' experiences.

***Sense of Belonging:*** The concept of sense of belonging was not explicitly studied in any of the 39 articles. However, the SACQ, employed in six articles, indirectly touched on institutional attachment and goal affiliation, offering insights into elements associated with a broader sense of belonging.

*What are the gaps and opportunities in the literature about the college experience of students with ADHD?* After a thorough examination of the findings, limitations, and discussion sections of the 40 articles we found several commonalities. Several studies express concerns about methodology, including the use of self-report data and the lack of standardized measures. Other common issues include sample representativeness, use of locally developed measures, and the need for verification of ADHD diagnoses.

In addition, the articles highlighted some gaps in the literature, particularly with diversity in samples and generalizability of findings. These gaps could be addressed by comparing subgroups, verifying ADHD diagnoses, and addressing diversity in samples. Other articles highlighted the variability in defining or identifying students with ADHD and opportunities for improving diagnostic assessments. These issues could also be addressed by conducting differentiated research, considering subgroups based on ADHD subtypes and coexisting conditions, are evident.

The 39 articles also noted some important recommendations for future work, including the need for longitudinal studies and for exploring the transition to college. Other recommendations include collaborating and communicating between researchers, clinicians, and educators and developing/testing interventions such as ADHD coaching and psychosocial support strategies.

**Study 3**

Study 3 involves in-depth interviews with STEM college students with ADHD to gain a more in-depth understanding of our results and better understand the role classroom teaching practices play in the academic success of engineering students with ADHD. It aims to answer the following questions: (1) *How do engineering college students who have ADHD perceive how traditional lecture-based courses influence their collegiate experiences (academic adjustment, classroom experiences, and sense of belonging)?* (2) *How do engineering college students who have ADHD perceive that active learning influences their college experiences?*

We focused on engineering college students with ADHD at a predominantly white institution research-intensive university in the Midwest, emailing a random sample of 1,800 students enrolled at the university and inviting those with a formal ADHD diagnosis to participate in one or two focus groups or an interview. The first focus group centered around lecture-based courses or instruction, and the second addressed active learning instruction. We conducted ten focus groups with a total of 31 participants representing 21 unique individuals and we are currently conducting interviews. After completing the interviews, we will transcribe all data and being analyzing the data.

**Summary**

Our explanatory, mixed-methods project involves three sequential studies and aims to explore the relationship between college experiences and academic success and the role classroom teaching practices play in the academic success of STEM college students with ADHD. The quantitative analysis of Study 1 demonstrated which collegiate experiential elements had a

significant relationship with academic success. Our scoping literature review of Study 2 shed light on what is known about the college experience, the gaps and opportunities in the literature about this topic, and what approaches are being used to understand this phenomenon. And the qualitative Study 3 uses focus groups and interviews to understand the role classroom teaching practices play in the academic success of engineering students with ADHD. Collectively, this research allows us to explore students' perceptions of how active learning and lecture-based classes influence their classroom experiences, academic adjustment, and sense of belonging.

## Acknowledgments

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