Academic Success of College Students with ADHD: The First Year of College

Laura Carroll, University of Michigan

Laura Carroll is a PhD candidate in Engineering Education Research at the University of Michigan. Laura's research interests are focused on academic success of students with ADHD, faculty development and change, and instructional barriers to implementing active learning.

Dr. Cynthia J. Finelli, University of Michigan

Dr. Cynthia Finelli is Professor of Electrical Engineering and Computer Science, Professor of Education, and Director and Graduate Chair for Engineering Education Research Programs at University of Michigan (U-M). Dr. Finelli is a fellow in the American Society of Engineering Education and the Institute for Electrical and Electronics Engineer, and she has served as Deputy Editor of the Journal for Engineering Education, Associate Editor of the IEEE Transactions on Education, and Chair of the Educational Research and Methods Division of ASEE. She founded the Center for Research on Learning and Teaching in Engineering at U-M in 2003 and served as its Director for 12 years. Prior to joining U-M, Dr. Finelli was the Richard L. Terrell Professor of Excellence in Teaching, founding director of the Center for Excellence in Teaching and Learning, and Associate Professor of Electrical Engineering at Kettering University.

Dr. Finelli's current research interests include student resistance to active learning, faculty adoption of evidence-based teaching practices, and the use of technology and innovative pedagogies on student learning and success. She also led a project to develop a taxonomy for the field of engineering education research, and she was part of a team that studied ethical decision-making in engineering students.

Prof. Stephen L DesJardins

Stephen L. DesJardins teaches courses related to public policy in higher education, economics and finances in postsecondary education, statistical methods, and institutional research and policy analysis. His research interests include student transitions from high school to college, what happens to students once they enroll in college, the economics of postsecondary education, and applying new statistical techniques to the study of these issues.

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Introduction

Students with attention deficit hyperactivity disorder (ADHD), many of whom plan to major in science, engineering, or mathematics (SEM), represent an increasing fraction of incoming college freshman [1], [2]. On average, these students experience less collegiate academic success, as traditionally measured by grades, than their peers without ADHD [2], [3], [4]. This grade difference has been attributed to difficulty with time management, organization, and attentional focus [3], [5].

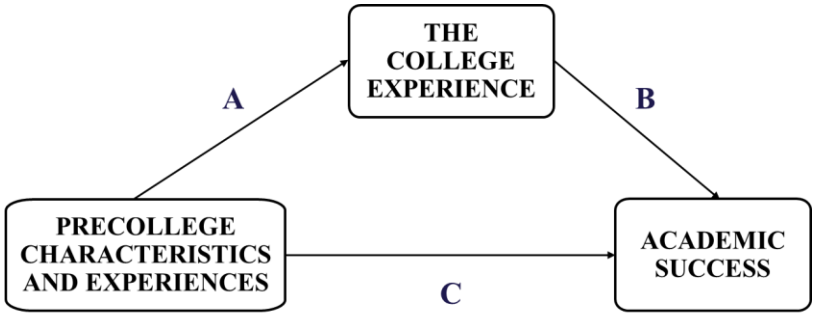
Instructors and administrators in higher education can more inclusively support the academic success of a diverse student body if they are aware of the unique experiences of specific groups of students. For example, students with ADHD may tend to prefer instruction involving active learning compared to more traditional instructional pedagogies (e.g., prolonged lecture) [6]. Additionally, researchers question how traditional aspects of engineering education, such as a limited role of creativity, may relate to the academic success of students with ADHD [3]. College students with ADHD are more likely to exhibit higher levels of creative and divergent thinking relative to their peers without ADHD [3], [7], [8]. This type of thinking is advantageous for solving real-world interdisciplinary problems and developing innovative solutions, yet not fully appreciated in traditional engineering education [3]. Taylor and coauthors recommend "allowing room for divergent and creative thinking" in engineering education to improve inclusivity [3, p. 13].

Our goal is to explore the first-year academic success of college students with ADHD majoring in SEM, with a specific focus on students' first-year college experiences. Guided by Terenzini and Reason's [9] college impact model, we will explore how *the college experience* (*classroom*, *curricular*, and *out-of-class*) mediates the relationship between *precollege characteristics and experiences* and *academic success* of students with ADHD. Students with ADHD may have unique classroom, curricular, and out-of-class experiences in college, e.g., [10]; understanding these experiences and exploring their relationship with academic success is a first step in improving inclusivity.

Conceptual Framework

The conceptual framework for this study relies heavily on Terenzini and Reason's [9] college impact model, which builds on the work of Astin [11], Tinto [12], and Pascarella [13]. This college impact model posits that students' educational *outcomes* are influenced by *precollege characteristics and experiences* as well as *the college experience (organizational context* and *individual student experience*) [9]. The mediating relationship described by the college impact model is displayed schematically in Figure 1. Terenzini and Reason's model is broadly used to study collegiate outcomes [14] (e.g., ethical development [15] and "personal and social competence" [16, p. 271]).

Figure 1
Schematic of the mediating relationship between precollege characteristics and experiences, the college experience, and academic success (following [17]) in Terenzini and Reason's college impact model [9]



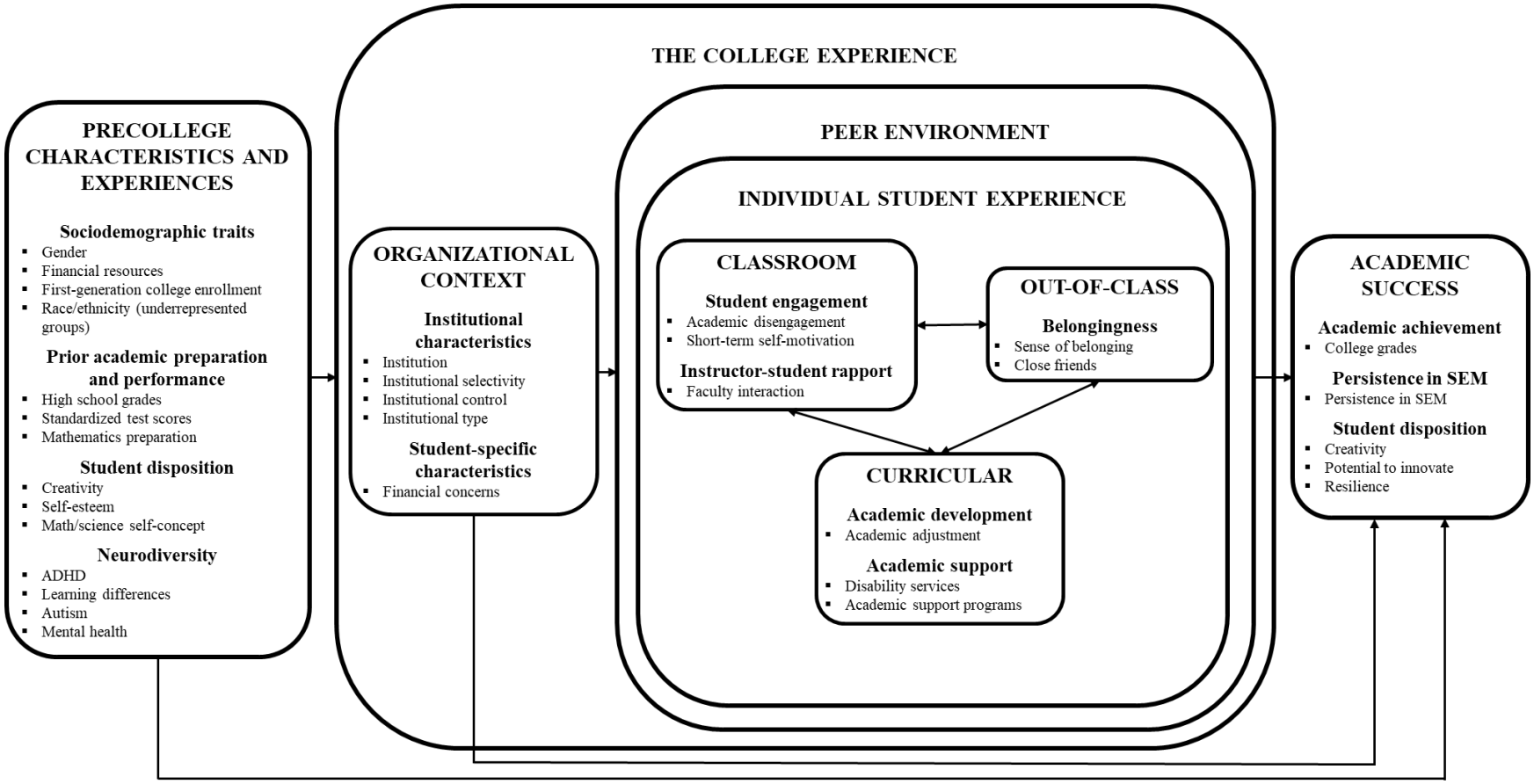
We tailor this college impact model to our study of *academic success* by including *neurodiversity* [18] in precollege characteristics and experiences and defining elements of the model [19], as shown in Figure 2. We generally follow Reason's [14] description of the individual student experience to define *classroom* as student engagement and instructor-student rapport, *curricular* as academic development and academic support, and *out-of-class* as belongingness [19]. We also consider research studies of college students with ADHD in these definitions, particularly within *student disposition* and the individual student experience.

Precollege characteristics and experiences consist of *sociodemographic traits* (gender, financial resources, first-generation college enrollment, and race/ethnicity, underrepresented groups), *prior academic preparation and performance* (high school grades, standardized test scores, and mathematics preparation), and *student disposition* (creativity, self-esteem, and math/science self-concept). Based on studies of college students with ADHD and SEM persistence, we define student disposition as comprising of creativity [3], [7], [8] self-esteem [20], [21], and math/science self-concept [22]-[24]. We include ADHD, learning differences, autism, and mental health (e.g., depression) as elements of *neurodiversity*, following [18].

The college experience captures both the organizational context and the individual student experience [9]. For organizational context, we use *institutional characteristics* (institutional selectivity, control, and type) and *student-specific characteristics* (financial concerns) [19]. Within classroom experiences, we include *student engagement* (e.g., class preparation, assignment completion) and *instructor-student rapport* (e.g., interactions between a student and their instructors, such as attending office hours) [19]. For curricular experiences, we focus on students' *academic development* (study, organizational, and time management skills) and *academic support* (interactions with the disability services office and participation in academic support programs, such as first-year seminars). Finally, we use *belongingness* for out-of-class experiences [19].

Figure 2

Conceptual framework, based on [9] and [14], for studying the academic success of SEM college students with ADHD



Academic success encompasses more traditional college outcomes (i.e., *academic achievement*, as measured by college grades, and *persistence in SEM*) as well as less often used measures (i.e., creativity, potential to innovate, and resilience). We add the latter *student disposition* measures based on research studies identifying creativity [3], [7], [8] and resiliency [25] as strengths shared by many individuals with ADHD.

Research Questions

For this study, we ask four research questions:

RQ1. What relationships exist between students' precollege characteristics and experiences, the college experience, and academic success for students with and without ADHD?
RQ2. What relationships exist between students' precollege characteristics and experiences, the college experience, and academic success for SEM students with and without ADHD?
RQ3. Does the college experience mediate the relationship between precollege characteristics and experiences and academic success for students with and without ADHD?
RQ4. Does the college experience mediate the relationship between precollege characteristics and experiences and academic success for SEM students with and without ADHD?

Methods

Data

We will conduct a mediation analysis using Higher Education Research Institute's (HERI) multi-institutional, longitudinal data from The Freshman Survey (TFS) [26] and Your First College Year (YFCY) Survey [27]. The TFS and YFCY include items about students' precollege characteristics and experiences and experiences and academic success during their first-year of college, respectively [26], [27]. The data set includes matched TFS/YFCY responses from four student cohorts (beginning college in 2010, 2012, 2014, and 2016) for students who answered the TFS item about whether or not they have ADHD. Table 1 provides the estimated sample size by cohort. This study has been reviewed by the University of Michigan Institutional Review Board, and has received a "Not Regulated" determination (HUM00200369).

Table 1
Sample size of the TFS/YFCY data set (Provided by HERI)

YFCY year	College students		SEM college students	
	without ADHD	with ADHD	without ADHD	with ADHD
2011	11,882 (95.4%)	576 (4.6%)	2,740 (96.1%)	112 (3.9%)
2013	11,567 (95.6%)	535 (4.4%)	3,726 (96.3%)	142 (3.7%)
2015	5,780 (94.6%)	329 (5.4%)	1,691 (96.0%)	71 (4.0%)
2017	4,147 (94.0%)	264 (6.0%)	1,314 (94.9%)	71 (5.1%)
Total	**33,376 (95.1%)**	**1,704 (4.9%)**	**9,471 (96.0%)**	**396 (4.0%)**

Measures

Measures of students' precollege characteristics and experiences are self-reported by incoming freshman on the TFS and shown in Table 2. They are either HERI TFS variables [26], constructs [28], or transformed from HERI TFS variables. Variables for sociodemographic traits include gender (using sex of respondent as a proxy; *FEMALE*; 0=male, 1=female), financial resources (parents' income; *PARINCOME*; categorical), first-generation college enrollment (*FIRSTGEN*; 0=no, 1=yes), and race/ethnicity (underrepresented groups; *URGROUP*; 0=no, 1=yes). Students' average grade in high school (*HSGPA;* categorical), standardized test score (ACT composite score; *ACT*; continuous or average of verbal and math SAT score; *SAT*; continuous), and mathematics preparation (highest math course completed in high school; *MATHPREP*; categorical) are used as measures of students' prior academic preparation and performance. Student disposition measures include proxies for creativity (self-rating of creativity; *CREATIVITY*; 1=lowest 10%, 2=below average, 3=average, 4=above average, 5=highest 10%), self-esteem (self-rating of intellectual self-confidence; *SELFCONF*; 1=lowest 10%, 2=below average, 3=average, 4=above average, 5=highest 10%), and math/science self-concept (academic self-concept [28]; *ACADEMIC_SELFCONCEPT_TFS*; continuous). In neurodiversity, we include multiple variables including whether a student reported having ADHD (*ADHD*; 0=no, 1=yes), a learning disability (*LDIFF*; 0=no, 1=yes), autism spectrum disorder (*ASD*; 0=no, 1=yes), or a psychological disorder (e.g., depression; *MHEALTH*; 0=no, 1=yes).

Within organizational context, we will control for institutional characteristics using a pseudo-institution id (*INSTITUTION*), institutional selectivity (*SELECTIVITY*; TBD), control (*PUBLIC*; 0=private, 1=public), and type (*FOURYEAR*; 0=2-year, 1=4-year or university). For student-specific characteristics, we will use whether a student had concerns about financing college (*FINCON*; 0=no, 1=yes).

We operationalize YFCY HERI variables [27] and constructs [28] for the three domains in the individual student experience, as listed in Table 2. We include two constructs for students' classroom experiences quantifying academic disengagement (*ACAD_DISENGAGEMENT*; continuous) and faculty interaction (*FAC_INTERACTION*; continuous). We also include a measure of students' short-term self-motivation (using bored in class as a proxy; *BORED*; 0=not at all, 1=occasionally, 2=frequently). For curricular experiences, we use another construct, academic adjustment (*ACADEMIC_ADJUSTMENT*; continuous), and variables for students' interaction with the disability services office (*DISABSERV*; 0=no, 1=yes), participation in first-year seminars (*SEMINAR*; 0=no, 1=yes), and participation in an academic support program (*ACADSUPP*; 0=no, 1=yes). We operationalize belongingness in out-of-class experiences with the sense of belonging construct (*SENSE_BELONG*; continuous) and a variable measuring the frequency of students' interactions with close friends at their college (*FRIENDS*; 0=twice a term or less, 1=one to two times a month, 2=at least weekly).

Table 2

Model components (and related construct [28]) and survey items [26], [27]

Model components		Item/s (construct or survey)
Precollege characteristics & experiences		
Sociodemographic traits	Gender	Sex of respondent; Survey choices: Female, Male
	Financial resources	Parents' income
	First-generation college enrollment	Parent has a college degree
	Race/ethnicity (underrepresented groups)	Race/ethnicity
	Neurodiversity	ADHD; Learning disability; Autism; Psychological disorder
Prior academic preparation and performance	High school grades	High school grades
	Standardized test scores	ACT composite score; Reading SAT score; Math SAT score
	Mathematics preparation	Years of study, Mathematics; Highest math course completed
Student disposition	Creativity	Creativity (self-rating)
	Self-esteem	Intellectual self-confidence (self-rating)
	Math/science self-concept (academic self-concept[1])	Academic ability; Mathematical ability; Intellectual self-confidence; Drive to achieve (all self-ratings)[2]
The College Experience		
Organizational context	Institutional characteristics	Institution; Institutional selectivity; Institutional control; Institutional type
	Student-specific characteristics	Financial concerns, incoming freshman; Financial concerns, end of first year
Individual student experience: Classroom	Student engagement (academic disengagement[1])	Been late to class; Skipped class; Turned in course assignment(s) late; Turned in course assignments that do not reflect your best work; Fell asleep in class[2]
	Student engagement	Bored in class (proxy for short-term self-motivation)
	Instructor-student rapport (faculty interaction[1])	Interact with faculty outside of class or office hours; Asked a professor for advice after class; Communicated regularly with your professors; Amount of contact with faculty; Interact with faculty during office hours[2]
Individual student experience: Curricular	Academic development (academic adjustment[1])	Adjust to the academic demands of college; Develop effective study skills; Manage your time effectively; Understand what your professors expect of you academically[2]
	Academic support	Interact with disability services; Participate in first-year seminar; Participate in academic support program
Individual student experience: Out-of-class	Belongingness (sense of belonging[1])	Feel member of college; Sense of belonging to campus; Part of campus community; Recommend college to others[2]
	Belongingness	Interact with friends attending the same college
Outcomes		
Academic success	Academic achievement	College grades
	Persistence in SEM	Major as incoming freshman; Major at the end of first year
	Student disposition	Creativity; Potential to innovate; Resilience

Note. [1]HERI construct [28]. [2]HERI construct items [28].

Academic success is measured at the end of students' first year (i.e., by the YFCY) [27]. For academic achievement, we include students' overall college GPA (*COLLGPA*; categorical). We define persistence in SEM as majoring in SEM at the end of the first-year after indicating a SEM major as an incoming freshman (*SEMPERSIST*; 0=persisted in a SEM major after indicating a SEM major as an incoming freshman (the base category), 1=switched to a non-SEM major after indicating a SEM major as an incoming freshman, 2=changed to a SEM major from a non-SEM major, 3=not majoring in SEM as an incoming freshman or at the end of the first year). Persistence in SEM data is only available for students who took YFCY in 2017 and we will exclude undeclared students from our analysis of persistence in SEM. We operationalize creativity, potential to innovate, and resilience with students' self-ratings of their creativity (*FYCREATIVE*; 1=lowest 10%, 2=below average, 3=average, 4=above average, 5=highest 10%), tendency to seek alternative problem solutions (*INNOV*; 1=lowest 10%, 2=below average, 3=average, 4=above average, 5=highest 10%), and willingness to accept mistakes as a part of the learning process (*RESILIENCE*; 1=lowest 10%, 2=below average, 3=average, 4=above average, 5=highest 10%), respectively.

Analysis

This study is a work-in-progress, in which we will conduct a mediation analysis [17] to answer our research questions. Based on Terenzini and Reason's model [9], we hypothesize that the college experience mediates the relationship between precollege characteristics and experiences and academic success, as shown schematically in Figure 1. The specific statistical method chosen will be dictated by the nature of the outcome variable (e.g., categorical/ordinal or continuous). We will use linear regression modeling (ordinary least squares) to model continuous outcomes (e.g., academic disengagement and instructor-student rapport) and multinomial (ordered) logistic regression [29] modeling for nominal (ordinal) outcomes (e.g., persistence in SEM for nominal and creativity for ordinal). We will also use year fixed effects [30] to account for the multiple student cohorts examined.

Formally, the modeling of the full model (i.e., Paths A and B in Figure 1) for one nominal academic success outcome, persistence in SEM, follows [31, p. 339]:

$$\ln \frac{\Pr(y=m|x)}{\Pr(y=b|x)} = X'\beta_{m|b} \text{ for } m = 1 \text{ to } J \qquad (1)$$

where X is a vector of precollege characteristics and experiences and the college experience variables presented in Table 2, the βs are associated parameters to be estimated by the model, J = the number of nominal categories for an outcome, and m is the pairwise comparison of any of these categories to the base or reference (b) category. When persistence in SEM is the outcome, the J=4 nominal outcome categories are as defined previously. The main coefficients of interest are those related to the individual student experience variables defined in Table 2.

Summary

We plan to conduct a mediation analysis to study the relationship between students' precollege characteristics and experiences, the college experience, and academic success of students with ADHD. We will employ a college impact model to guide our analysis of multi-institutional,

longitudinal data from students as incoming freshman and then again after finishing their first year. Through our analysis, we will identify aspects of the college experience of students with ADHD related to academic success. These findings will guide our future qualitative study exploring these aspects in more depth.

From these studies, our findings on classroom experiences may enable instructors to consider their classroom environment and instruction and how it is related to the academic success of students with ADHD. Similarly, we may identify elements of academic support and development associated with the academic success of students with ADHD, thereby providing administrators and other staff members research-based evidence for tailoring, adding, or modifying academic support and development programs. Ultimately, we hope our research contributes to more diverse graduating cohorts, including more students with ADHD, pursuing SEM careers.

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