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Improving ACCESS: An Academic Support Program for First-Year STEM Students Working Toward Calculus

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Introduction

Since the implementation of the National Defense Education Act in 1958, the United States has proven to be on the cutting edge of science, technology, engineering, and math (STEM) education. With an elite reputation, we have witnessed the rapid development of technology, but in order to keep up with this ever-growing demand, we need a workforce that is able to maintain that momentum. American institutions of higher education offer valuable and prestigious degrees across STEM disciplines. However, students in these programs are only retained at a rate of 40 percent. The President's Council of Advisors on Science and Technology (PCAST, 2012) has determined that in order to keep up with national demands, the U.S. needs to produce a million STEM graduates over the next decade. Students who begin degrees in STEM often face academic challenges with little support, causing them to change paths (PCAST, 2012). Through extensive research, the PCAST (2012) has determined three major themes in STEM education that can contribute to retention: to improve the first two years of STEM education in college; to give all students the tools to succeed; and to diversify pathways to STEM degrees.

One of the major obstacles for students entering STEM fields is the rigorous math curriculum that begins as soon as they enter higher education (Kassaee & Rowell, 2016). Students are often expected to enter their first year at the calculus level, which is simply not the case for many (Shaw & Barbutti, 2010). For students who are not mathematically prepared to begin at that level, very few supports are currently in place for them to gain the essential skills they need to succeed (Rodgers, Blunt, & Trible, 2014). Knowing this challenge, the question driving this research is how can STEM State University create an academic support program to retain first-year STEM students working toward calculus?

The College of STEM at STEM State University offers nine different undergraduate degrees across seven departments. As one of five academic colleges, it serves a large portion of the undergraduate population. With the average math SAT score between 480 and 560 for incoming students, many STEM students are not at the calculus level upon entrance (National Center for Education Statistics, n.d.). In order to ensure these students are successful in their intended STEM field, it is necessary that they are provided with the tools and support to flourish. The developed academic support program consists of three intentional activities that contribute to STEM student success. The program was designed through the lens of Schlossberg's transition theory as a way to provide students with the support and strategies to achieve holistic success in their transition to a demanding major (Anderson, Goodman, & Schlossberg, 2012).

The Accelerating Connections Creating Education Success in STEM (ACCESS) program was intentionally designed to address both retention and holistic support of STEM students at STEM State University. Through involvement in the program, students will persist in their major, feel supported both academically and personally, and experience a sense of belonging. Each of these outcomes will contribute to the students' abilities to persist to graduation and join the STEM workforce. The literature review that follows highlights relevant findings around STEM student retention, impactful practices in facilitating their success, and existing programs that have applied those practices into creating a cohesive resource.

Literature Review

With the growing national need for STEM graduates, there is an increasing number of students seeking out STEM disciplines. Unfortunately, the number of students entering these majors is significantly higher than those graduating. There is a clear need for new retention efforts to provide the necessary support to students in these programs. By evaluating literature on the current retention initiatives and the persistence of STEM students, we can gain insight into their unique experiences and the practices that are most effective in increasing their persistence. Analyzing these practices through existing academic support programs has led to the development of ACCESS.

Retention and Persistence of STEM Students

Much research has been done on the factors that predict and contribute to STEM student retention and success. Shaw and Barbutti (2010) studied students' patterns of persistence within a chosen major, with an emphasis on STEM disciplines. The research question sought to identify characteristics of students who persist in the major they selected in high school compared to those who changed majors. Literature cited in this study mentioned the relationship between major persistence and satisfaction with the academic environment. Literature also stated that over half of the students who enter STEM majors wind up either switching majors or leaving their institution without a degree: "The greatest loss of students in the science, math, and engineering pipeline occurred in the transition from high school to college" (Shaw & Barbutti, 2010, p. 21). This study utilized data on over 54,000 students across 39 institutions nationally. Students intended majors were acquired through an SAT questionnaire, and compared to that of the third year from data submitted by participating institutions.

The study found that 59 percent of students beginning their college career in a STEM major were no longer in that same field by their third year. Students who persisted in their intended major were found to have had higher GPA's while in high school and college. Interestingly, the fields with the lowest amount of switching were engineering and technology. Underrepresented students, including women, Black and Hispanic students, and those of first-generation status were less likely to persist in STEM majors. Additional results stated that AP exam completion and strong math performance were indicators of future persistence. The study's findings suggest that there is a need for effective advising around major exploration and selection, especially during the first year. Linking first-year seminars to major curricula are a way to develop learning communities and create space for students to academically and socially integrate into the campus.

Similarly, Premraj, Thompson, Hughes, and Adams (2019) investigated factors that predict graduation rates of underrepresented students in STEM disciplines. They used six research questions to examine how race, ethnicity, gender, high school achievement, and early college GPA's influenced degree completion and number of years to degree completion. Literature cited discussed the high rate of students entering STEM fields upon arrival to college, but the drastically low completion rates. This data highlighted an issue with persistence, especially among underrepresented students. The literature also emphasized common predictive factors of success in STEM, which include SAT scores, high school rank, and first- and second-year college GPA. Data was collected from a sample of 2,422 students at a research university in Texas for three academic years. The records consisted of enrollment numbers and demographic data, in which first-generation status was self-reported.

The study found that SAT scores were the most effective predictor of STEM success for minority and first-generation college students. When examining the time needed to complete a degree, it was found that the higher the first year GPA, the faster a student would complete their degree. This was seen the most significantly in women and racial and ethnic minorities in STEM fields. The results suggest that institutions can work toward promoting success in underrepresented STEM students by using similar data to create retention-focused programs. It is essential that these programs are leveraged within the student's first year, in order to facilitate future success.

While the above pre-college factors may predict what will happen upon arrival to college, much can be done within the first year to create a sense of belonging in a STEM community. Wilson, Jones, Bocell, Crawford, Kim, Veilleux, Floyd-Smith, Bates, and Plett (2015) studied the links between levels of belonging and classroom engagement, in both behavioral and emotional contexts. The research questions entailed investigating which levels of belonging were most consistently associated with behavioral and emotional engagement, and if institutional types have an impact on these effects. Engagement in this study was not defined by the authors, but left to the perception of the student participants. However, the authors did define the distinctions between behavioral and emotional engagement. Behavioral engagement was defined as "student involvement in academic activities and has included measures of effort and participation in class discussions," while emotional engagement was defined "in terms of both perceived positive and negative emotional responses to academic experiences" (as cited in Wilson et al., 2015, p. 753). The collection of these components makes up academic engagement. Literature cited in this study described the vast collection of extant research in the areas of belonging and engagement, and the relationship between the two. Notably, belonging in the classroom has been linked to greater confidence, engagement, achievement, and persistence in STEM disciplines. Wilson et al.'s (2015) study surveyed 1,507 STEM students across five different institutional types. Belonging was measured at three levels (in class, academic major, and university), behavioral engagement measured effort and participation, and emotional engagement measured responses to class work.

The results of this study found that the intentional cultivation of belonging in the classroom positively impacted students' persistence and effort. Other results highlighted the links between class belonging and multiple forms of engagement, finding that belonging can be cultivated most effectively in the classroom when faculty know students' names, show warmth, and are prepared for class.

Faculty play an essential role in not only creating a sense of belonging, but also an academic environment in which students can persist. Xu (2018) examined the learning experience of STEM students and the factors that may contribute to their persistence toward graduation. Since students in STEM disciplines are graduating at rates roughly 20% lower than their non-STEM peers, the author sought to better understand what types of experiences students have in STEM and what resources institutions can provide to help promote success. Literature cited described the importance of accessible faculty to first year students. Previous research also mentioned advising as one of the most essential practices in promoting persistence and positively impacting retention rates. The literature described the main issues in STEM student persistence to be engagement, belonging, and institutional fit. This study consisted of an online survey of 404 students across three, four-year public institutions in Tennessee. The survey contained 7 open-ended and 57 multiple choice questions, most of which were on a Likert scale.

The most important finding of the study was that students' perceptions of the academic quality were most influential in determining persistence. This included the program itself, effectiveness of instruction, and accessibility of faculty members for help outside of class. Students who felt an appropriate balance of challenge and support were most likely to be retained. Results of the study also highlighted the importance of career advising for STEM students as a method of boosting engagement with their course content. Another notable finding indicated that while social engagement is essential to college adjustment, it was not a significant contributor to STEM student persistence. The results of this study indicate the need for the fostering of a high-quality academic environment, which can be done through the training of supportive and available faculty members, forming partnerships with local STEM employers, and regular career advising.

In order to best inform retention efforts, institutions must look at the experiences of not only STEM students, but the millennial student population as a whole. Turner and Thompson (2014) studied the millennial generation of college students and what factors contributed to enabling and preventing their success, especially their retention. In order to better inform retention efforts, the researchers sought to answer three questions. They inquired about the types of programs millennial freshmen choose to become involved with, what factors acted as barriers to the college transition, and what factors enhanced it. Literature cited in this study references the growing attrition issue across college campuses in the U.S. It was reported that for 75% of students who do not return sophomore year, "over 60% will not return to the same institution" (Turner & Thompson, 2014, p. 95). The literature also discussed the increasing relevance of retention rates to institutional success, both academically and financially. This study involved an interview of 30 students, of which 14 were women and 16 were men. All participants were traditionally-aged college students.

The interviews provided great insight as to what types of activities millennial students viewed as helpful or unhelpful to their transition. Sixty-seven percent of students interviewed shared that freshmen-focused programs were the greatest enabler of success. The development of effective study skills was cited by 65% of participants as the greatest obstacle to their success. Students identified academic challenges to be eased by the ability to develop comfortable relationships with faculty and adequate advising. Students who did not receive either of these supports considered them to be of vital importance to their academic progress. The results of this study indicate the need for more frequent student-instructor and student-advisor interactions, as well as continued trainings for all involved in the advising process. Workshops on study skills can also be of benefit to this student population.

Impactful Practices and STEM Student Success

Certain practices, both academic and cocurricular, have been suggested to contribute to the success of STEM students. Peterfreund, Rath, Xenos, and Bayliss (2008) explored the effectiveness of supplemental instruction (SI) in STEM courses. The research sought to analyze the correlations between SI attendance and final course grades, as well as the impact of demographic variables. SI is defined as an academic support service targeting high-risk courses rather than under-performing students. The sessions are run by peers who facilitate group conversation instead of re-lecturing. Literature cited described the benefits of SI to graduation rates, especially in academically underprepared students. Previous studies have also found that SI was equally impactful on students of all genders and races. Peterfreund et al., (2008) focused their study on the SI program at San Francisco State University (SFSU). Their SI program supported courses in biology, chemistry, mathematics, and physics. Data collected included grades for all STEM and SI classes and demographic data.

Five major findings were drawn from the study: SI users performed at a higher level than non-users; the differences in performance were not a result of the SI users being better students; SI users were more likely to take a subsequent course; men who attended SI benefited more than women; and the impact of SI was noticeably advantageous for underrepresented students. Data collected stated that over a span of seven years, 169 students who would have otherwise been "lost" from the major were retained because of their participation in SI. The results indicate that SI is a significant contributor to the retention of STEM students, and since it is relatively affordable, SI is a program worth investing in to foster persistence and success in STEM students.

When creating academic interventions, such as SI, it is essential to also be intentional about the manner in which those interventions are delivered. Molina and Abelman (2000) assessed the impact of style and approach in academic interventions for at-risk students. The authors examined how levels of intrusiveness of an intervention impacted performance and persistence of students on academic probation. Rather than focusing on the nature of the intervention, this study aimed to determine the role of the intervention process. In this study, advising was defined as intrusive "if it results in academic adjustment; that is, the adjustment involves the student's ability to self-refer and assume responsibility for academic performance…it is personal rather than merely professional, and it is dependent on how information is relayed rather than on the information itself" (Molina & Abelman, 2000, p. 6). Literature cited discussed lack of academic preparation, low familial support, and first-generation status as reasons that make today's students at risk for leaving an institution. The literature also described the need to shift from a prescriptive advising model to one that is more developmental and holistic. This study was conducted at a large, mid-western, urban university. A sample of 150 students on academic probation was randomly selected to take part in one of three interventions. The control group was nonintrusive, and the two experimental groups had varying levels of intrusion, moderate and full. The control group received only a letter regarding their probationary status and details about resources on campus. The two experimental groups also received this letter, followed by varying levels of intervention. The moderate-intrusion group received a 20-minute phone call discussing their probationary status and next steps. However, the full-intrusion group received a 40-minute phone call with the same content, plus a written contract of next steps, including appointments with tutors and counsellors.

The study found that the manner of intervention does matter, and that the more intrusive the intervention, the more effective it was than prescriptive and impersonal interactions, as measured by student performance and persistence. The results suggested that students who are at-risk benefit the most from intrusive advising practices, and thus, colleges should adopt them to ensure their success.

While Molina and Abelman (2000) evaluated the impact of style and approach in an academic setting, McCoy, Luedke, Lee-Johnson, and Winkle-Wagner (2019) studied intrusive practices in a cocurricular setting through a mentoring program. The researchers examined positive mentoring practices on students of color in STEM disciplines. The researchers sought to understand the strategies that were most effective in creating relationships between students and practitioner-educators, particularly with underrepresented students. The authors defined mentoring as “a relationship where a more experienced individual (the mentor) provides support (i.e., the acquisition of social and cultural capital) to a less experienced individual (the protégé)”

(McCoy et al., 2019, p. 1). Literature cited highlights the benefits of mentoring relationships in a college or university setting. Positive outcomes included greater retention, higher GPA's, and adjustment to college. Literature referenced in this study also showed that mentoring was found to be especially beneficial with students of color, who tend to be underrepresented in STEM. Researchers conducted a case study of 45 students of color at two institutions in the Mid-Atlantic region of the United States, one being a HBCU and the other a PWI. These included 31 undergraduate students, whose experiences were the focus of the study, and 14 graduate students.

McCoy et al., found that students of color were most impacted by mentoring practices that included unconditional positive regard, exposure to new perspectives, providing constructive feedback, and sharing cultural capital about available resources. Students felt most supported when they had someone that they knew believed in their abilities. The study's findings suggest that institutions should develop and implement mentoring programs for students of color in STEM disciplines, particularly with practitioner-educators. These programs must validate the students' backgrounds and encourage them to see themselves as not only students, but scholars and professionals.

Academic Support Programs and STEM Retention

Many colleges have taken the impactful practices discussed above and applied them in cohesive academic support programs. Rodgers, Blunt, and Trible (2014) developed and studied an intrusive advising program for at-risk, first-year STEM students as a method of boosting retention rates in STEM majors. The program sought to investigate whether additional support through the first year of advising and mathematics would impact student persistence. The authors defined intrusive advising as "a proactive approach to help motivate students and involve them in postsecondary education experiences" (Rodgers, Blunt, & Trible, 2014, p. 35). Literature cited stated that many current college students are not on a path to degree completion, but that advising was one of the most influential factors in retention. Literature also indicated that students who were academically underprepared began their college experience with low GPA's and lack of self-confidence. The program of study was titled Pathways Leading to Undergraduate Success in the Science (PLUSS) and was implemented at the University of Southern Indiana. The data collected compared students who attended the institution from five years prior to the existence of the program to four years of PLUSS participants. The program is multipronged, as it seeks to address several components of STEM students' experiences. The first component was an intrusive advising model with a low student-advisor ratio, similar to that of the coaching model. The advisors are carefully selected faculty within STEM departments. The program also included a cohort model for first-year seminar and mathematics courses. The first-year seminar was specifically designed for PLUSS students, rather than using the traditional curriculum.

The results of the program indicated that participation in PLUSS helped to increase retention, inter-departmental communication, and awareness of the importance of advising. The results also indicated that effective faculty advisor training combined with regular student interactions and a cohort model are effective practices in boosting retention in at-risk, first-year STEM students.

Whether it be through advising or a summer bridge experience, the programs of both Rodgers, Blunt, and Trible (2014) and Kassaee and Rowell (2016) aim to define what it means to be in STEM and prepare first-year students for success in their field. Kassaee and Rowell (2016) studied the role of motivation in the retention of first-year STEM students. Through a questionnaire and math summer bridge program, students' STEM motivation was measured on five levels. By investigating student motivation, the researchers sought to understand which factors would impact retention. Literature cited in this article suggested that STEM students in the United States perform at a rate lower than the international average, and this is only declining. Data indicated that this was primarily due to a severe disinterest in STEM disciplines amongst high school students. To address this issue, the researchers developed a program called Mathematics as a FirstSTEP to success in STEM (FirstSTEP) at Middle Tennessee State University, a large, public, four-year institution. Participants were 36 first-year STEM students with Math ACT subscores of 19-23. The demographics of the participants were 36 percent female, 64 percent male, 36 percent African American, and 64 percent white. This cohort was the fourth to participate in FirstSTEP. Students were compared to 85 first-year STEM students with similar ACT scores who did not apply to FirstSTEP. As a FirstSTEP participant, students applied and opted-in to the program, which included a mathematics summer bridge program. During those two weeks, students were assessed via pre and post precalculus readiness tests and a Science Motivation Questionnaire (SMQ-II), which asked students about their learning experiences in science.

Results indicated that the FirstSTEP students had high grade and career motivation, but were lacking in intrinsic motivation, self-efficacy, and self-determination to succeed as a STEM major. Through the acquisition of data on what motivates students, the FirstSTEP educators were better able to tailor the program toward the students' needs. As a result, FirstSTEP students saw greater success in precalculus grades and retention than the control group. These findings suggest that in higher education, we must make efforts to know our students as individuals in order to best support and motivate them to persist and graduate in STEM disciplines.

A summer bridge program was also of interest for Cleveland State University, where researchers expanded upon the program with additional peer tutoring and focused their resources on underrepresented students. Carver, Van Sickle, Holcomb, Jackson, Resnick, Duffy, Sridhar, Marquad, and Quinn (2017) implemented and analyzed a program for mathematically at-risk STEM students as a method of improving retention and graduation rates. The program, titled Operation STEM (OpSTEM), utilized both curricular and co-curricular components to foster success in the precalculus-calculus sequence. Literature cited for this study indicated that the United States is projected to have a severe deficit of STEM graduates over the next decade, much of which can be contributed to the low retention and completion rates within STEM disciplines. Previous research also shows that these rates are even lower for students of certain racial and ethnic identities, as well as first generation students. OpSTEM was implemented at Cleveland State University, a mid-sized, public, four-year institution. The program ran for several cohorts and included a control group and two different treatment groups. The first treatment group received only peer tutoring and were not of underrepresented identities. The second control group consisted of students of identities underrepresented in STEM and received the full program of OpSTEM Scholars resources. These included peer tutoring, as well as a summer institute, co-curricular cohort programming, faculty mentoring, and potential eligibility for a free summer calculus course. Data collected on precalculus and calculus grades from these groups were compared to students of similar identities prior to the implementation of OpSTEM.

The researchers found that students from both treatment groups saw increased performance in precalculus, indicating that the mandatory peer tutoring was successful. However, the second treatment group, which received the full program of resources, saw even greater gains in precalculus performance and retention rates. The findings of this study suggest that mandatory peer tutoring, or supplemental instruction, is a valuable tool in academically supporting STEM students. Specifically, in the precalculus-calculus sequence, which is known to be a drop-off point for students, the gate to retention can be widened through providing these opportunities.

The focus on underrepresented students has been common for these types of support programs and has also been explored in a learning community environment. Dagley, Georgiopoulos, Reece, and Young (2016) examined retention and graduation rates in STEM students through the implementation of a two-year learning community. The research question investigated whether a learning community would address the national attrition issue in STEM students. Literature cited in this study indicated that the majority of STEM attrition occurs during the first two years, and is frequently related to a lack of mathematic preparation. The lack of preparation often leads to lower grades, overwhelm, and decreased confidence, which are detrimental in such competitive disciplines. The researchers implemented the learning community, titled EXCEL, at the University of Central Florida (UCF), a large, public, four-year institution. EXCEL participants were first-year STEM students with math SAT scores in the second and third quartiles, typically 550-660. Recruitment efforts were directed toward underrepresented groups, including African American and Hispanic students, as well as women. The EXCEL program consisted of cohort math classes, social activities, an optional residential component, required recitations and tutoring with graduate teaching assistants, specific advising days around key points of the semester, and faculty-led research opportunities. EXCEL is an opt-in program, so students in the cohort were compared to a control group of non-EXCEL students. Retention rates were measured for seven cohorts, and graduation rates for four.

The researchers found that students participating in EXCEL saw higher retention and graduation rates. This effect was magnified in underrepresented groups. Hispanic EXCEL students were retained at a higher rate than any other group. EXCEL women were also retained at a higher rate than their non-EXCEL peers. In addition, researchers found that EXCEL students were graduating at the same rate as students who were more mathematically prepared upon entering college. The study's findings suggest that the creation of community offered within an LLC is an effective method toward improving the retention, performance, and satisfaction of STEM students, especially those who are underrepresented.

Much research has already been done on the retention and persistence of STEM students and the practices that can help facilitate their success. Predicting and understanding contributing factors to student persistence allows higher education professionals to better inform their retention efforts. Providing academic support services, such as supplemental instruction, and creating opportunities for regular student-faculty interactions can be instrumental in the first-year experience of STEM students. By observing how other institutions have put these practices into place, an academic support program tailored specifically to mathematically underprepared first-year STEM students can be developed and implemented.

Theory Overview

This project was developed through the lens of Nancy Schlossberg's Transition Theory. As a content and process theory, Transition Theory is widely used across the field of higher education. Schlossberg provides a model for supporting adults in transition, which can be applied directly to first-year students as they transition from high school to college. Schlossberg defines a transition as "any event, or non-event, which results in changed relationships, routines, assumptions, and roles" (as cited in Patton, Renn, Guido, & Quaye, 2016, p.37). It is important to note that a transition only exists if perceived by the individual undergoing the change. Schlossberg categorizes transitions into three categories: anticipated transitions, which are predicted; unanticipated transitions, which are not predicted; and non-events, which are expected transitions that do not occur (Patton, et al., 2016). These types of transitions are categorized by the perception of the individual experiencing the change and the meaning they associate with it.

Schlossberg proposes the remedy to a successful transition to be found in her four S model: situation, self, support, and strategies. Each of these components is specifically unique to the individual experiencing change and will best inform coping mechanisms. All four S's work together to provide a comprehensive model of coping with transition (Figure 1). By evaluating these factors, the transition can be better understood.

Situation. When experiencing a transition, every individual will be in a unique situation. This varies based on several factors: triggers, what initiated the transition; timing, how relatively good or poor the time period of the transition is; control, what components the individual has autonomy over; role change, if involved in the transition; duration, how long the transition will last; previous experience, how the individual has handled similar transitions in the past; concurrent stress, what factors are contributing to the stress of the transition; and assessment, what emotions the individual associates with the transition (Anderson, Goodman & Schlossberg, 2012). Each of these components varies in every transition, highlighting the need to pause and evaluate before looking to solutions.

Self. Similar to the situation, every individual experiencing a transition is unique in the inherent characteristics they bring. These characteristics fall into two major categories: personal or demographic characteristics, and psychological resources. Personal and demographic characteristics include life stage, gender, race and culture, socioeconomic status, and health. Each of these factors influence the way a person experiences life, especially during transitions. Psychological resources include ego development, optimism, self-efficacy, commitments, values, resilience, and spirituality. These characteristics can be drawn upon to withstand pressures in times of change. While the first two S's, situation and self, are inherent to the individual and are often static, we can look to the next two S's, support and strategies, to determine how to confront and work through transitions.

Support. Individuals receive social supports that are classified by the type of relationship, including intimate, family, friends, and communities. Social support through these connections can help individuals experience respect, affirmation, assistance, and feedback through the transition. Examples of social support can include encouragement, financial assistance, or advice from trusted loved ones. Social support is frequently measured through convoys, which are person-centered networks that provide different levels of support. A convoy can also be disrupted through a transition, which can lead to shifts in the three measures of respect, affirmation, and assistance.

Strategies. The last of the four S's describes how an individual copes with transition. Through research, three themes have emerged in response to stress. The first response modifies the situation. This can include disciplining children in parenting or seeking a compromise in a relationship. The second response is controlling the meaning of the problem, such as positive comparisons. The last response manages stress after the transition has occurred, such as denial or hopefulness (Anderson, Goodman & Schlossberg, 2012). Coping strategies are also interrelated with the self. For example, the ego can become damaged during periods of stress, which impacts one's psychological resources. Due to the individualistic nature of the four S model, there is no single strategy that can be applied in all circumstances, but rather natural approaches that can be taken based on the available supports.

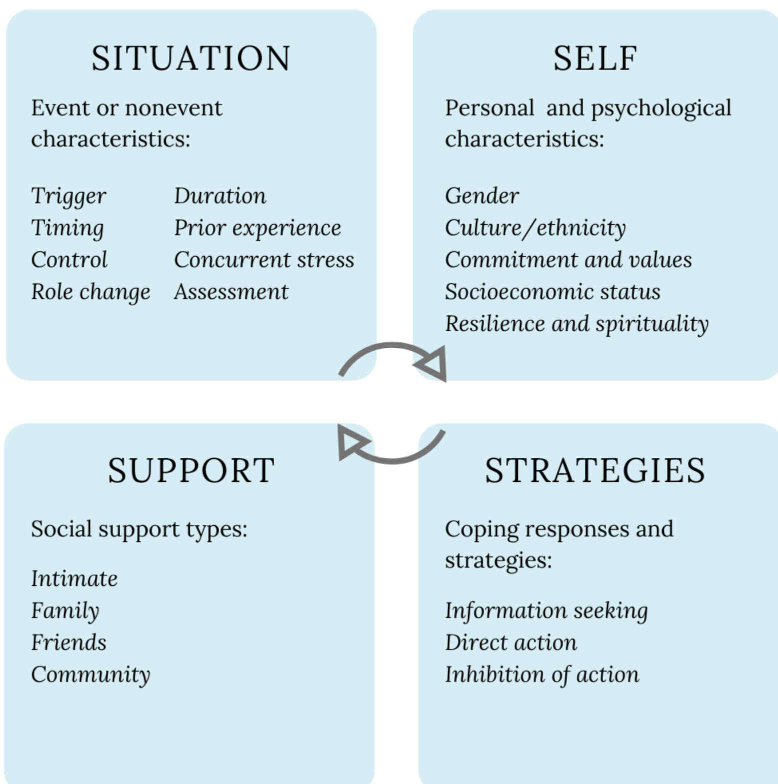

Figure 1. Visual representation of Schlossberg's four S transition model, adapted from Anderson, Goodman, and Schlossberg (2012).

Schlossberg's four S model provides context in navigating any transition. When analyzing a change, the situation and self are often fixed. These are unique characteristics to the individual and circumstance of the change itself. However, the way in which one approaches the change through utilizing supports and strategies can determine a different outcome. In the situation of a first-year student adjusting to college life, every student will bring their own intrinsic traits. However, it is the institutional supports and the way they are utilized that can impact how successfully a student transitions into the college environment. Higher education professionals can zone in on the needs of first-year students to provide future generations with beneficial supports and strategies to navigate the change. Successful implementation of the four S model should leave students feeling well-adjusted and a sense of belonging in their new environment.

ACCESS was designed through the lens of the four S model, seeking to provide first-year STEM students with the support and coping strategies necessary to a successful transition into their major. Through a cohort model and a small advising team, ACCESS students will receive support from their peers, faculty, and staff members. This multi-pronged community of support is important in that students can relate to their peers, while seeking guidance from professionals. Providing this community of support will aid students in their college transition. Students will acquire coping strategies for their transition through their custom courses and regular advising appointments. Having professionals that are trained and equipped to provide students with these strategies will enhance their transition into the early academic demands of a STEM major. ACCESS was developed with these two S's at its heart, with the goal of reducing the challenge of transition to facilitate greater success.

Project Plan

Overview and Outcomes

Based on the research of best practices to support STEM students, I developed a program to academically support mathematically underprepared first-year STEM students at STEM State University. The program, titled Accelerating Connections Creating Educational Success in STEM (ACCESS), is based in Schlossberg's Transition Theory and aims to provide students with the supports and strategies necessary to successfully transition into a rigorous academic major. Its purpose is to connect students with the key people and tools they need to successfully transition into their first year of college as a STEM student. The main features of ACCESS include a cohort model, regular academic advising, and peer-led supplemental instruction, all operating out of a centralized office space.

One outcome of the program is that students will persist in their major through involvement in a cohort. The cohort will consist of a collective college algebra course with a linked First Year Experience (FYE) seminar, both of which will be taught by the same faculty member. In the following Spring semester, the cohort will take precalculus. In an interview conducted by Turner and Thompson (2014), almost seventy percent of students shared that first-year-focused programs were the greatest enabler of a successful transition into college. By developing a cohort, students can create connections with their peers who they can relate to through shared experiences. The goal is that ACCESS students will support one another as scholars as they begin their academic journeys.

The second outcome of the program is that students will feel supported both academically and personally through frequent advising. Academic advisors can act as the support component of Transition Theory. Through their interactions with students, advisors can provide affirmation, assistance, and feedback as they navigate their first semester of college (Anderson, Goodman, & Schlossberg, 2012). By utilizing an appreciative advising approach, students will be affirmed in what they are experiencing, while also receiving advice in how to most effectively move forward in their college transition. Through advising, students will be able to develop personalized academic plans that are custom designed to their goals. Advisors will be equipped with knowledge on additional campus resources, such as tutoring, counseling, and financial aid. By understanding how to make effective referrals to these offices, students can be holistically supported.

The third outcome is that students will feel a sense of belonging through creation of a physical space. By having one central space for all things ACCESS-related, students will begin to feel more comfortable in their new environment. The suite will be open for students to use as a productive space to study and work on homework. By having a physical location to visit, students will experience a feeling of membership in the program and foster their sense of belonging at the university and as a STEM student.

Intentional Activity #1: Constructing a Cohort

ACCESS students will participate in a cohort math and FYE class. This cohort will be determined through admissions criteria and contacted in early June about participation in the program. More details will be discussed later in the Outreach and Engagement Plan. During the Fall semester, students will take college algebra and FYE. During the Spring semester, students will take precalculus. According to Shaw and Barbutti (2010), linking a first-year seminar to a major course is a way to foster academic and social integration into the campus. By putting the students in the same group with the same instructor, they will become more comfortable in their new environment. Each of the courses have been intentionally constructed to optimize the learning and persistence of ACCESS students.

FYE will utilize a uniquely designed curriculum that is tailored to the STEM student experience. In addition to transitional content, the course will incorporate study skills, career development, and introduce early research skills (for the course schedule, refer to Appendix A). Students will begin the first two weeks being introduced to the course, the college, and one another. The following four weeks will be spent covering study skills that students can apply based on what they know about their personal learning styles. This section was intentionally placed toward the start of the semester because it allows students the chance to apply the skills early in their courses for optimal success. After study skills, there will be a four-week segment on career development. This segment was included based on the study from Xu (2018) which stated that career advising helped students to more deeply engage with their course content. In these sessions, students will have the opportunity to build resumes and LinkedIn profiles, conduct informational interviews, and learn about the internship process. Often times, students believe the myth that they must wait until their junior year to apply for internships, when many companies are actually eager to hire first-year students. Students will then spend one week learning about the course registration process. This will be followed by three weeks on research skills, such as navigating peer-reviewed journal articles and keeping a lab notebook. Introducing these skills early will allow students to feel more confident and prepared upon entering an internship or research experience. The last week will be a course wrap-up and celebration of completion.

Participation in the FYE course will provide students with the strategies needed to navigate their transition early on (Anderson, Goodman, & Schlossberg, 2012). These topics will not only promote a successful transition into college, but also into an academically rigorous major. By customizing the curriculum to the unique experience of STEM students, students will gain the necessary skills to persist in their major, despite their label as being mathematically underprepared. The final project of the FYE course will require the students to create a physical tool that they can carry with them into the Spring semester. This can be a handbook of resources or collection of materials they gathered from their first semester. The purpose of this tool is for students to have easy access to the course information so they can reference it later.

The college algebra and precalculus courses will be taught by the same instructor as FYE in order to ensure consistent student support across the cohort. The courses will follow a traditional curriculum, but taught in an intrusive manner that encourages grit. Molina and Abelman (2000) stated that an intrusive approach focuses more on the manner of delivery than the content itself. While originally applied in an advising context, an intrusive approach can also be practical in the classroom. Their results indicated that underprepared students could benefit the most from intrusive practices, and therefore they will be applied in the ACCESS math courses. This manner of instruction will be the distinct difference between a typical course and the ACCESS section, allowing students the space to explore and grapple with the content rather than simply memorizing steps. The students will be partially assessed on their grit and willingness to approach a problem in new ways until they find the correct answer. The courses will involve more group work and project-based learning than high-stakes exams.

Both of the ACCESS math courses will be supported by peer-led supplemental instruction (SI). SI is a model in which peer leaders facilitate problem solving amongst current students through optional study sessions outside of class time. It is meant to target historically difficult courses, rather than at-risk individuals, making it an ideal source of academic support for the ACCESS cohort. According to Peterfreund, Rath, Xenos, and Bayliss (2008), students who utilized SI performed at a higher level than their non-attending peers. STEM State University has a robust SI program amongst STEM disciplines, and thus the ACCESS leaders will be trained through that program. However, the specific ACCESS math SI leaders will ideally be upperclassmen students who were a part of ACCESS in their first-year. Selection of the SI leader will be to the discretion of the math faculty member and SI coordinator.

Participation in the ACCESS algebra and precalculus courses will allow students to see their capacity for deeper learning and ability to succeed in a STEM discipline. These courses were intentionally selected for the cohort because regardless of major, every STEM student is required to take math. Students in these disciplines are expected to enter at the calculus or precalculus level, which is not always the case. Students who enter at the algebra level are often dismissed and encouraged to seek out other majors. With the right support, these students are fully capable of succeeding in a STEM discipline, which is exactly what the ACCESS courses were designed for. By providing students with academic tools in FYE and encouraging an intrusive and grit-focused approach in math, students will be well prepared for the calculus sequence to follow. The growth mindset and grit emphasis will encourage persistence not only in the course, but also in the major.

Intentional Activity #2: Constructing an Advising Team

The ACCESS team will be made up of four key people: the director, assistant director, an academic advisor, and a faculty member. Organizationally, the director will oversee both the assistant director and faculty member. The academic advisor will be most directly overseen by the assistant director. This cross-campus collaboration between faculty and staff is exactly what will make ACCESS students feel supported both academically and personally.

Selection of the faculty member will be through an application process. There will not be a new hire for the role, but the faculty member will be from the existing math department. The ACCESS director will send an email to all math department faculty explaining what the program is, the position description, and a link to a brief form. Interested faculty can apply through this form by answering a series of questions around why they would like to participate in ACCESS. The ACCESS director and assistant director will then go through the applications to decide which faculty member most clearly aligns with the program's values of being student-centered, asset-based, and holistic. The selected faculty member will be responsible for teaching the ACCESS sections of college algebra, precalculus, and FYE, which will be counted in their course load.

New team members will be on-boarded by the director, who will train them on the mission and values of the program. Hiring will occur during the Spring semester, so that the team members can be sufficiently trained prior to the cohort's June orientation. Ongoing training will be provided for all ACCESS team members. The director will be responsible for training the assistant director, advisor, and faculty member on NACADA advising approaches, specifically developmental, appreciative, and proactive advising. These approaches will be incorporated throughout all interactions with students. The team will also have access to regular professional development opportunities to stay informed about current issues in STEM and advising STEM students. Producing a high-quality academic environment can be done through training faculty members, which encourages student persistence (Xu, 2018). Since both faculty and staff will receive the same training, all team members will be able to meet students where they are and provide support, both academically and personally. Although the faculty member will not formally advise, they will engage in informal advising through their day to day interactions with students. Unlike the advisors, the faculty member will see the students almost every day, which is why it is essential for them to be trained the same way.

The ACCESS academic advisor will be a new hire, selected through an open application process. The advisor must be someone who shares the values of the program and preferably someone experienced in advising STEM students. Due to the rigid nature of STEM curricula, the advisor must be able to design personalized academic plans for the students, based on their individual goals. According to Turner and Thompson (2014), access to adequate advising is of the utmost importance for first-year students' academic progress. While all three staff members will participate in advising students, the academic advisor will be assigned to the majority of the cohort.

Students in the ACCESS cohort will each be assigned an academic advisor, who will be one of the three staff members. Advising will occur on a regular basis and be tailored to the academic calendar. Key points of advising will be during the first two weeks of the semester for introductions, after the first month to check in, the end of October for midterm grades, mid-November for course registration, and at the end of the semester. A similar trend will follow in the Spring semester. During advising meetings, discussion topics will include personal, academic, and career goals, college adjustment, developing personalized academic plans, and strategizing for success. These holistic conversations will allow students to feel supported both personally and academically. This is an essential component of the program, and a solid source of support for students navigating their first year in a STEM major (Anderson, Goodman, & Schlossberg, 2012).

Intentional Activity #3: Creating the ACCESS Suite

In order to foster a sense of belonging within the ACCESS community, a physical space will be created. The ACCESS suite will be located in Hemenway Hall. By placing the suite within the science building, students can easily visit the space before or after class, making it accessible for commuter students as well as residents. Hemenway is also in close proximity to the Center for Academic Success and Achievement, where students can go for tutoring and accessibility services.

The center will consist of a large, open study area with tables and white boards along the walls. This space will be utilized for supplemental instruction sessions throughout the week, but can also be a great study space for students to gather. The suite will be open for all students, not just ACCESS students, to work on group assignments, form study groups, or simply have a productive space to do homework. In addition to the open study spaces, there will be several public computers and printers available for student use. Having these resources in the same building as many of their classes will be convenient for students and draw them into the space. Along the perimeter of the suite will be the offices of the director, assistant director, and academic advisor. The math faculty member will not have an office in the suite, but be located within the math department (for the floor plan, refer to Appendix B). The math department's offices are also located in Hemenway Hall, so the faculty member will be easily accessible. The instructor can, however, use the space to hold review sessions outside of class time. There will be a small conference room in the space for the entire ACCESS team to gather for monthly meetings. The suite will be open during the hours of the building, with the staff offices closing at the end of every work day.

The ACCESS suite will also be used to host a series of programs throughout the academic year. The FYE end of semester celebration is an example of one of those events. Programs will be social in nature and be held two to three times per semester as a way to build community within the cohort. This sense of camaraderie has been found to improve student persistence and satisfaction (Dagley, et al., 2016). Programming will be especially beneficial for commuter students, who may not see their peers outside of class time.

Benchmarking

The ACCESS program was designed with inspiration from the STEP program at Western Michigan State University (WMSU). As a mid-sized public institution, WMSU has a breadth of resources available to their STEP students. The program is grant-funded by the National Science Foundation as a STEM Talent Expansion Program (STEP), which began as a way to support mathematically underprepared STEM students. It is located within the College of Engineering and Applied Science (CEAS). Key features of the program include a cohort model, a specific FYE course, free peer tutoring, and personalized academic advising (WMSU, 2020a).

STEP features cohorts of 10-25 students who take anywhere from five to nine courses together throughout their first year at WMSU. Each cohort is led by a faculty of staff mentor who advises and develops programs for their students (WMSU, 2020b). Within the STEP program resides the CEAS Preparatory program, which provides additional support to students in the college who enter at the algebra level, as determined by SAT or ACT math scores. Students in CEAS Prep must pass Algebra II with a B prior to continuing to precalculus and declaring a major within the college (WMSU, 2020c). I chose to incorporate a similar progression for ACCESS students, where they will take college algebra as a cohort and proceed into precalculus the following semester. I chose not to include the grade requirement, but rather allow the students to follow the departmental scaffolding requirements. At STEM State, students would need a C- in the course in order to progress. This will prevent students unnecessarily retaking courses and spending additional time and money.

A tailored FYE course was developed for engineering students in the CAES Prep program. It was designed with the intent to provide students with the skills they need for success in an engineering program. These include study skills, time management, and career development (WMSU, 2020c). The final project of the FYE course is a workbook through which students navigate their first semester. The workbook consists of a series of reflective questions around education in STEM and effective academic habits (L. Yaeger, personal communication, March 18, 2020). Career development is also an essential component of the course, and the CEAS career advisor visits during one class meeting. There is also a course requirement to attend the college's career fair (L. Yaeger, personal communication, March 18, 2020). These course topics and final project were key features that I adopted into the ACCESS FYE section. By providing students with the skills they need to persist in a STEM major early on, they are better able to implement them and achieve success.

Peer tutoring is a major component of not only CEAS Prep, but the entire STEP program. The homepage of the STEP website boasts a vast variety of options, with over twenty tutors covering over thirty subjects (WMSU, 2020a). This tutoring occurs in three different locations, two of which are residence halls. The tutors are upperclassmen students majoring in math, science, and engineering. The students undergo an extensive training process to ensure they are well equipped to provide academic support to the STEP students (L. Yaeger, personal communication, March 18, 2020). I adapted this type of peer tutoring program into supplemental instruction, as a way to continue providing peer-led academic support to ACCESS students. I chose SI over tutoring because of the facilitator role that the leader takes on. ACCESS students will not simply be re-taught by a tutor, but guided through a problem to collectively find a solution.

In a conversation with the STEP academic advisor, she shared that 89 percent of STEP students have a staff advisor, and only smaller programs utilize faculty advising (L. Yaeger, personal communication, March 18, 2020). The STEP team values providing personalized academic plans for their students, and that is something I wanted to carry into ACCESS. For STEP students on academic probation, there is a specific retention advisor who meets with students for individualized academic success coaching (L. Yaeger, personal communication, March 18, 2020).

With the STEP program contributing to a 39 percent increase in graduation rates, it is clear that these tactics are effective in retaining mathematically underprepared STEM students (WMSU, 2020a). A cohort model, custom FYE course, peer tutoring, and personalized advising all work cohesively to provide STEM students with the tools they need to persist in such rigorous disciplines. Each component of the STEP program has provided inspiration from which I've drawn upon in the development of ACCESS.

Outreach and Engagement Plan

Enrolled students who have a high school math GPA of under 2.3 and indicated interest in a STEM major on their application will be qualified for entrance into the ACCESS program. Over the summer, admissions will share the list of ACCESS-qualifying students to the director, who will responsible for outreach. The director will email the students using asset-based language to welcome them to ACCESS (for an example email, refer to Appendix C). This type of language will allow students to feel supported rather than place a stigma on participation.

ACCESS will be an opt-out program, so all qualifying students will be automatically placed in the program unless they choose otherwise.

During summer orientation, there will be a 45-minute breakout session for ACCESS students. The director, assistant director, and faculty member will lead an information session about the program and serve as a meet-and-greet event for the cohort to begin getting to know one another. During the course registration portion of the day, the ACCESS advisors will be available to assist students in course selection and placing them all in the cohort sections.

Throughout the academic year, ACCESS will utilize social media to highlight what happens in the program. The assistant director will run active accounts on Facebook and Instagram. These will be used to celebrate the accomplishments of students in the program through spotlight posts. They will also serve as a method of communication to update students on supplemental instruction and advising. The suite will be used to host small programs for the ACCESS students, which can be documented on the social media pages as well. The ACCESS account will actively interact with other offices on campus. They will share content that is applicable to ACCESS students and promote on-campus resources. Current students and their families can follow the accounts for updates, and prospective students can witness real students in the program. To ensure ongoing marketing of the program, the ACCESS team will be present at additional events throughout the academic year, such as accepted student days and open houses.

Conclusion

The research informing the ACCESS program at STEM State University sought to better understand the experiences of STEM students and the practices that higher education institutions can implement to best support them. STEM students who enter college and are not mathematically at the calculus level, more often than not, end up in a completely different major by the time they graduate. These students are often dismissed as incapable of succeeding in a STEM major, without being given any support to do so. This leads to feelings of incompetency and discouragement as they are left to find another program of study that they are less passionate about. ACCESS was created to end this cycle at the source, by immediately providing first-year STEM students with an abundance of support and strategies to succeed in their major.

The literature suggested that STEM students, when provided with the proper support, are capable of flourishing despite their initial level of mathematic preparation. Practices such as peer tutoring, cohort models, effective advising, and linked courses have suggested to be effective in both retaining STEM students and improving their math performance. Informed by this literature, ACCESS was created with student success at its center, and focuses on transforming the first-year experience for participating students. As an opt-out program for all qualifying first-year STEM students, the goal is to provide them with the support and coping strategies necessary to adjust to not only college life, but the demands of STEM disciplines. Created through the lens of Schlossberg's Transition Theory, ACCESS provides support to students through three intentional activities: a cohort model with custom linked courses; a cohesive advising team; and a physical space to gather. Through engaging with these activities, students will persist in their major, feel supported holistically, and feel a sense of belonging, both in their major and at STEM State University.

The retention of STEM students can be drastically impacted by the implementation of programs like ACCESS. If the national STEM retention rate increased by just 10 percent, the U.S. would be well on our way to having a sufficient volume of STEM graduates. Not only will ACCESS contribute to this number, but it will produce high-quality professionals that are well equipped to bring innovation and creativity to the global scientific community.

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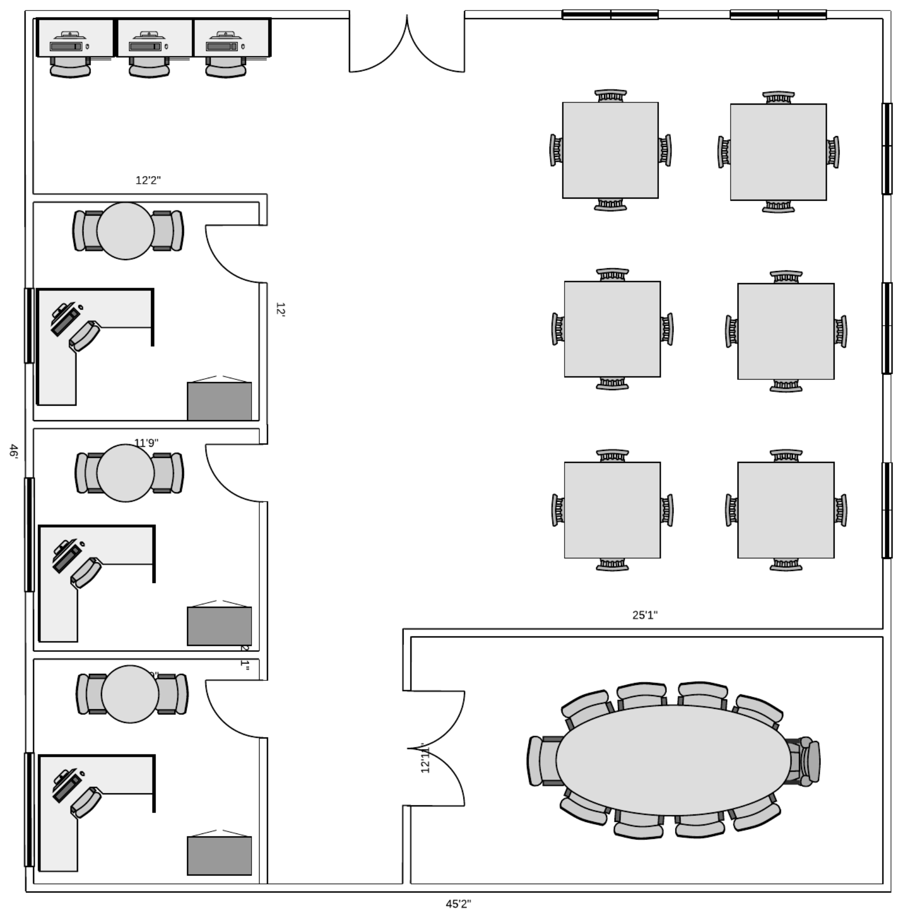
Appendix A
FYE Semester Schedule

Week 1: Introduction	Welcome, introduction, ice breaker, course overview expectations
Week 2: College Resources	Health and counseling, tutoring, dining, recreation
Week 3: Study Skills	Note taking
Week 4: Study Skills	Time management
Week 5: Study Skills	Study strategies, visit from academic success staff
Week 6: Study Skills	Growth mindset and grit
Week 7: Career Development	Take career inventory
Week 8: Career Development	Visit from career services, resume and LinkedIn workshop
Week 9: Career Development	Informational interviewing
Week 10: Career Development	Internships 101
Week 11: Course Registration	How to register and prepare for advising
Week 12: Research Skills	How to read a journal article
Week 13: Research Skills	How to search for journal articles, visit from library staff
Week 14: Research Skills	How to keep a lab notebook
Week 15: Course Wrap-Up	Takeaways, celebration of completion

Appendix B
ACCESS Suite Floor Plan



Appendix C
ACCESS Welcome Email

[Student's name here],

Congratulations on your acceptance to STEM State University and welcome to the ACCESS program! Designed with student success at its core, ACCESS was developed to help first-year STEM students adjust to life in college and the academic rigor of being in a STEM major. We are here to support you through this transition.

As an ACCESS student, you can look forward to:

- Being a part of a cohort with other ACCESS students. In your first semester, you will take college algebra and your First-Year Experience seminar together.
- Supplemental instruction. We know math can be challenging and is essential for all STEM disciplines, so we built in peer leaders to offer sessions outside of class. SI attendance has been shown to boost your grade in the course.
- Personalized academic advising. You will meet with your ACCESS advisor regularly in order to help you build an academic plan that is tailored to you and your interests.
- Visiting our suite. We are located in Hemenway Hall and would love for you to visit! This is where you will meet with your advisor, attend supplemental instruction sessions, and you can even use it to study.

If you would not like to utilize these resources, you can choose to opt out of the program by June 15. We look forward to working with you soon!

[Director's name here]

Director, ACCESS Program