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WIP: Understanding the Pipeline: Investigating the Impact of Intro STEM Courses on Major Choice

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Abstract

Through our Work in Progress (WIP) paper, we propose investigating why students who initially indicate interest in STEM are not enrolling in a STEM major using a detailed interview protocol and an analysis of enrollment data.

At our small liberal-arts college, students declare a major in their second year. However, in the summer preceding their arrival they declare academic interests and are matched to advisors in the disciplines they self-selected. Throughout their first year, students take a common first-year seminar, a first-year writing course (of their selection), and STEM students take 1-3 introductory STEM courses. Several years of data shows that a large proportion of the students who initially expressed interest in STEM declare a non-STEM major in their second year. We are investigating why student's interests change. In this paper, we will outline our structured interview protocol and its ties to applicable research. Through a structured interview protocol, we plan to answer the following research questions: 1) Why are students interested in STEM declaring in non-STEM majors? 2) What experiences in their first year are influencing their major declaration decision?

In this paper, we describe our institutional issues and how it informed our interview protocol.. The protocol is developed to capture student interests and motivations for STEM fields, explore community developments impact on their first year, and investigate the effectiveness of pre-college courses/preparations. Through this protocol, we will identify factors that impact student major declarations and create impactful interventions to increase student STEM retention.

Introduction

At our institution, students indicate their first and second major interests at the time of matriculation but declare the major in their second year. Three years of data shows that only 50% of students who indicated an interest in STEM majors declared STEM majors. Although these STEM retention rates are comparable with national trends, our students experience a unique first year due to our One Course At a Time (OCAAT) plan. While we have seen growth in students' STEM professional identities, measured by the PIO-4 assessment in the 23/24 academic year, we continue to see many STEM-interested students declare non-STEM majors. In order to better understand the reasons behind STEM-interested students leaving STEM majors, we are creating and implementing interview protocol to investigate the impact of OCAAT introductory STEM courses on STEM retention.

Institution Description

Our private liberal arts institution is located in a rural area in Iowa with an enrollment of just over 1000 students and class sizes averaging 13 students to 1 instructor. Cornell is a

primarily white institution with a student body that is 60% white, which is above the national average of 55% [1]with 30% of first-year students coming from Iowa and 4% of students being international. The student body is also majority men (51.5%) with women (44%) being far below the national average and the remaining population with an undeclared gender. However, we have a somewhat higher percentage of first-generation students at 27%, which is partially due to our admissions protocol. Our admissions protocol does not require any standardized testing or admissions essay, which allows for greater first-gen recruitment in our rural state.

From 2019-2022, our institution saw an increase in the number of students enrolled, with the percentage of women and people of color increasing. However, we have experienced a decline in the percentage of STEM declarations, especially among minority populations. This study aims to investigate the reasons behind the low STEM retention, specifically focusing on the impact of the OCAAT schedule on STEM identity and sense of belonging.

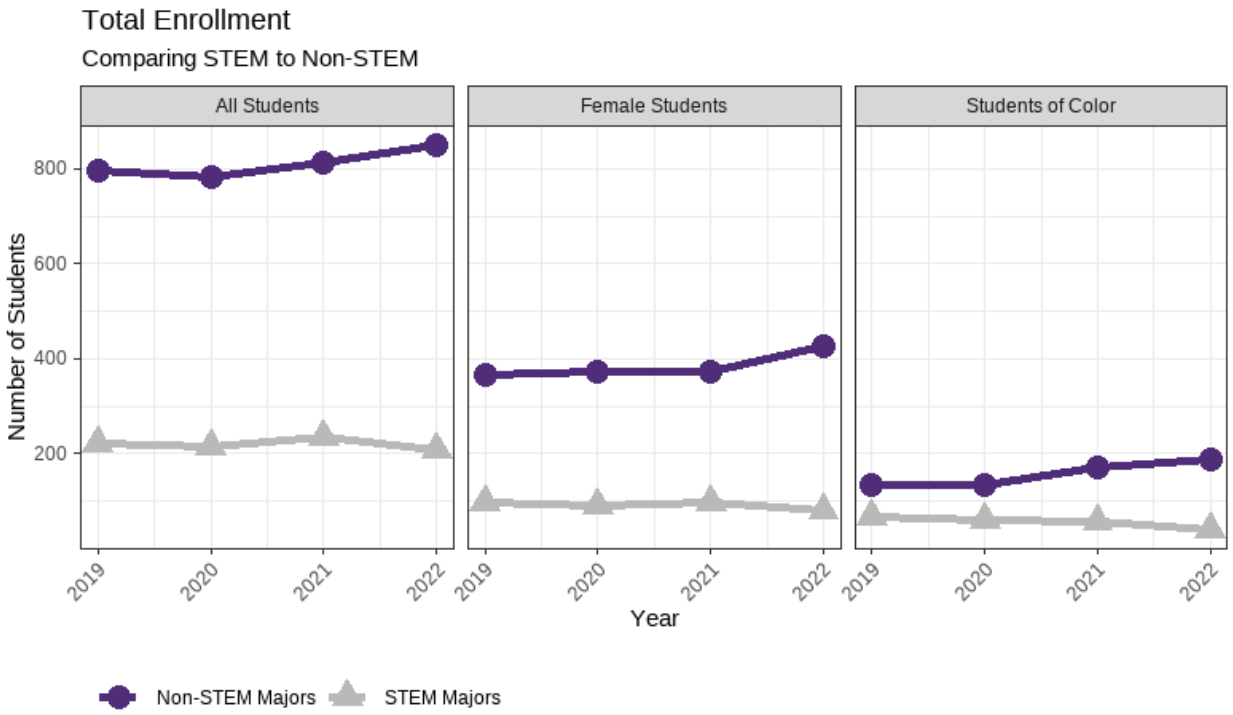

Figure 1

Cornell College utilizes a One Course At A Time (OCAAT) schedule where students are enrolled in one course for 18 course days. Students spend 2 - 4.5 hours in the classroom per day which allows them greater contact hours with the professor than typical for a 4 credit course. Each semester consists of 4 blocks, and each student takes 8 courses in an academic year. Due to the nature of the OCAAT plan, instructors have greater freedom to experiment with pedagogy and are often able to incorporate hands-on learning within the classroom. Students also have the ability to change courses within a semester more frequently and create better pathways to personal success. The small class sizes of 13 to 1 also lead to better engagement between the professors and students.

While the OCAAT schedule allows students to have greater flexibility in their course selection throughout a semester, it can cause students to have large breaks between their first-year STEM courses. As an example, Student A may take Calculus 1 in Block 4 of their freshman year (November into December), and take physics 1 in Block 6 (February into March), a gap of approximately 2 months between the courses. Student B, however, may take a slower track and enroll in Calculus 1 in Block 6 of their freshman year which results in them taking Physics 1 in Block 4 of their sophomore year (since Calculus 1 is a prerequisite for Physics 1), a gap of approximately 9-10 months between the two heavily related courses. The large gaps between related courses may have negative implications for retention in STEM. However, this issue has not yet been researched by our institution. Our first investigation using the STEM-PIO-4 instrument found that our first-year STEM courses do, on average, increase STEM professional identity; however, we still have low persistence of STEM students from first-year to second year. In order to gain a better understanding of the impact of the block plan on student STEM retention, we are creating an interview protocol for students who leave the STEM pipeline which will investigate:

1) Why are students interested in STEM declaring in non-STEM majors?
2) What experiences in their first-year are influencing student decisions?

From the results of these answers, we hope to better inform retention efforts that align with our unique schedule system. Throughout this paper, we will discuss our research-informed interview protocol and planned implementation as a work-in-progress.

Interview Protocol

The interviews are designed for open-ended conversations that may last 30-45 minutes, depending on the student interviewed. The questions begin with an introduction of the student and an exploration of their initial enrollment motivations and interests to develop a rapport with the interviewer. The questions then dive into the impact of their pre-college experiences, how they formulated their community on campus, and their STEM course experiences. We also will be interviewing students who entered Cornell College with a declared interest in STEM, but were not retained in the STEM pipeline. One limitation, however, is that we will be unable to interview students who left the college. Our goal for this project is to identify which of these factors are most impactful for students on our unique schedule to inform future research.

Interview Introduction

In order to create a conversational flow and gain more in-depth answers to questions, our interview protocol begins with introductory questions that are meant to allow the interviewee to become comfortable with answering. Research has found that interview protocols are more effective when there is a more conversational flow to the work. The initial questions ask about the student's motivation to attend Cornell College and their initial interests. These questions will also help our researchers identify common motivators for students on our campus for later research.

Pre-College Experience

The persistence of STEM students is often built on their pre-college experiences and STEM success [2], [3]. Students are most likely to persist through a STEM degree if they have higher high-school GPAs and exposure to courses such as calculus [3]. Pre-College classes also impact a student's beliefs and interests in math and science, which impacts their likelihood to declare an engineering major [4], although gender was found to be a greater indicator of engineering major declaration than pre-college experiences. Due to our high number of first-generation students and rural recruitment students, much of our population has fewer of these college preparatory courses. COVID-19 also drastically decreased the number of students with calculus experience before college. While our college has created more tutoring opportunities and different pathways for students with less success, we do not currently know the impact of these courses on the students.

There has also been a link between pre-college experiences outside of the classroom and student self-efficacy in STEM [5]. Hobbies and extracurricular interests can increase students' retention because they believe more in themselves. Because of the impact of hobbies/extracurricular activities on retention, we have also created questions to capture this data.

Asking about the student's pre-college experiences can give us insight into their level of preparedness before college and their attitudes toward STEM. Because of the importance of hobbies, we will also inquire about initial interests and hobbies before entering Cornell College. Pre-college readiness is a known issue for retention at our institution, which has led to the development of multiple courses and tutoring opportunities on campus. However, we have not yet investigated the impact of these new courses on our students. We hope that these interviews will help us identify this potential issue and determine if our current systems are sufficient to help students.

Community Development

Research has shown the development of community in STEM can greatly increase resilience [6] a sense of belonging [7] and satisfaction [8] which all contribute to retention. According to Schreiner [8], the best predictor of retention for students in their first-year is their community development. This includes their sense of belonging as well as their accessibility to an advisor which were labeled together as "Campus Climate." Community development is a multifaceted idea that can include family, friends, extracurriculars, advisors, etc.

At our institution, students are assigned an advisor in a field that interests them. These advisors are their only constant contact during their first semester as they change classes every 20 academic days. Because STEM fields have historically been referred to as "chilly", especially in regards to interactions with advisors/professors [9], [10] we have a set of questions dedicated to the impact of the academic advisor on students. Our institution also acknowledges the importance of engaged advisors and trains faculty to advise students holistically, and not only academically.

Community can also include family, friends, and extracurricular groups. Allendoerfer et al [11] found that family is the largest tie to community for students, their friends are the second most important group, and groups/communities can increase a sense of belonging for students but are a more distant form of community. Because of the importance of friends, we will ask students about the development and retention of their friend group and if they have common academic interests along with asking them about their engagement in extracurricular groups on campus. Community is especially important to diverse groups such as women and minorities [6], [7], [12]. In order to better understand how students formed their communities on campus, we have developed questions that ask them about any official groups that they are a part of as well as their friend groups and their perspective on their advisors and STEM professors.

Through our interview questions, we hope to better understand how community development may have impacted the students who were not retained in STEM. Our questions are intended to help us identify which areas of community the students felt were under-developed and find pathways to better strengthen those spaces.

STEM Course Experiences

The final portion of our interview protocol investigates the student's perceptions of their first-year STEM courses. Due to the flexibility of the OCAAT schedule, students can take a variety of first-year STEM courses, or none at all depending on their interests and field. We plan to begin this portion of the interview asking them to describe what courses they enrolled in as well as their experiences within the classroom.

One of the most significant indicators for persistence in engineering has been a high GPA [13] and we are aware that students often underperform in their first-year classrooms. Student's perception of their ability to understand/learn material has been found as a significant factors on their self-efficacy [14] and doing poorly in a course will drastically impact their perceptions of self. However, Schreiner [8] found that GPA is more indicative of sophomore retention than freshmen. If many students leave STEM due to underperforming in courses, we will likely need to establish better pathways to success through additional support courses.

Satisfaction indicators for Freshmen in the classroom relied on the perception that the future major has valuable course content [8]. Students in their first year of college want to feel that they are welcome, to enjoy their classroom, and to develop a sense of belonging. With that in mind, we also have questions inquiring if they were able to develop community in their STEM courses and maintain it on the OCAAT schedule.

Through our questions surrounding their classroom experiences, we hope to identify common factors that may be contributing to a lack of persistence in STEM in the classroom environment. Depending on the common responses in these interviews, we can develop more effective programs to increase persistence and enrollment that are more uniquely tailored to our OCAAT schedule.

Interview Participants/Implementation

We will be interviewing sophomore students who initially indicated their first interest in engineering, mathematics, computer science, or ecology but did not declare a STEM major after their freshman year. The students will be contacted via email by one of our researchers and asked to participate in this study. Due to us not offering a reward, this will likely be a self-selecting group that is highly motivated to help the college. While this may influence our study, we are hoping that the depth of the questions will discover common trends that can later be implemented into a survey and more broadly distributed.

Broader Impacts

Our goal with this project is to identify why students who initially declare an interest in STEM are not persisting with STEM majors in their second year. While there are multiple theories regarding motivations to persist, our unique OCAAT schedule makes it difficult to identify how to best support our students. We also acknowledge that Covid-19 has continued to impact our students academically, and our college has made efforts to accommodate students but are unsure of the impact of our actions. Through our findings, we hope to also provide information for other schools with similar student make-ups on how to proceed with retention measures.

For institutions dissimilar to us, these structured protocols may help with identifying the impact of specific courses on students. The depth of interview and investigation into specific experiences will allow greater insight to how our current student body perceive college as we come closer to the demographic cliff.

Interview Protocol

Do you mind stating your year and major declaration?

What brought you to *Institution*?

When you came to *Institution*, what fields were you interested in? Did you have any hobbies related to these fields? What were they?

Why did those interest you?

Were you able to take any math classes prior to college?
IF YES: Which ones? Did you enjoy them? Why or why not?
IF NO: Move to next question

Were you able to take any science classes prior to college?
IF YES: Which ones? Did you enjoy them? Why or why not?
IF NO: Move to next question

When you first came to *Institution*, what careers most interested you? Why were you interested in those careers?

Are you involved in any groups on campus? What drew you to those groups?

Tell me about your friends on campus, what majors are they in, are they interested in the same subjects as you?

Tell me about your experiences with your advisor on campus. Were they easy to access? How would you describe your conversations with them? (replace advisor with STEM Professor)

Did you take any STEM courses in your first year?
If YES: Which ones? Tell me about your experiences in your STEM classes. What went well? What did you find difficult? Did you feel well prepared for your STEM courses?
IF NO: What courses did you take? Why did you choose these courses?

Did you make any friends or study groups in your STEM classes?
YES:Are you still in contact with those people? How do you maintain that connection?
NO: Did you find it difficult to connect to people in those classes? Why or Why not?

You stated that you declared a major in _____, how did your first-year courses help influence this decision?

What career are you currently pursuing?

Were there any experiences you had outside of class that influenced your decision to major in _____?

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