From Bachelor's to Master's: Growing Student Engagement in Accelerated ECE Pathways

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This paper outlines the initiatives undertaken by the Department of Electrical and Computer Engineering at a large, public R1 institution to boost the number of students transitioning from undergraduate to master's programs through an accelerated track. Students who are accepted into this program can seamlessly transition from their undergraduate studies to a master's program, with a possibility of completing both within five years.

We describe a concerted, multipronged effort involving faculty, advisors, and staff working collaboratively to increase the proportion of students pursuing accelerated pathways from undergraduate programs in electrical and computer engineering and other closely related programs to our two master's programs. These efforts include curriculum changes at both the undergraduate and graduate levels, cost incentives, employment opportunities, and the removal of various admission barriers to improve the overall student experience. Additionally, outreach initiatives starting at the freshman level and continuing through to the senior year—such as classroom visits, targeted advising and messaging, and publicizing the programs and their benefits through websites and social media—have been implemented. This paper will describe these initiatives and their impact.

Over the past six years, these consistent efforts have significantly increased undergraduate student participation in these pathways and enhanced the student experience. The ECE department has observed an increase from just a handful of students participating each year to over 35 students participating in the pathways this year. Furthermore, the department has also managed to increase the proportion of non-pathway junior and senior-level students taking graduate courses because of these efforts. This paper will detail these initiatives, present results and outline future work aimed at overcoming challenges in retaining students and supporting them in completing their master's degrees. The results of this work have implications for any program who is looking to increase student engagement and recruit more students into their accelerated track from their undergraduate programs as they constitute an attractive pool of potential graduate students.

Motivation and Background

With the growing need for a highly skilled and specialized workforce in engineering and related fields, coupled with the declining trend in international student enrollment, many institutions in the U.S. are ramping up efforts to increase enrollment in their master’s programs in various

ways. Similarly, the Electrical and Computer Engineering (ECE) department at George Mason University has been intensifying efforts over the past several years, especially with the need to increase the number of graduates in the computer engineering (and other closely related fields) at both the undergraduate and graduate levels through the Tech Talent Investment (TTIP) program supported by the state of Virginia [1].

Although there are various sources of students for the master's programs in the ECE department, one pipeline is the existing undergraduate student body via the bachelor's/accelerated master's (BAM) track (also commonly referred to in the education community as a 4+1 program). These programs enable students to complete a combined undergraduate and graduate degree in approximately five years, resulting in savings both in cost and time. Despite the program's existence for a few decades and its advantages, participation has historically been quite low up until the past few years. This paper describes some of the efforts the department undertook, in combination with changes that occurred at the college and university level, to increase participation in the BAM program and the positive outcomes observed as a result. Before providing more details, some background about the department will be presented to give context to these initiatives.

The Electrical and Computer Engineering (ECE) department at George Mason University resides within the College of Engineering and Computing. George Mason University (an R1 institution) is the largest public institution in the state of Virginia and graduates of the ECE department primarily work in companies, labs and other institutions in the greater Washington D.C metropolitan area. The department offers two undergraduate programs accredited by the Engineering Accreditation Commission of ABET (electrical engineering and computer engineering), four master's programs (including electrical and computer engineering) and a PhD in ECE. The undergraduate electrical engineering (EE) program requires completion of 121 credits, the computer engineering (CPE) program 126 credits, and the master's programs all require 30 credits to be completed to earn the degree. As of fall 2024, there were close to 600 undergraduate students enrolled in the department. Figure 1 illustrates the 10-year fall enrollment trend in the two undergraduate programs combined.

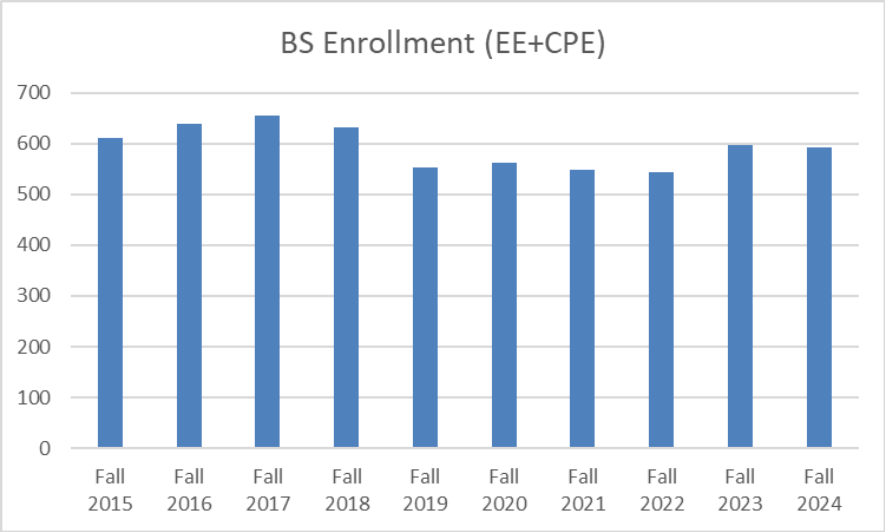


Figure 1. 10-year undergraduate fall enrollment trend

The department draws a sizeable portion of its undergraduate population from the community colleges in the region that transfer into the university either having fully completed an associate's degree, or part of an associate's degree. One of these robust transfer pathways is through the ADVANCE agreement established in 2018 between George Mason and Northern Virginia Community College (NOVA) [2], [3]. The rest of the undergraduate students mostly start as freshmen through direct admission into the major. There is also a notable fraction of students who start as undeclared and then work to declare their major in electrical or computer engineering if they meet the criteria to declare [4]. The rest of the students coming into the majors are those who change their major from another one within the college or university as well as those who transfer into the programs from other in-state or out-of-state institutions.

Enrollment in the master's programs in electrical and computer engineering is mainly a mix of full-time international students, working professionals who are pursing a graduate program either on a full-time or part-time basis, as well as students who have come into the program through an accelerated bachelor's/master's program. All graduate classes are offered in the evenings from 4:30 p.m. onwards to provide flexibility for students to take classes after work. Figure 2 illustrates the combined EE and CPE fall semester enrollment in the two master's programs for the past 10 years.

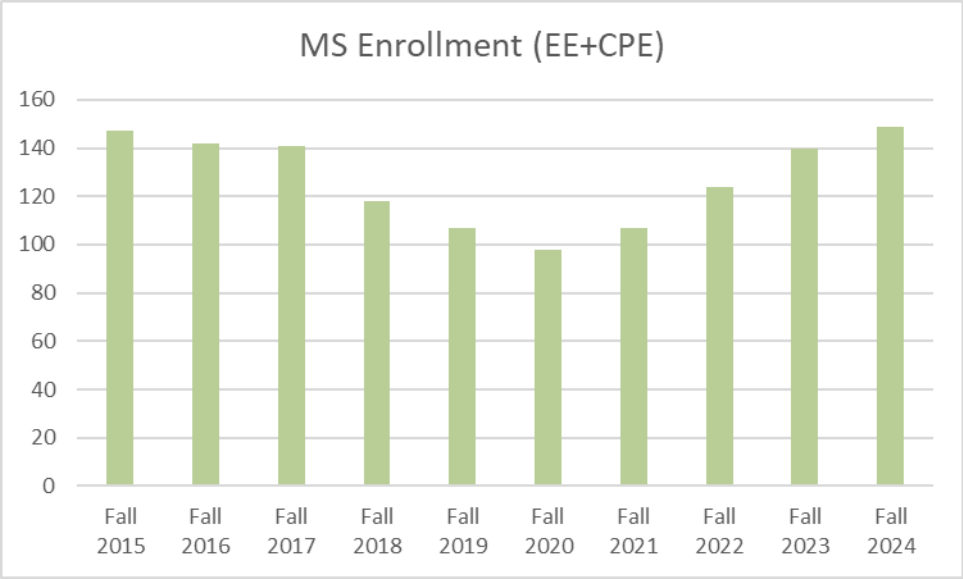
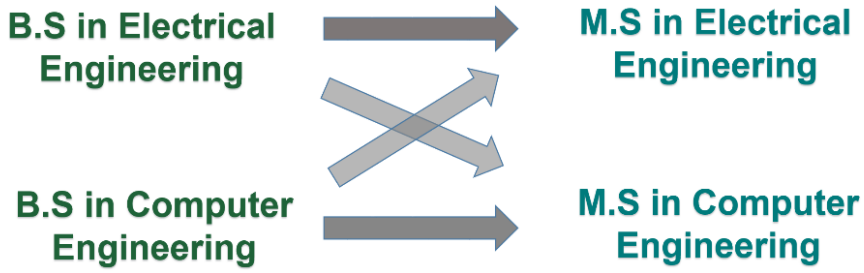


Figure 2. 10-year master's fall enrollment trend

The department offers accelerated pathways from its bachelor's to its master's programs called the Bachelor's/Accelerated Master's (BAM) path. Students from the undergraduate programs have the option to enroll in one of the master's programs as illustrated in figure 2 provided they meet specific admissions criteria. Once students earn their undergraduate degree, they can directly transition into the master's and complete any remaining graduate requirements. The department also offers the BAM program to students from other majors, a few of which are also listed under the pathways shown in figure 3.

BAM Pathways for ECE Majors:



BAM Pathways for non-ECE majors:

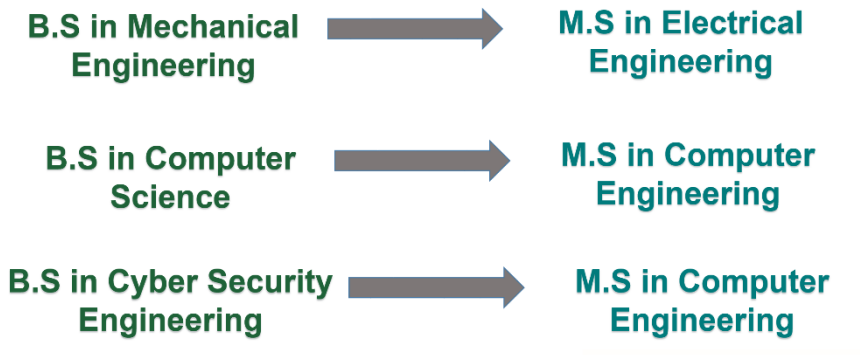


Figure 3. BAM options available to ECE and non-ECE students

By enrolling in one of the BAM programs, students can complete an undergraduate and master's degree in as little as 5 years by taking several graduate level courses while still an undergraduate during (mostly) their senior year and then applying these credits to meet the requirements of both the undergraduate and graduate degree. The BAM programs not only provide the opportunity to complete a master's in a shorter amount of time but also result in significant cost savings as will be detailed in a forthcoming section.

Despite the many advantages of enrolling in a BAM program, enrollment notably remained limited to only a few students each year, with around 5-7 students applying annually and only 3-5 students eventually opting to enroll. This trend continued up until around 2018, corresponding to roughly only 2-3% of seniors enrolling in the various BAM options offered.

Several reasons are believed to have contributed to these low participation rates, including limited promotion of the programs and the relatively smaller number of overlapping credits between the bachelor's and master's programs. As a result, by the time students found out about the program, many of them had already completed all or part of their degree requirements that precluded them from fully taking advantage of the acceleration opportunity. There was also a decentralized approach within the department to advising interested students. Although individual faculty advised and assisted students with the BAM application process, they varied in their level of engagement in advising students. Furthermore, outreach about the accelerated programs was minimal, and the benefits of enrolling were not well publicized. These factors collectively likely resulted in the lower engagement figures we observed in the past.

Starting around 2018, the ECE department ramped up activities to promote its accelerated programs and re-aligned its admission criteria. Furthermore, in 2021, several modifications were

made at the university and college levels to make the programs more accessible to students, including increasing the number of overlapping credits and allowing students to apply at an earlier stage in their undergraduate careers. These combined efforts and their impacts are described in the forthcoming sections.

Programmatic Modifications

Starting around the 2020-2021 academic year, three main modifications were made to ensure that the pathways were more accessible to current and future student populations. These changes include:

- Aligning GPA requirements for admission
- Allowing students to apply earlier in the program
- Increasing the number of overlapping credits between the undergraduate and graduate programs

Prior to 2021, undergraduate students pursuing a bachelor's degree in the ECE department were required to achieve a GPA of at least 3.25 at the time of application to allow entry into the BAM program. Given that the minimum GPA requirement for regular master's admission was slightly less (at 3.0), the department decided to align the GPA requirement for admission to the BAM with that required for regular master's admission. With matching GPA requirements, several more students became eligible to apply each semester.

Again, prior to 2021, BAM students could only take up to 6 graduate credits (corresponding to 2 classes) that could be used to overlap between the undergraduate and master's programs. BAM students could also take up to 6 graduate credits that could be put on reserve during their time as undergraduates. So technically a BAM student could complete up to 12 master's level credits while they were still an undergraduate student. Another change implemented at the university level from 2021 onwards was the number of overlapping credits being increased from 6 to 12 credit hours. As a result, a highly motivated BAM student could now technically complete 18 out of the 30 credit hours required for a master's degree before transitioning to the master's program. Figure 4 illustrates the overlap before and after the change for the electrical engineering program which requires completion of 121 credits at the undergraduate level and 30 credits at the master's level.

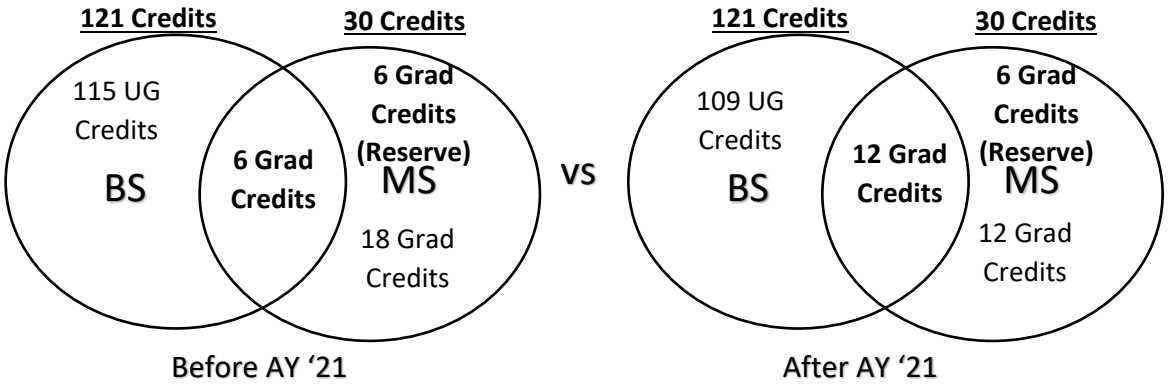


Figure 4. Comparison of credit overlap before and after 2021

A third change was to reduce the number of credits required to have been completed as a prerequisite to apply to the BAM program. Prior to 2021, students were eligible to apply only after completion of at least 75 credits, and could start taking graduate classes only after completion of 90 credit hours. The number of credits for application was reduced from 75 to 60 credits, allowing students to apply at the conclusion of their sophomore year. Furthermore, students were allowed to take graduate level classes after completing 75 credit hours instead of waiting to earn 90 credits as previously required. These two changes enabled eligible students admitted to the accelerated program to start taking graduate classes during the second semester of their junior year instead of waiting for their senior year, thereby giving an opportunity to complete more graduate credits while still an undergraduate and taking advantage of the full acceleration offered by the program.

With the increase in the number of overlapping credits, EE and CPE students are now allowed to select all three of their technical electives (totaling 9 credits) from among the wider variety of graduate class offerings. The rest of the 3 credits can be completed by taking the equivalent of a graduate level electronics class (such as semiconductor devices, digital or analog integrated circuit design) for the EE program in lieu of the required linear electronics II class. For the CPE students, the graduate equivalent of a computer network architectures and protocols class is now taken in lieu of the required computer networking protocols class.

Outreach Efforts

The department also spent a significant amount of effort in building early awareness and implementing targeted outreach. Early awareness within the student body about the accelerated

programs was achieved by providing information during orientation sessions for freshmen and transfer students. BAM programs were highlighted by advisors during their visits to community colleges, even before students came into the university.

Outreach efforts were especially ramped up during the semester before students were eligible to apply which was during the second semester of the sophomore year and the first semester of the junior year. A few key classes that students commonly take during those years were selected and dedicated advisors and other faculty/admissions staff visited these classrooms to provide information about the accelerated programs, the eligibility criteria, the benefits of pursuing the program as well as the application process. Some of these classes where faculty and advisors actively engaged with students about these issues included embedded systems, linear electronics as well digital electronics. These visits were then followed up with 1-1 meetings with interested students. Advisors also sent proactive outreach emails to students who met the minimum GPA criteria inviting them for a meeting. A 5-minute video, posted on the webpage was created and shared in various classes providing an overview of the accelerated program, advantages of obtaining a graduate degree and the potential positive career impacts.

Student Advising

Although all ECE faculty regularly advise students in the department, it was decided that a centralized approach to BAM advising would be more efficient. A dedicated advisor who is actually an alumna of the master's program in electrical engineering and is an administrative faculty member therefore undertook the role of "BAM advisor". The BAM advisor serves as the primary contact for students, providing guidance about all aspects of the program. Instead of seeking out individual faculty for recommendations or guidance, students can directly work with the BAM advisor, providing information about requirements and assisting students with the application process, including submitting recommendations for accelerated study. Having a single point person submit a recommendation for students applying to the BAM program rather than requiring multiple faculty members made the process more efficient (although other faculty can also submit recommendations). As a dedicated full-time advisor, the BAM advisor is familiar with most of the students and is uniquely positioned to provide recommendations for accelerated programs and course selection. The BAM advisor has valuable insights into each student's strengths and abilities, offering solid information for the admissions team to evaluate. Lastly, by having a single point of contact, students can access the information they need in a timely and efficient manner, avoiding any potential delays.

Online Engagement

Another key effort towards increasing awareness was ensuring that information was disseminated widely and was furthermore easily accessible to students. One of the ways this was accomplished was to share information about the BAM programs by creating a dedicated webpage that provided all necessary details, including requirements and admission steps. Faculty and staff actively directed students to this webpage, where they could find forms and other relevant information about the accelerated pathways. A QR code which was used to direct students easily to the website was displayed during class visits and other events. Additionally, the pathways were periodically advertised on the ECE department's LinkedIn, Facebook, and Instagram accounts. Campaigns were conducted to increase student engagement with the department's social media channels. The successes of BAM students were featured in the department's videos and news publications, which were then shared with students and shared on social media, leading to increased community engagement.

Employment Opportunities

Being a student in the BAM program has the additional potential benefit of employment opportunities through assistantships. The ECE department hires over 30 graduate teaching assistants (TAs) and wage graders (mostly from its own student body) and more than 10 undergraduate learning assistants (LAs) each semester. Graduate students support faculty during class sessions, including hands-on active learning activities, and assist in grading homework, lab reports, and other assignments. They also oversee lab activities and teach recitations. Learning assistants are undergraduate students who have previously taken the course they are assigned to assist with. They are hired to help students during class and lab sessions, hold office hours, and provide additional support in other ways. Several learning assistants eventually decide to pursue the BAM program as they build closer relationships with the department, faculty, and students.

One advantage of working as a learning assistant is the experience gained working with students and faculty, which presents an advantage when applying for a TA position as BAM students transition to the master's program. Students who have served as an LA are well suited to continue assisting in these classes as soon as they transition to the master's program. The TA position provides tuition benefits and a stipend, offering an economic advantage to BAM students.

Cost Estimates

As mentioned earlier, aside from the savings in time, one of the primary benefits of pursuing accelerated programs is the potential for substantial savings in tuition. This is especially advantageous for in-state students, who receive the most significant financial benefits, although out-of-state students also benefit greatly from the overall reduction in cost. During the 2024-2025 academic year, the cost of a 30-credit MS program (tuition only) was approximately $21,000 for in-state students and roughly $45,000 for out-of-state students (excluding any fees or additional expenses). By taking full advantage of the 12 overlapping credits between the BS/MS programs and completing and reserving 6 graduate credits while still an undergraduate, an in-state BAM student can earn their MS degree at roughly 47% less cost compared to a non-BAM in-state student directly admitted to the MS program.

The savings are more pronounced for in-state students due to the substantial difference between undergraduate and graduate tuition rates per credit hour. The cost of in-state tuition for 1 graduate credit hour is roughly 1.6 times the cost of a credit hour for an undergraduate class. Since BAM students can take graduate classes at undergraduate tuition rates, the cost savings are amplified by taking advantage of the full span of graduate classes allowed (including the additional 6 graduate credits that can be put on reserve). Although the savings are slightly less for out-of-state students, they are still considerable in size. The difference between graduate and undergraduate tuition rates for out-of-state students is small, so the cost savings of pursuing the BAM program mainly comes from being able to overlap 12 credits between the undergraduate and graduate degree. For out-of-state students completing all 12 overlapping credits with 18 graduate credits remaining after they transition to the MS program, the cost savings amount to approximately 40%. For out of state students, there is not as big of a financial incentive to take the 6 additional graduate credits to be put on reserve compared to the in-state students (although some students still prefer to do so as they can later apply those credits to the MS program). These cost savings estimates are summarized in the table below.

2024-2025 Tution	Per-credit hour		Cost of MS 30 credits (without BAM)	Cost of MS-BAM (12 overlapping credits+6 credits on reserve)	Percent Savings (6 credits on reserve)	Cost of MS-BAM (12 overlapping credits+0 credits on reserve)	Percent Savings (0 credits on reserve)
In-state(UG)	$433.00						
Out-of-state (UG)	$1,452.00						
In-state(G)	$709.00		$21,270.00	$11,106.00	47.79%	$12,762.00	40.00%
Out-of-state (G)	$1,520.00		$45,600.00	$26,952.00	40.89%	$27,360.00	40.00%

Table 1. Comparison of Tuition Costs: MS Program for Non-BAM Students vs. BAM Students

Results and Additional Outcomes

Starting in 2018, there has been a steady increase in the number of students applying and enrolling in our BAM programs. As of the writing of this paper (fall 2024/spring 2025), there were 35 ECE students enrolled in a BAM program in the department. During the 2023-2024, academic year, around 10% of the graduating class were in the BAM program. These figures are a significant jump compared to earlier times, when we historically had only around 3-5 students annually opting into the program.

One additional positive outcome that can be partially attributed to the initiatives described herein was that an increasing number of undergraduate students elected to enroll in 500-level (graduate level) courses irrespective of whether they wanted to pursue the accelerated track or not. The outreach activities not only resulted in more participation in the accelerated program but also increased interest by qualified and motivated non-BAM students to take graduate classes as electives. These students may not necessarily be interested in pursuing the accelerated program but decide to take these classes for various reasons such as due to their interest to delve deeper into subjects not offered at the undergraduate level, the greater variety of 500-level courses available in some areas, and the experience of taking a graduate-level class. They may also consider returning later to pursue a graduate degree. Permission to take a graduate class is given only to students who meet the prerequisite, grade and GPA requirements and is provided primarily by the BAM advisor in consultation with the faculty teaching the course that the student is seeking permission for. As interest in 500-level graduate classes have grown by the undergraduate student body, the department has been able to offer a wider variety of 500-level classes which has in turn benefited both the undergraduate, master's and PhD students both within and outside of the department.

A final outcome worthy of inclusion is the potential to recruit doctoral students from among the BAM student body. There have been several students over the past few years who transitioned from the BAM to the PhD program. As students have an opportunity to start graduate work earlier and get exposed to research, there is much opportunity for faculty to collaborate and mentor students thereby leading to recruitment of students into the doctoral program [5].

Conclusions and Future Work

We are very pleased to share that the department has been successful in growing student engagement in the accelerated programs within a span of around 6-7 years. With that said, it would be impossible to measure the degree to which each of these initiatives individually may have contributed to this positive outcome. We think that the combination of initiatives implemented at the university, college and department levels as described in this paper collectively played a role in increasing student interest and ultimately participation. The change in policy to increase overlapping credits from 6 to 12 has likely been the most significant

incentive, as it leads to substantial cost and time savings for students. That aside, we had actually observed our numbers starting to increase even before 2021 when this programmatic change was implemented. The increase in students opting into the BAM programs started to rise when we started to implement more targeted outreach efforts aimed to increase awareness among the student body and was amplified when the programmatic changes became effective.

Our future work will focus on continuing to build upon and refine our existing practices. We plan to implement additional activities, including building a community of BAM students who can serve as ambassadors, provide mutual support, and offer feedback to the curriculum committee and department leadership. One near-term task is to develop a new, shorter video featuring current BAM students, specifically geared towards social media channels.

We will also need to closely examine success markers, given that students start taking graduate classes earlier in their academic journey. As these students pursue an accelerated track with less maturity in the program, there may be challenges related to degree completion. Additionally, there may be opportunities to engage them in different ways to support their academic progress.

Furthermore, we plan to analyze retention rates and degree completion rates (e.g. 5- and 6-year degree completion rates) of BAM students. This analysis will help us identify additional ways to support these students throughout their journey to earning a combined undergraduate/master's degree. We believe that most BAM students who complete the undergraduate program but do not transition to the master's program decide not to continue due to the additional time commitment required to complete the remaining graduate program requirements, coupled with enticing job offers from industry in the Washington metropolitan region. Future work will therefore examine strategies to address these challenges and improve retention.

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