Board 248: ECS Scholars Progress Report: Outcomes from a Data-Driven Support Strategy

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Introduction: Project Description

The major goal of the project is to contribute to addressing the national need for well-educated scientists, mathematicians, engineers, and technicians by supporting the retention and graduation of high-achieving, low-income students with demonstrated financial need at Baylor University. Over its five-year duration, this project has funded four-year scholarships to two cohorts of 11 students each, who are pursuing Bachelor of Science degrees in the fields of Engineering, Electrical and Computer Engineering, Mechanical Engineering and Computer Science, Data Science and Bioinformatics. The total funding for the project is roughly one million dollars over 5 years, and the average scholarship award is $7500 per student per academic year.

The program is designed for Engineering and Computer Science (ECS) Scholars to participate in activities which include an orientation, seminar series, cohort building activities, and faculty mentoring. Support services and activities for ECS Scholars build upon existing activities at the university and feature peer mentoring, study abroad opportunities, alumni mentoring, support and training for undergraduate research, professional development workshops, connections for internship opportunities and tutoring support.

A distinguishing feature of the project is the use of EAB's Navigate, a web-based software platform for tracking student progress, coordinating student care, facilitating communication, and employing predictive analytics. Major goals of the project included developing expertise in using a student dashboard and integrating student data, with the potential broad impact of informing the STEM community of best practices for timely interventions, improving retention and graduation rates, and facilitating career development.

The Navigate platform is used for predictive analytics and to track and document ECS Scholar progress toward achieving benchmark goals in the areas of retention, graduation rates, internships, undergraduate research experiences, and job placement. The use of predictive analytics has significant potential for helping students arrive at successful outcomes. However, it is an assumption of this project that the successful use of predictive analytics should take into consideration not simply the accuracy in identifying students who are struggling but in the social attributions of success and perceptions of a "big data" tool that might be received alternatively with enthusiasm or suspicion. This project investigates how student perceptions of what factors influence their success align with those attributed by faculty/mentors and predictive analytics. Additionally, the project is investigating students and faculty/mentors' perceptions about the extent in which predictive analytics are helpful for identifying factors that inhibit and promote success.

The rest of this paper will briefly summarize the outcomes and accomplishments we have achieved through year four of the grant, and then the focus of the paper will shift to a discussion of our experiences using the Navigate platform and making recommendations about future

directions for using a platform that allows for comprehensive data collection, analytics, and communications.

This paper presents an empirical examination of the EAB Navigate platform as it pertains to two specific student cohorts. It is important to note that our analysis is conducted without presupposing the overall efficacy or value of the platform. Our aim is not to evaluate the platform's design or to pass judgment on its utility broadly. Instead, we focus solely on documenting and discussing the observed outcomes associated with our targeted use cases, which may lie outside the intended design parameters of the system. Our objective is to contribute to the ongoing discourse on educational technology by providing data-driven insights specific to our project's scope and context.

Project Outcomes and Accomplishments

The successes and challenges for the first year of the grant were described in [1]. While a pandemic related issues led to the necessity of adapting recruiting and support activities, we have been successful in maintaining two cohorts of 11 students with the first cohort matriculating Fall 2020 and the second matriculating Fall 2021. A total of 31 students have been supported in the program. Five students left the program because of poor academic performance, three students left because of a change of major, and one student left the program because of a better scholarship opportunity at a different school. The 22 students currently in the program are on-track for graduation with overall average GPA of 3.51. All the 22 active students in the 2 cohorts have been successfully placed in at least one internship experience and also participate in a diverse range of student activities and organizations. It is noteworthy that 3 ECS Scholars were invited and participated in 2023 S-STEM scholars meeting. A survey administered in Fall 2023 show a high level of satisfaction with the program.

Description of EAB's Navigate Platform

Navigate is a comprehensive technology platform designed to support student success in higher education institutions. Its primary goal is to improve outcomes for students by providing tools and insights that help colleges and universities optimize their resources and strategies. The list below describe key features and attributes of the software.

- *Integrated Advising and Student Support:* Navigate combines technology, research, process improvement, and predictive analytics to help institutions identify students who might be at risk and intervene effectively. The platform allows for the coordination of care among advisors, faculty, and other support staff to ensure that students receive timely and targeted assistance.

- *Predictive Analytics:* The platform uses data and predictive modeling to identify students who are at risk of not completing their courses or programs. This allows institutions to proactively reach out and provide support before students encounter significant difficulties.

- *Appointment Scheduling and Case Management*: Navigate facilitates easy scheduling of appointments between students and advisors, tutors, or other support staff. It also allows for the tracking and management of student cases, ensuring follow-ups and maintaining a history of interactions and interventions.

- *Customized Communication*: The platform enables personalized communication with students through various channels such as email, text messaging, and in-app notifications. This helps in delivering tailored messages and reminders, improving engagement and response rates.

- *Academic Planning and Degree Auditing*: Students can use Navigate to plan their academic paths, track their progress toward degree completion, and explore various major and career options. The platform can integrate with an institution's degree audit system to provide real-time progress updates.

- *Reporting and Insights*: The platform offers robust reporting capabilities, allowing institutions to track key metrics related to student success and retention. This data can be used to inform policy decisions and improve student support services.

- *Mobile App:* Navigate often includes a mobile app component, making it easier for students to access resources, schedule appointments, and receive communications on their mobile devices.

Navigate: Limited Success with Predictive Analytics

With the project goal of enhanced student success in mind, we embarked on an initiative using the EAB Navigate platform from the beginning of the project. We saw the tool as having the potential of allowing a multifaceted approach to monitoring student progress, harnessing the potential of predictive analytics to preemptively identify and support at-risk students. One of our primary goal was to leverage Navigate's capabilities to ensure timely interventions, thereby improving student retention and academic outcomes.

However, during the implementation phase, we encountered several challenges, particularly in optimizing the predictive analytics feature of Navigate. While EAB Navigate is acclaimed for its ability to analyze student data and predict potential academic risks, our experience revealed a lag in the timeliness and accuracy of these predictions. This delay in generating actionable insights posed a significant hurdle in our objective to provide immediate support to students who might be veering off track. Additionally, it has become apparent that the opaque mechanisms of the analytics algorithm might not be ideally suited for the creation of prompt alert signals, particularly in the context of first-year students.

It is important to note that we encountered several pragmatic issues that led to our difficulties in harnessing the predictive capabilities of EAB Navigate. We encountered several friction points early in the project particularly in the realm of data capture and utilization. A significant portion of student attrition, notably due to academic performance issues, tended to occur early in their academic journey, often during the first semester. This pattern posed a unique challenge as our institution had a limited depth of experience in utilizing Navigate for early detection and intervention purposes. The complexities of our situation were further compounded during the pandemic. Successful use of the system is reliant on a diverse group of stakeholders - including advisors, tutors, faculty, and even card swipe systems - for data entry. However, the disparate nature of these sources, coupled with the extraordinary circumstances of the pandemic, led to inconsistencies and delays in data collection. This, in turn, hindered our ability to timely and effectively leverage Navigate for mitigating early student attrition, a critical period where intervention is most needed and can be most impactful.

As a response to these challenges, our strategy pivoted towards more traditional approaches such as faculty-generated progress reports, inputted directly into the Navigate system, and historical grade data from prior courses. This method proved to be more effective in real-time identification of students needing assistance. Faculty reports offered more traditional, on-the-ground insights into student performance and engagement, which, when combined with historical academic data, seemed to be a more trusted approach for engaging students at risk.

This shift in approach, integrating faculty-generated progress reports and historical grade data, underscores the importance of human judgment and direct academic feedback in the realm of student success initiatives. While predictive analytics offer a promising tool, they must be complemented with real-time, human-generated insights to be truly effective. Our experience suggests that a hybrid model, which combines the technological prowess of EAB Navigate with the personalized touch of faculty and staff insights, is a more pragmatic and effective approach in supporting student success.

Although the predictive analytic aspect of the project did not materialize in the way we had hoped, there are still strong reasons to continue to pursue that capabilities of tools such as EAB Navigate for supporting at risk students. As our education research team, conducted qualitative research interviews with ECS Scholars, ideas emerged related to Engineering Identity and how tools such as Navigate may be used in this context.

Engineering Identity

In the education literature, Engineering identity refers to the extent to which an individual identifies with the engineering profession and perceives themselves as an engineer. For our purposes, we extrapolate the ideas from the literature to also encompass majors related to computer science. This concept has gained significant attention in educational research, particularly in exploring how this identity affects students' motivation, engagement, persistence,

and success in engineering (and related) fields. Here's a very brief synopsis of the literature on this topic: (see for example, [2] and [3]).

Formation of Engineering Identity: Studies often focus on how engineering identity develops among students. Key factors include academic experiences, hands-on projects, internships, interactions with practicing engineers, and involvement in engineering communities. This development is seen as critical in determining a student's commitment to and persistence in the field.

Influence on Educational and Career Pathways: Research shows that a strong engineering identity is linked to greater persistence in engineering programs and a higher likelihood of entering engineering careers. Students who strongly identify as engineers are more likely to overcome challenges and stay committed to their studies.

Impact of Gender and Diversity: A significant body of literature examines how gender, ethnicity, and cultural background influence the formation of engineering identity. Studies reveal that underrepresented groups in engineering often face challenges in developing a strong engineering identity due to stereotyping, lack of role models, and feelings of exclusion.

Educational Interventions: There is a focus on how educational interventions, such as project-based learning, mentorship programs, and inclusive teaching practices, can strengthen engineering identity among students. These interventions are particularly effective in enhancing the identity development of women and underrepresented minorities in engineering.

Relationship with Self-Efficacy and Performance: The literature also explores the relationship between engineering identity, self-efficacy (belief in one’s abilities), and academic performance. A strong engineering identity is often associated with higher self-efficacy and better academic outcomes.

Evolution Over Time: Some studies track how engineering identity evolves from the early educational phase through professional practice. These longitudinal studies provide insights into how experiences in both educational settings and the workplace shape one’s identification as an engineer.

Rodriguez et al. [2] review the literature on engineering identity within higher education, highlighting a growing body of work focused on women and underrepresented minorities, and emphasize the need for future research to expand on engineering identity frameworks and their development across diverse student populations. The findings by Godwin et al. [3] indicate that emphasizing recognition and agency beliefs in educational programs can enhance students' identification with engineering, potentially leading to increased engagement and retention in the field.

A software tool like EAB Navigate could be instrumental in studying and supporting the development of engineering identity among engineering and computer science students. By leveraging its robust data collection and analysis capabilities, Navigate can track various factors that contribute to the formation of engineering identity, such as academic performance, engagement in hands-on projects, participation in engineering clubs or activities, and utilization of mentorship programs. The predictive analytics feature of Navigate can identify students who might be struggling with their engineering identity, enabling timely interventions. For instance, students showing signs of decreased engagement or facing academic challenges could be connected with mentorship opportunities, career counseling, or peer support groups that reinforce their identity as budding engineers or computer scientists. By providing a centralized platform for monitoring and supporting students' journey, EAB Navigate can play a crucial role in enhancing their identification with and commitment to the engineering and computer science disciplines, ultimately contributing to their academic success and persistence in the field.

Future Direction: Using LLMs with Navigate to Strengthen Engineering Student Identity

As we enter the last year of the ECS Scholars program, we are excited about potential future directions that have been inspired by our experiences using Navigate. As mentioned earlier in the paper, one important pragmatic reality of using this type of tool is data entry. In general, we have had great success with data entry from our profession student success staff who consistently work within the system and are immediately familiar with the data entry expectations and the methodologies for capturing the data. However, we rely on several sources of data that come from people who seldom use EAB:Navigate and have pragmatic time constraints that make it impractical to expect substantial changes to this reality. Our future directions are centered on making strides in two key areas over the coming year: improving the collection of data and advancing our ability to analyze that data promptly. The consistent gathering of data on student engagement from multiple channels is a vital challenge that must be addressed to achieve enduring progress. Additionally, we anticipate that LLMs will be of significant value in organizing, analyzing, cleaning, and identifying patterns in student data, thus providing educational experts and academicians with insights that promote the development of Engineering Identity.

Easing the Data Collection Process through LLM Integration

Addressing the challenge of data entry in EAB Navigate, due to the wide array of individuals contributing diverse data to accurately map a student's journey, has been a complex issue. However, the rapid advancements in Large Language Models (LLMs) present a promising solution to alleviate these friction points. The idea is to streamline the data input process, making it more user-friendly and less time-consuming. By enabling users to simply reply to an email, fill out a Google Form, or input data into a basic spreadsheet, we can significantly reduce the burden of manual data entry. Subsequently, these inputs can be seamlessly reformatted and integrated into the EAB Navigate system with minimal human intervention. As we approach the fifth and final year of our project, we are enthusiastic about exploring and demonstrating the potential of

LLMs to revolutionize the way we collect and process data, enhancing the overall efficacy of our student support system through EAB Navigate.

Navigating Data Complexity: Applying LLMs to Structure Navigate Reports

The integration of Large Language Models (LLMs) with the data output from the Navigate platform holds the promise of significantly enhancing the structure and analysis of extensive datasets. Navigate, by design, produces comprehensive reports that, while rich in data, often manifest as unwieldy spreadsheet files that demand substantial manipulation to yield actionable insights. The sheer volume and complexity of these datasets can obscure critical long-term trends and patterns necessary for strategic decision-making in educational settings.

LLMs can be tasked to introduce a new level of sophistication in data management by transforming raw spreadsheets into structured, easily navigable formats. By programming LLMs with precise prompts, researchers can instruct these advanced algorithms to execute a variety of data wrangling tasks that typically consume considerable human effort and time. These tasks include categorizing data points, identifying and rectifying inconsistencies, and arranging information into user-friendly dashboards or reports.

The ability to observe longitudinal trends in student engagement and outcomes is crucial for shaping educational strategies and interventions. However, such trends can be difficult to discern through manual analysis alone, especially when dealing with multiple cohorts over extended periods. LLMs, with their capacity for pattern recognition over large datasets, can be invaluable in surfacing these trends. They can perform deep dives into historical data, highlight shifts and developments, and provide predictive insights based on established patterns.

Furthermore, researchers and educators often seek to understand specific aspects of student data, such as factors contributing to student retention or the effectiveness of certain pedagogical approaches. With traditional analysis tools, the exploration of such patterns can be labor-intensive and constrained by the tools' capabilities. However, with LLMs, researchers can customize the analysis by crafting prompts that direct the model to focus on patterns or anomalies. This level of control allows for a more targeted analysis, facilitating a granular understanding of the factors influencing student experiences and educational outcomes.

We foresee the potential of using LLMs and Navigate's data output as transforming the way educational data is processed, analyzed, and interpreted. It offers a path to not just simplifying the complexity of data but also to enhancing the ability of researchers to uncover insights that drive meaningful improvements in fostering student success and shaping educational policy.

Summary and Conclusion

This paper has discussed the objectives and outcomes we have achieved with a grant designed to support the retention and graduation of high-achieving, low-income STEM students with majors

in and related to engineering and computer science. The EAB Navigate platform was a pivotal tool in our efforts, intended to integrate student data for targeted support and interventions. Despite challenges, particularly with early detection and intervention for at-risk students, the project has demonstrated the constructive role of technology when combined with the mentorship from faculty and support staff. As we move to the final year of the project, we are exploring the potential of using Large Language Models (LLMs) which we view as a promising avenue for automating and enhancing our data collection and analysis processes. While the full potential of LLMs in this context remains to be explored, preliminary efforts suggest a promising future for such technologies in educational settings.

References

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