The Ranked Analysis of Major Programs System (RAMPS)

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Abstract

Higher education presents students with increasingly structured curricula, complex prerequisite chains, and limited flexibility to explore different disciplines. These challenges often hinder academic mobility and timely degree completion, which are particularly critical in engineering education where course sequencing and prerequisite dependencies determine student progress. To address these challenges, we developed the Ranked Analysis of Major Programs System (RAMPS), a data-driven advising and degree-analysis platform that transforms institutional and student data into transparent, interactive insights. Consider a second-year computer science student who has completed 45 credits and is exploring a switch to computer engineering. Using RAMPS, this student can visualize how completed coursework would apply to the new major and how the change would affect progress toward degree completion. The system provides a side-by-side comparison between current and prospective majors, displaying which degree requirements are satisfied, partially satisfied, or unmet. By presenting progress at the level of degree requirements rather than raw credit totals, RAMPS makes explicit the structural implications of major transitions, particularly in highly sequenced engineering programs. For advisors and faculty, RAMPS supports proactive guidance and improved forecasting of enrollment demand by making the data behind student decisions more transparent. Beyond advising, RAMPS enables analytics for curriculum design, bottleneck identification, and resource allocation. This paper describes the design and architecture of RAMPS, including key data structures, algorithms, and integration methods, and presents early results from pilot testing and user feedback from students and advisors.

Introduction

Academic degree programs are governed by structured curricula and prerequisite constraints that define how students progress toward graduation. When students consider changing academic majors, these constraints can introduce substantial uncertainty regarding credit applicability and time to degree. As students refine their interests, explore emerging career pathways, or encounter unexpected challenges in their initial programs of study, many consider alternative majors. While such exploration can be a healthy component of the undergraduate experience, major changes often introduce unintended consequences, including delayed graduation, accumulation of excess credits, and increased financial and advising burdens. These challenges are especially pronounced in highly structured programs, where tightly sequenced curricula limit flexibility and restrict opportunities for recovery.

The difficulty of navigating major transitions is amplified in disciplines such as engineering and other STEM fields, where progress toward degree completion depends not only on the total number of credits earned, but also on how coursework aligns with formal degree requirements. Deviations from expected course sequences, whether due to course availability, insufficient grades, or exploratory coursework, can cascade into additional semesters of enrollment. As a result, students may appear close to graduation based on accumulated credits, while remaining several terms away from satisfying all degree requirements.

Despite the prevalence and consequences of major changes, students often lack access to tools that clearly communicate the academic implications of such decisions. Traditional degree audit systems are typically designed to certify graduation eligibility within a single program rather than to support exploratory comparisons across multiple programs. Evaluating how completed coursework applies to an alternative major frequently requires manual interpretation by advisors or ad hoc what-if analyses, which are time-consuming, difficult to scale, and prone to inconsistency. Moreover, existing systems rarely provide side-by-side comparisons of degree progress across majors or actionable estimates of how a transition would affect time to graduation.

Recent work in academic analytics has demonstrated that student progress cannot be accurately characterized by credit accumulation alone, but must instead be evaluated in terms of degree requirement satisfaction. Cohort-based progress analytics reconcile individual student transcripts with formal degree requirements across populations of students, enabling institutions to identify systemic patterns related to time-to-degree, credit inefficiency, and curricular bottlenecks. These approaches have been shown to reveal where students generate credits that do not apply toward degree completion and which requirements most frequently impede progress [4].

At the core of cohort-based progress analytics is a formal reasoning framework that represents degree requirements as structured constraints and optimally assigns completed coursework to those requirements. This framework enables progress to be quantified as the proportion of required credits satisfied rather than the proportion of credits attempted. Progress analytics built on this foundation have been successfully used to support engineering advising and program reform by making degree progress transparent and actionable for advisors and administrators [3]. However, while cohort analytics provide valuable insights at the population level, they are not designed to directly support individual students making real-time academic decisions.

Students considering a change of major require personalized analyses that extend beyond their current program to include multiple prospective degrees. Such analyses must evaluate how completed coursework maps to alternative degree requirements, identify unmet requirements, and estimate the impact of these differences on expected time to graduation. Addressing these needs requires extending progress analytics from a cohort-level evaluative tool to an individual-level decision-support system.

To address this gap, we developed the Ranked Analysis of Major Programs System (RAMPS), a student-facing platform designed to support informed academic decision-making during major transitions. RAMPS leverages the same underlying progress reasoning framework used in cohort analytics, applying it at the individual student level to evaluate degree requirement satisfaction across multiple programs in real time. By integrating student transcript data with institutional degree structures, RAMPS enables students to compare prospective majors, understand how their completed coursework applies to each program, and visualize academic pathways toward degree completion.

This work makes the following contributions: (1) it demonstrates how progress analytics traditionally used for cohort-level evaluation can be extended to support individual student decision-making; (2) it presents a system that enables requirement-level comparison of degree programs during major transitions; and (3) it shows how requirement-level progress analytics can support informed academic decision-making by exposing the consequences of alternative degree pathways.

The remainder of this paper is organized as follows. The next section provides background on degree structures and progress reasoning. We then describe the design and workflow of the RAMPS platform, followed by illustrative use cases. The paper concludes with a discussion of implications for academic advising and institutional planning.

Background

Academic degree programs are governed by formal degree requirements that specify the conditions under which a credential may be awarded. These requirements are typically satisfied through the successful completion of coursework subject to prerequisite and co-requisite constraints that enforce ordering and dependency relationships. A curriculum corresponds to a particular selection of courses that satisfies all degree requirements for a given program, while a degree plan represents a term-by-term arrangement of those courses that respects prerequisite constraints and sequencing rules. Importantly, a single set of degree requirements may be satisfied by many distinct curricula, each of which may yield multiple valid degree plans depending on course sequencing and course availability [1].

The structure induced by prerequisite and co-requisite constraints plays a central role in shaping student progress. These constraints are commonly modeled as directed acyclic graphs in which courses are represented as nodes and prerequisite relationships are represented as directed edges. Such representations reveal how degree programs encode ordering constraints that limit flexibility and govern the flow of students through the curriculum. Prior work has shown that the structure of these graphs strongly influences curricular complexity, the number of feasible degree pathways, and the likelihood of delayed progress [2].

Reasoning about academic progress therefore requires more than tracking accumulated credit hours. It requires determining how completed coursework applies toward degree requirements and identifying which requirements remain unsatisfied. Because degree requirements often permit multiple options for satisfaction and impose ordering constraints through prerequisites, students with similar credit totals may be at substantially different stages of progress toward degree completion. This disconnect between credit accumulation and true degree progress is particularly pronounced in highly structured programs, such as engineering and other STEM disciplines.

Prior work has addressed this challenge through the development of progress analytics, a framework for evaluating academic progress in terms of degree requirement satisfaction rather than credit accumulation [3]. In this framework, degree requirements are represented as formal constraints, and student transcripts are reconciled with those constraints using optimization-based reasoning.

Completed coursework is assigned to degree requirements in a manner that maximizes progress toward degree completion while respecting all program constraints. This approach enables progress to be quantified in terms of satisfied requirements rather than raw credits earned.

Progress analytics have been applied at the cohort level to support academic advising and program evaluation. By aggregating individual progress measures across defined student populations, cohort-based analyses reveal patterns related to delayed progress, credit inefficiency, and structural bottlenecks that are not readily observable through traditional degree audits [4]. These insights have been shown to support data-driven advising practices and program-level decision-making by making the structural properties of degree programs explicit.

While cohort-based progress analytics provide valuable population-level insights, the same reasoning framework can be applied at the individual student level to support personalized academic decision contexts. Extending progress analytics to individual analyses enables students to evaluate how their completed coursework applies to multiple degree programs and to reason about alternative academic pathways in a transparent and principled manner. This capability forms the foundation for the RAMPS system described in the following section.

RAMPS system overview

The Ranked Analysis of Major Programs System (RAMPS) is a student-facing decision-support platform designed to assist undergraduate students in exploring and evaluating potential changes in academic major. RAMPS extends progress analytics from a cohort-level evaluation tool to an individualized, real-time system that enables students to reason about degree progress across multiple academic programs. By integrating student transcript data with institutional degree requirements, RAMPS provides transparent and actionable insights into credit applicability, degree requirement satisfaction, and projected time to graduation.

At a high level, RAMPS operates by reconciling a student's completed coursework with the formal degree requirements of both their current major and one or more prospective target majors. The system evaluates how previously completed courses satisfy degree requirements under each program and identifies unmet requirements that remain for completion. This analysis enables students to compare academic progress across majors in a principled manner, rather than relying on accumulated credit totals or manual degree audits.

RAMPS takes as input a student's academic transcript, including completed courses and earned credits, along with the student's declared major and catalog year. Using this information, the system retrieves the corresponding degree requirements and prerequisite structures for all candidate programs. Students may then select one or more alternative majors from across colleges and departments for comparison. For each selected program, RAMPS applies progress analytics to evaluate requirement satisfaction and compute progress toward degree completion.

The primary outputs of RAMPS are presented through an interactive interface designed to support exploratory decision-making. For each major under consideration, the system provides a summary of degree progress that distinguishes between satisfied, partially satisfied, and unmet requirements. Requirements are organized by category (e.g., core, general education, electives), allowing students to see where previously completed coursework applies and where additional effort is required. By presenting progress information at the requirement level, RAMPS makes explicit the academic consequences of a potential major transition.

The typical user workflow begins when a student logs into RAMPS and is presented with a searchable list of academic majors spanning multiple colleges and departments. From this interface, the student may select one or more prospective majors for exploration and comparison. Upon selection, RAMPS performs an on-demand analysis using the student's existing transcript and the formal degree requirements associated with each selected program, generating updated progress summaries for both the student's current major and the selected alternatives. Students may then compare majors side by side, enabling them to evaluate trade-offs in terms of requirement satisfaction, applied credits,and remaining degree requirements.

By making degree progress transparent and comparable across programs, RAMPS supports informed academic decision-making during major transitions. Rather than relying on ad hoc advising conversations or static degree audits, students are empowered to explore academic alternatives with clear visibility into the structural implications of their choices. The following section illustrates this workflow through representative use cases drawn from student interactions with the system.

Illustrative use case

To illustrate how RAMPS supports informed decision-making during academic major transitions, we present a representative use case involving an undergraduate student exploring alternative degree programs. This scenario reflects a common advising context in which a student seeks to understand how previously completed coursework would apply to multiple potential majors and how such a transition would affect progress toward degree completion.

The workflow begins when a student accesses RAMPS and selects one or more prospective majors for comparison from a searchable list spanning multiple colleges and departments (Figure 1). This interface enables students to explore academic programs beyond their current major and to consider cross-disciplinary transitions. Multiple target majors may be selected simultaneously, allowing students to evaluate several academic pathways within a single analysis.

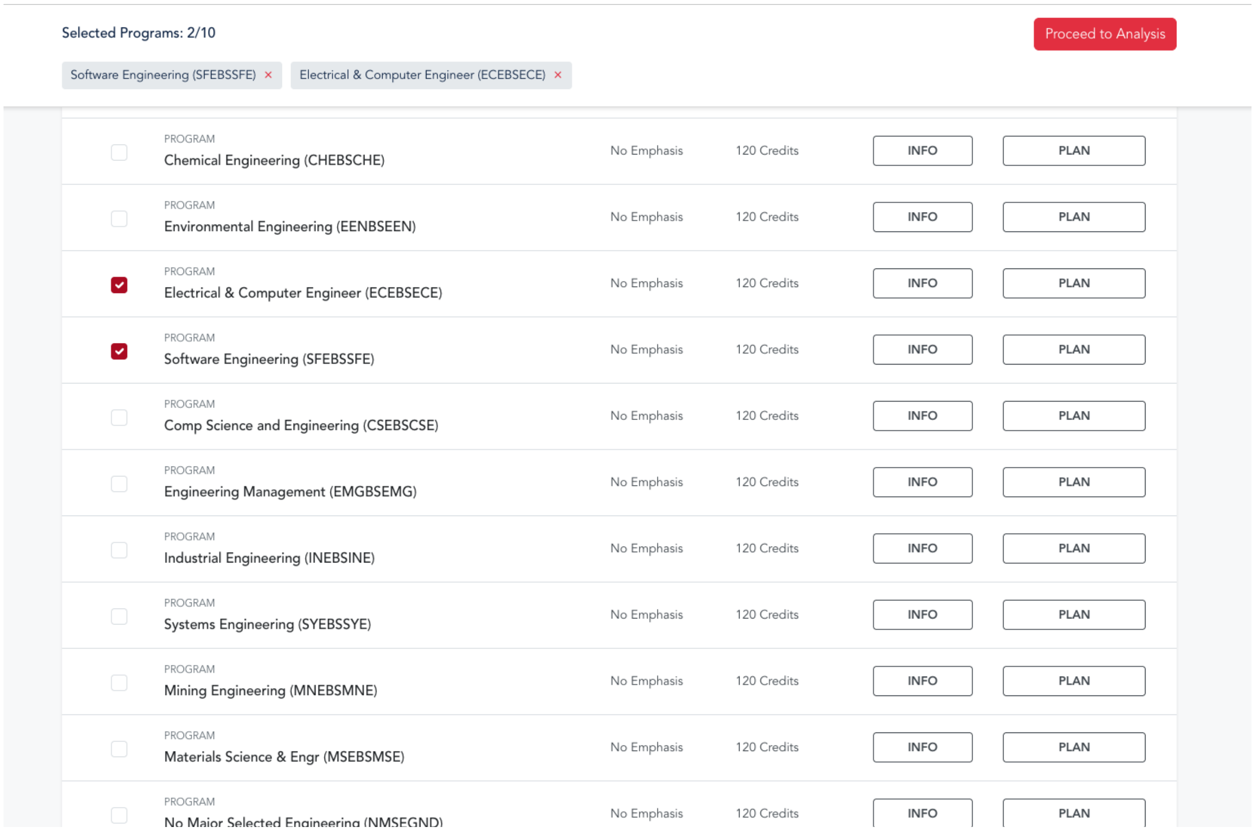


Figure 1. Interface for selecting prospective majors across colleges for comparison.

After selecting prospective majors, RAMPS performs an on-demand analysis using the student's existing transcript and the formal degree requirements associated with each selected program. The system then presents a summary view comparing the student's current major with the selected potential majors (Figure 2). This summary reports estimated degree completion, applied credits, and remaining required credits for each program, enabling students to evaluate how their completed coursework maps to different degree structures.

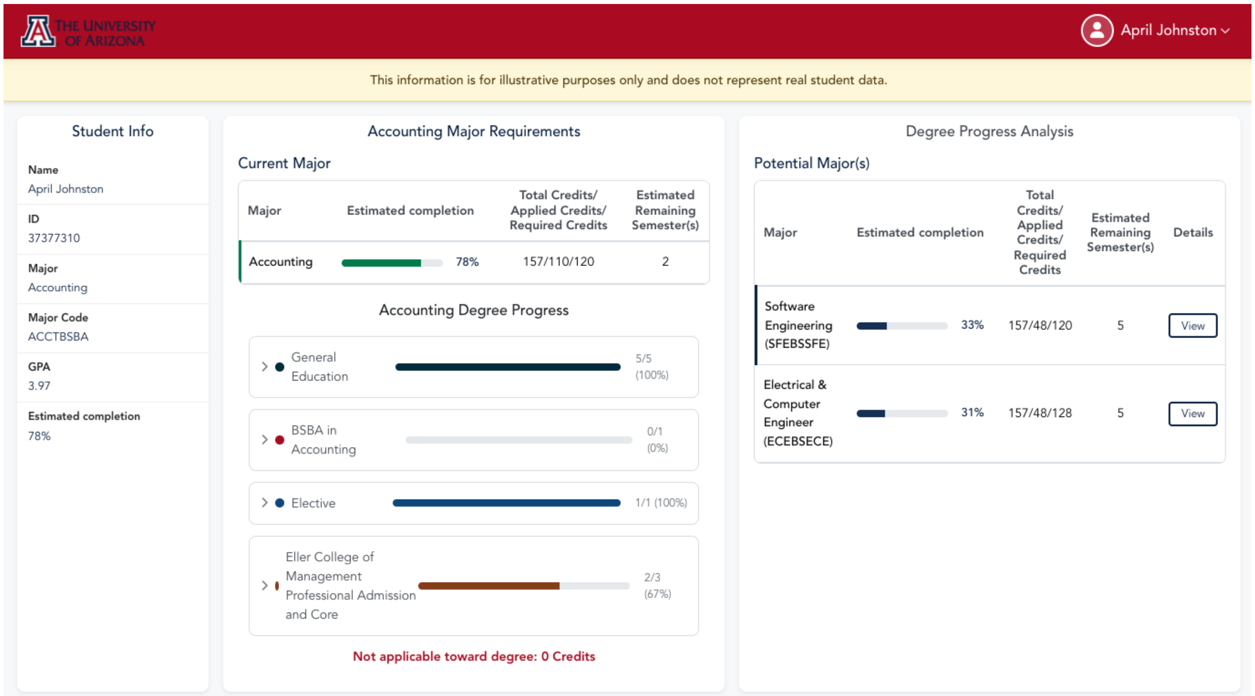


Figure 2. Summary comparison of academic progress for the current major and selected potential majors.

To support deeper exploration, RAMPS provides requirement-level detail views for both the student's current major and each selected potential major. Degree requirements are organized by category, such as general education, core requirements, and electives, and are explicitly marked as satisfied, partially satisfied, or unmet. This representation makes clear which requirements have been fulfilled through prior coursework and which would require additional effort following a major transition.

Figures 3–4 and Figures 5–6 present a *subset* of the requirement-level satisfaction details for the student's current major and a selected potential major, respectively.

General Education — 32 Credits

General Education Foundation Composition & Second Language

Foundation Second Language - Second Semester Proficiency

Requirement Name	Satisfied Courses	Available Courses
Second Semester Language Course (satisfied)	GRK 102 - Elem Classical Greek II SPAN 3PL - Spanish Placement 3rd Semest SPAN 2PL - Spanish Placement 2nd Semest	Requirement satisfied

Foundation Composition

Option 2: Foundation Composition - 2 Course Sequence

Requirement Name	Satisfied Courses	Available Courses
Option 2: Foundation Composition - 2 Course Sequence (satisfied)	ENGL 1CAP - Adv Placement Eng Lit/Comp Ele ENGL 1LAP - Adv Placement Eng Lang/Comp El	Requirement satisfied

General Education Core Requirements

GE Exploring Perspectives

Requirement Name	Satisfied Courses	Available Courses
Artist Courses (satisfied)	TFTV 160D1 - Popular Entertainment	Requirement satisfied
Social Scientist Courses (satisfied)	HIST 2EAP - Adv Placement Eur Hist Elect2	Requirement satisfied
Humanist Courses (satisfied)	HIST 2AAP - Adv Placement Amer Hist Elec2	Requirement satisfied
Natural Scientist Courses (satisfied)	CHEM 151 - Chemical Thinking I	Requirement satisfied

GE Building Connections

Requirement Name	Satisfied Courses	Available Courses
Building Connections Courses (satisfied)	CLAS 160B1 - Meet the Ancients: Greece/Rome HNRS 150B2 - Exploring Electronic Presence RELI 305 - Greek+Roman Religion	Requirement satisfied

Figure 3. Requirement-level satisfaction details for the student's current major (top portion).

Requirements Partially Satisfied

Eller College of Management Professional Admission and Core — 59 Credits

Business Emphasis Area

Requirement Name	Satisfied Courses	Available Courses
Ethics (satisfied)	ISTA 161 - Ethics in a Digital World	Requirement satisfied

Professional Admission Requirements & Foundation Courses

Requirement Name	Satisfied Courses	Available Courses
Fundamentals of Business Communication (satisfied)	BCOM 214 - Fundamentals of Bus Comm	Requirement satisfied
Business Calculus (satisfied)	MATH 122B - First-Semester Calculus	Requirement satisfied
Pre-Admission Core I (satisfied)	ACCT 200 - Intro to Financial Acct ACCT 210 - Intro to Managerial Acct BNAN 276 - Statistic Inference in Mngmt MIS 111 - Cmptrs+Interntwk Society BNAN 277 - Analytic Methods for Business	Requirement satisfied
Pre-Admission Core II (satisfied)	MIS 112 - Computers/Internet Society Lab	Requirement satisfied
Economics (satisfied)	ECON 200 - Basic Economic Issues	Requirement satisfied

Eller Professional Core

Requirement Name	Satisfied Courses	Available Courses
Entrepreneurship and Innovation (NotSatisfied)		Available Courses
Professional Core (Partially Satisfied)	BCOM 314R - Business Communication FIN 360 - Quantitative Financial Mngmt MGMT 310A - Org Behavior+Management MIS 304 - Use+Managing Info System MKTG 361 - Intro to Marketing	Available Courses

Figure 4. Requirement-level satisfaction details for the student's current major (continued).

Requirements Satisfied

General Education — 29 Credits

General Education Foundation Composition & Second Language

Foundation Composition

Option 2: Foundation Composition - 2 Course Sequence

Requirement Name	Satisfied Courses	Available Courses
Option 2: Foundation Composition - 2 Course Sequence (satisfied)	ENGL 1CAP - Adv Placement Eng Lit/Comp Ele ENGL 1LAP - Adv Placement Eng Lang/Comp El	Requirement satisfied

General Education Portfolio (Exit Course)

Requirement Name	Satisfied Courses	Available Courses
General Education Portfolio - Exit Course (satisfied)	UNIV 301 - General Education Portfolio	Requirement satisfied

General Education Core Requirements

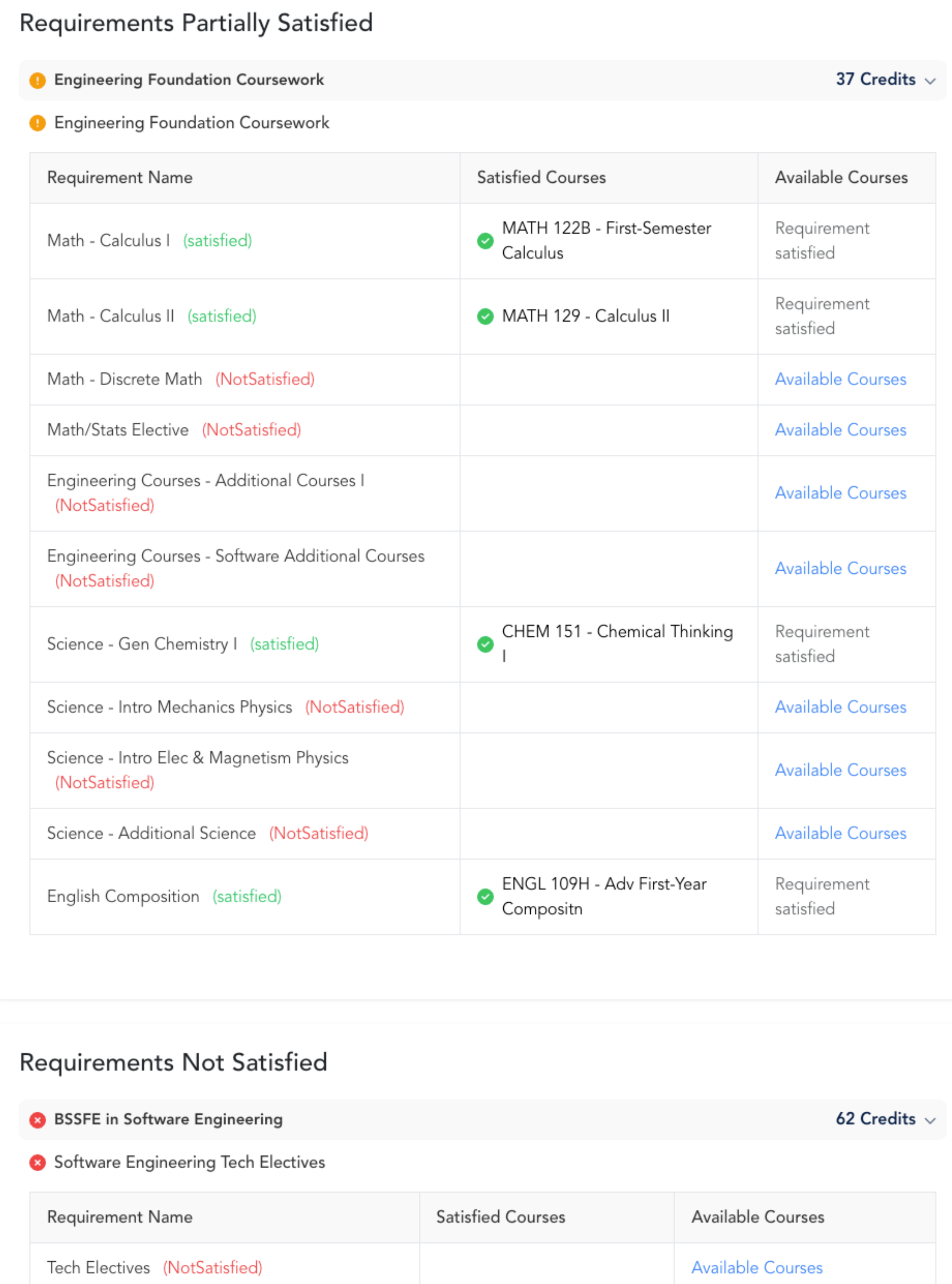
GE Exploring Perspectives

Requirement Name	Satisfied Courses	Available Courses
Artist Courses (satisfied)	TFTV 160D1 - Popular Entertainment	Requirement satisfied
Social Scientist Courses (satisfied)	HIST 1EAP - Adv Placement Eur Hist Elect	Requirement satisfied
Humanist Courses (satisfied)	HIST 1AAP - Adv Placement Amer Hist Elec	Requirement satisfied
Natural Scientist Courses (satisfied)	CHEM 151 - Chemical Thinking I	Requirement satisfied

GE Building Connections

Requirement Name	Satisfied Courses	Available Courses
Building Connections Courses (satisfied)	HNRS 150B2 - Exploring Electronic Presence HNRS 218 - Communicating Photography RELI 305 - Greek+Roman Religion	Requirement satisfied

Figure 5. Requirement-level satisfaction details for the selected potential major (top portion).



Requirements Partially Satisfied

Engineering Foundation Coursework **37 Credits**

Engineering Foundation Coursework

Requirement Name	Satisfied Courses	Available Courses
Math - Calculus I (satisfied)	MATH 122B - First-Semester Calculus	Requirement satisfied
Math - Calculus II (satisfied)	MATH 129 - Calculus II	Requirement satisfied
Math - Discrete Math (NotSatisfied)		Available Courses
Math/Stats Elective (NotSatisfied)		Available Courses
Engineering Courses - Additional Courses I (NotSatisfied)		Available Courses
Engineering Courses - Software Additional Courses (NotSatisfied)		Available Courses
Science - Gen Chemistry I (satisfied)	CHEM 151 - Chemical Thinking I	Requirement satisfied
Science - Intro Mechanics Physics (NotSatisfied)		Available Courses
Science - Intro Elec & Magnetism Physics (NotSatisfied)		Available Courses
Science - Additional Science (NotSatisfied)		Available Courses
English Composition (satisfied)	ENGL 109H - Adv First-Year Compositn	Requirement satisfied

Requirements Not Satisfied

BSSFE in Software Engineering **62 Credits**

Software Engineering Tech Electives

Requirement Name	Satisfied Courses	Available Courses
Tech Electives (NotSatisfied)		Available Courses

Figure 6. Requirement-level satisfaction details for the selected potential major (continued).

In the illustrated example, courses that fully satisfy requirements in the student's current major may only partially satisfy, or not satisfy, requirements in a prospective major. These distinctions are often difficult to identify using traditional degree audit tools but are made explicit through RAMPS's requirement-based analysis. By presenting progress at the level of degree requirements rather than raw credit totals, RAMPS highlights the structural implications of a major change.

Through this workflow, RAMPS enables students to iteratively explore alternative academic programs, compare progress across majors, and identify potential challenges associated with degree transitions. Rather than relying on manual advising interpretations or static reports, students are provided with transparent, requirement-level insights that support informed and realistic academic decision-making.

Discussion

The RAMPS platform demonstrates how progress analytics can be extended beyond cohort-level analysis to support individualized academic decision-making. By grounding degree progress in formal requirement satisfaction rather than credit accumulation, RAMPS provides students with a clearer and more accurate understanding of how their academic choices affect time to degree. This shift in perspective is particularly important during moments of academic transition, such as when students consider changing majors, where traditional degree audits offer limited insight into alternative pathways.

One of the primary contributions of RAMPS is its ability to make degree structures and constraints transparent to students. Rather than presenting degree requirements as static checklists, the system exposes how completed coursework applies to different programs and highlights which requirements remain unmet. This transparency supports more informed decision-making by allowing students to reason about trade-offs between majors, such as additional coursework requirements or extended timelines to graduation. From an advising perspective, this capability enables more productive conversations grounded in shared, data-driven representations of degree progress.

RAMPS also illustrates how optimization-based progress reasoning can be operationalized in a student-facing context without requiring users to engage with underlying technical complexity. Students interact with intuitive visualizations, while the system handles the combinatorial reasoning required to assign coursework to degree requirements. This separation between analytical rigor and user experience is critical for scalability, as it allows complex degree structures to be navigated by students with varying levels of academic and institutional knowledge.

Beyond individual decision support, RAMPS has implications for institutional planning and policy. Aggregated usage data and transition patterns can provide insight into which majors students most frequently explore, which requirements act as barriers to mobility, and where curricular alignment across programs may be improved. Such insights can inform curriculum design, articulation agreements, and targeted interventions aimed at reducing excess credits and improving on-time graduation. While these analyses are beyond the scope of this paper, the RAMPS framework provides a foundation for future work in this direction.

There are also limitations to the current implementation of RAMPS. The accuracy of requirement-level progress analyses depends on the quality and completeness of institutional data, including degree requirement definitions and prerequisite structures. While RAMPS provides transparent insights into how completed coursework applies to different degree programs, it does not attempt to model individual student behavior or predict future academic outcomes. Instead, the system is designed to support informed exploration by making structural degree constraints explicit, while allowing students to independently consider additional contextual factors through linked resources and advising conversations.

Future work will focus on expanding the scope and evaluation of RAMPS as a decision-support platform. Planned extensions include enhancing requirement-level analytics, improving cross-program comparison capabilities, and conducting longitudinal studies to assess how access to transparent degree information influences student decision-making and advising interactions. Additional evaluation across diverse institutional contexts and student populations will be necessary to assess the generalizability and impact of the system.

Conclusion

This paper presented the Ranked Analysis of Major Programs System (RAMPS), a student-facing decision-support platform designed to assist undergraduate students in evaluating potential academic major transitions. By extending progress analytics from cohort-level evaluation to individualized, real-time analysis, RAMPS enables transparent comparison of degree progress across multiple academic programs based on degree requirement satisfaction rather than credit accumulation.

Through requirement-level progress summaries and personalized degree plans, RAMPS makes the structural implications of major changes explicit to students and advisors. The illustrative use case demonstrates how the system supports informed and realistic academic decision-making during critical transition points. More broadly, RAMPS highlights the potential for analytics-driven approaches to improve advising effectiveness, reduce excess credit accumulation, and support timely degree completion in structured academic programs. Future work will focus on expanded evaluation, integration of uncertainty measures, and broader institutional deployment.

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