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Reframing Mathematics as Foundational Infrastructure in Engineering Education: Developing the Engineering Math Resource Center

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Abstract

Mathematics functions as both an epistemic foundation and a representational language within engineering practice; however, for many undergraduate students, it remains a significant hurdle, where the focus is on executing algebraic and computational steps rather than interpreting results, connecting mathematical actions to physical systems, and reasoning within the context of the problem. This Work-in-Progress paper examines the ongoing development of a university-wide effort to teach mathematics as an integrated, practice-oriented component of engineering education through the institutionalization of the Engineering Math Resource Center (EMRC) at Utah State University (USU). The EMRC is intentionally designed as an embedded academic infrastructure that aligns mathematical engagement with the cognitive and professional practices of engineering.

The EMRC supports more than 600 students each semester, primarily sophomores (44.9%) and freshmen (35.3%), with fewer juniors (8.5%) and seniors (1.5%), through peer-led sessions that connect mathematical analysis to engineering-relevant contexts. Its instructional design emphasizes structured inquiry, translation between symbolic and physical models, and iterative sense-making. Peer facilitators are trained to prioritize explanation and interpretation, framing mathematics as a tool for reasoning about systems rather than a sequence of procedures. Within this environment, student engagement is directed toward conceptual understanding, applied reasoning, and reflective practice.

Preliminary evidence drawn from participation patterns, course performance trends, and qualitative data sources suggests that engagement with the EMRC is associated with differences in how students approach mathematical problem solving and how they describe the role of mathematics in engineering contexts. In particular, qualitative findings indicate shifts from procedure-centered approaches toward more interpretive and representation-based reasoning, with students increasingly framing mathematics as a means of analyzing system behavior and informing design decisions.

Ongoing work focuses on expanding institutional integration, strengthening collaboration between engineering and mathematics faculty, and developing more rigorous longitudinal analyses of student outcomes. By examining the EMRC as both an academic support structure and a site of inquiry, this study contributes to understanding how mathematics can function as an embedded component of engineering learning environments.

Introduction

Progression through undergraduate engineering programs has historically been governed by tightly coupled prerequisite structures that regulate access to disciplinary coursework [1]. Accreditation standards such as those established by ABET, together with the sequential structure of engineering curricula, underscore mathematics as a foundational prerequisite for disciplinary advancement. Mathematics is the formal language through which engineering systems are modeled, analyzed, and communicated, and progression through engineering curriculum is dependent on successful completion of successive mathematics courses [1]. Despite its central role, mathematics instruction is often delivered as a separate enterprise, remaining structurally and pedagogically decoupled from core engineering coursework [2]. When students are left to connect mathematical abstractions to engineering applications on their own, they may develop procedural proficiency without the conceptual understanding and mathematical fluency necessary for engineering problem solving [3], [4].

In practice, conventional undergraduate mathematics curricula emphasize symbolic manipulation, efficient execution of standard procedures, and decontextualized problem structures, often privileging correctness over interpretation. As a result, students struggle to apply mathematics in engineering contexts, even when underlying structures are equivalent [5], [4], [6], thus reflecting a limitation in how mathematical knowledge is organized, where procedures are triggered by surface features rather than underlying relationships. This pattern of student behavior is referred to as *procedural constraint* in this paper and is most visible in early, mathematically intensive courses, where it contributes to delayed progression and attrition [7], with disproportionate impacts on students from historically underrepresented groups [8].

In response the limitations of mathematical knowledge organization in students, engineering education has increasingly emphasized instructional models that integrate mathematical reasoning with disciplinary practice [9]. Mathematics functions as a representational and analytical language in engineering and is inseparable from how engineers conceptualize systems, evaluate trade-offs, and justify decisions. Supporting these practices requires instruction that extends beyond procedural competence to include the use and interpretation of mathematical models in context. Prior work on contextualized instruction, modeling-centered learning, and interdisciplinary collaboration reflects the necessary instructional shift [7], [10], but most efforts remain localized, limiting their scalability and sustained institutional impact [6].

At Utah State University (USU), a land-grant R1 institution, the Engineering Math Resource Center (EMRC) is an academic support structure designed to connect mathematical concepts with engineering practice at scale. Housed within the College of Engineering, it is directed by engineering faculty and staffed by undergraduate peer leaders, operating in coordination with mathematics faculty to maintain curricular alignment. The EMRC is embedded within the engineering learning environment, with the goals of aligning peer-mediated support to course expectations and emphasizing engineering-relevant, collaborative, and iterative problem solving. Prior work at USU identified mathematics readiness as a primary predictor of persistence through large-scale cohort analysis, motivating the development of both a preparatory pathway and the EMRC [11]. That work established institutional need and documented early implementation but did not examine how such a structure influences students' engagement with mathematics in engineering contexts.

Building on prior work at USU [11], this paper examines the EMRC as both an institutional structure and a site of inquiry into mathematical engagement. Rather than focusing on outcome improvement, the focus is on how an embedded, peer-led environment influences students' approaches to mathematical reasoning in engineering contexts. This Work-in-Progress investigates the continued development and evaluation of the EMRC as an integrated support model, with attention to how participation relates to students' use of mathematical reasoning, contributing to discussions of mathematics integration, student persistence, and institutional infrastructure in engineering education.

Background and Related Work

Research in engineering education documents differences between how mathematics is taught and how it is used in engineering contexts. Gainsburg analyzes instructional practices in mathematics courses and shows that they emphasize formal techniques and symbolic manipulation, often with limited attention to application [12]. Zandieh and Rasmussen further demonstrate that students develop mathematical knowledge that does not consistently transfer to applied engineering settings[10]. Building on this work, Bing, Redish, and Smith show that students who demonstrate proficiency in symbolic manipulation frequently encounter difficulty interpreting mathematical expressions in relation to system behavior, physical meaning, and design constraints [4], [5]. These studies collectively characterize a gap between procedural performance and applied reasoning.

Research on mathematical activity in applied settings identifies representation use as a central component of this gap. Ainsworth describes how experts organize symbolic, graphical, and conceptual representations to reason about complex systems and to interpret relationships among variables [3]. In contrast, studies of student problem solving show that learners often treat representations independently, failing to connect symbolic expressions with graphical trends, physical intuition, or the assumptions embedded in engineering models [4], [5]. Zandieh and Rasmussen further the understanding that applied mathematics involves interpreting quantities, relationships, and structures across contexts [10].

Researchers have developed contextualized and modeling-centered approaches to address these challenges. Klingbeil et al. examine integrated engineering mathematics curricula that embed mathematical concepts directly within engineering problems and courses, allowing students to encounter mathematical ideas in the context of system modeling and design [7]. This approach emphasizes early and repeated exposure to application, with the goal of aligning mathematical learning with engineering practice. Klingbeil et al. also report improvements in student motivation, retention, and conceptual understanding, particularly in early engineering coursework [7]. Similarly, Zandieh and Rasmussen analyze modeling-centered pedagogies that treat mathematics as a tool for representing, analyzing, and refining engineering systems, emphasizing its role in reasoning and decision-making [10]. These approaches support conceptual understanding and more flexible knowledge use across contexts by foregrounding interpretation and application. However, most implementations remain confined to individual courses or specific curricular sequences, which constrains their scalability and limits their ability to influence students' experiences across the broader curriculum.

Parallel work on peer-led learning highlights the role of instructional environment in supporting mathematical understanding. Litzinger et al. characterize peer-led team learning as a form of cognitive apprenticeship, in which facilitators model disciplinary thinking and support students in articulating reasoning, explaining processes, and reflecting on their understanding [13]. Research on supplemental instruction similarly shows that peer-mediated environments support conceptual understanding, persistence, and academic confidence across STEM disciplines [13]. These environments also reduce affective barriers and normalize productive struggle, creating conditions in which students are more likely to engage deeply with challenging material. At the institutional level, the effectiveness of these models depends on how they are integrated within the curriculum [8], [14]. Thus, implementations treated as peripheral supports have limited influence on instructional coherence and institutional culture, particularly when they remain disconnected from core coursework.

Despite these advances, existing research has not fully addressed how support for mathematical reasoning and representation use can be sustained across courses as part of students' ongoing work in engineering programs. Prior work has largely focused on course-level interventions or supplemental models that operate alongside instruction, leaving open questions about how mathematical support can function as an embedded component of the broader learning environment and how such structures influence students' mathematical activity over time.

At Utah State University, Grover et al. identified mathematics readiness as a key predictor of persistence and motivates the development of the Engineering Math Resource Center (EMRC) as a form of ongoing mathematical support [11]. This paper examines the continued development and evaluation of the EMRC, with attention to how participation relates to students' use of mathematical reasoning in engineering contexts.

Institutional Context and EMRC Design

Recurring patterns in foundational mathematics courses motivated the development of the Engineering Math Resource Center (EMRC). Among pre-major and early-career engineering students, instructors and support staff observed persistent difficulty applying mathematical concepts beyond the contexts in which they were introduced. These difficulties were most apparent when students interpreted mathematical models in relation to physical systems, system behavior, and engineering constraints, and extended beyond computational accuracy to challenges in selecting appropriate representations, interpreting results, and connecting formal expressions to physical meaning.

EMRC participation data provide additional context for these observations. From Spring 2012 through Spring 2024, the center experienced sustained growth in utilization, with the majority of visits consistently coming from freshmen and sophomore students enrolled in calculus, differential equations, and linear systems. Attendance patterns show repeated use by individual students across a term and clear increases in demand during the first weeks of the semester and in the periods leading up to midterm and final assessments. Most interactions occur through individual or small-group sessions initiated by students in response to active coursework needs. At the same time, utilization of broader academic support resources across the institution remained uneven. A mismatch between the support students perceived as relevant to their engineering coursework and disciplinary goals and available institutional structures contributed to uneven participation in more general academic support offerings.

The EMRC operates within the College of Engineering as part of the college's academic support infrastructure. Engineering faculty direct the center, and undergraduate engineering students serve as peer leaders. The center maintains ongoing coordination with mathematics faculty through regular communication about course pacing, common areas of difficulty, and the types of problems students encounter across mathematics and engineering courses. This coordination supports alignment between EMRC sessions and the mathematical demands students encounter in their coursework, allowing the center to respond directly to evolving instructional needs. The EMRC primarily supports students enrolled in engineering degree programs, including those completing required sequences in college algebra, calculus, differential equations, and linear systems, while remaining open to students from related disciplines whose coursework emphasizes applied mathematical reasoning.

Peer leaders are selected based on their ability to communicate reasoning, engage with students, and demonstrate a willingness to continue developing their own understanding of mathematics. Selection prioritizes how students approach learning and explain ideas, rather than relying solely on demonstrated procedural proficiency. Training is structured and iterative, combining faculty guidance with peer-led development. Leaders identify areas for growth, reflect on their facilitation practices, and refine their approach over time, while faculty provide oversight, feedback, and alignment with program objectives.

Instruction within the EMRC centers on reasoning, explanation, and interpretation. Sessions emphasize connections between mathematical procedures and engineering meaning, with facilitators guiding students to articulate assumptions, interpret intermediate results, and evaluate the consistency of their solutions. Mathematical work is treated as an iterative process involving interpretation, evaluation, and refinement.

Session design prioritizes sustained engagement with engineering-relevant problems, often drawn directly from concurrent coursework or from representative systems that reflect disciplinary practice. Facilitators support students in understanding a variety of mathematical actions as tools for reasoning about system behavior. Attention is given to dimensional analysis, estimation, and the interpretation of results within context. When inconsistencies arise, students revise models and revisit assumptions, reinforcing mathematical reasoning aligned with engineering analysis and decision-making.

Evaluation Approach and Methodology

The EMRC has been developed and refined iteratively since its initial implementation (Spring 2012–present), with the explicit goal of maintaining flexibility and enabling short feedback cycles within and across semesters. Rather than fixing the Center into a rigid structure, this approach allows adjustments to session design, peer leader preparation, and instructional alignment as student needs become more visible through use. Accordingly, the evaluation strategy is designed to support this responsiveness, prioritizing timely insight into how the EMRC is functioning in practice rather than retrospective judgment of effectiveness.

Instead of treating assessment as a summative measure, the evaluation examines how students use EMRC support, how patterns of participation change with repeated involvement, and how those patterns relate to course progression and persistence in engineering programs. A mixed-methods approach is employed to capture both measurable academic outcomes and aspects of learning that are experiential and developmental. This design reflects the recognition that changes in mathematical understanding, problem-solving approach, and disciplinary development are not fully observable through quantitative indicators alone, particularly during the early phases of an evolving institutional initiative [15].

Quantitative evidence is drawn from institutional records to examine participation patterns, course performance, and indicators of academic persistence among students who attend the EMRC. These data include longitudinal records of EMRC attendance, enrollment and performance in foundational mathematics and engineering courses, and academic standing across semesters.

To contextualize these patterns, Figure 1[1] presents longitudinal appointment data illustrating growth in EMRC utilization over time (Spring 2012–Spring 2024), with higher participation rates observed in more recent semesters. This trend establishes a baseline for subsequent analyses and indicates that the EMRC has become an increasingly utilized component of the academic support infrastructure rather than a marginal resource.

[1] EMRC data analysis conducted by Alessandro Rodriguez, USU College of Engineering Data Team, 2024.

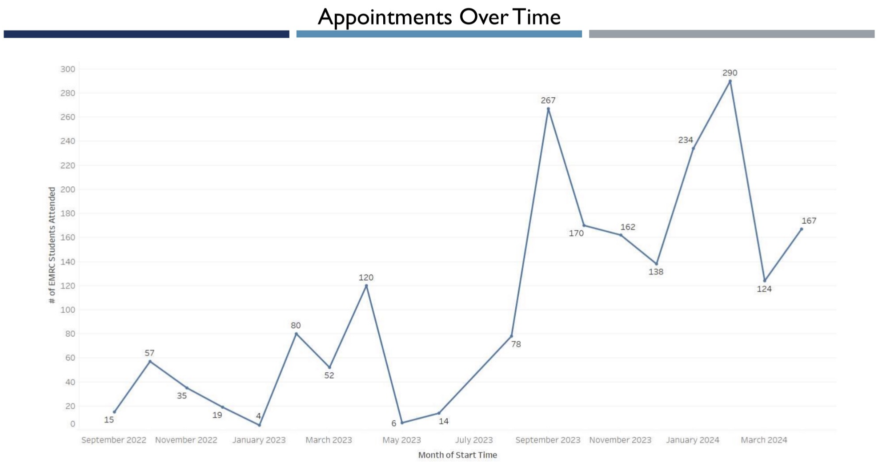

Figure 1: Longitudinal EMRC appointment data showing growth in student participation over time across PREP, freshmen, and sophomore engineering populations, *Spring 2012-Spring 2024*.

Comparative analyses examine trends between EMRC participants and non-participants enrolled in the same courses, with attention to observable differences in enrollment patterns, course progression, and academic outcomes. At this stage, analyses remain descriptive and exploratory, intended to identify patterns and potential relationships rather than to support causal claims. Because participation in the EMRC is voluntary, these comparisons may reflect underlying differences in preparation, motivation, or help-seeking behavior; findings are therefore interpreted as associative rather than causal. This use of institutional data aligns with evaluation practices for developing programs, where early analyses are used to guide refinement and inform subsequent, more rigorous study.

Qualitative data are collected to complement these institutional measures and to capture dimensions of learning not visible in grades or enrollment records. Sources include written student reflections, facilitator field notes, and semi-structured interviews with a subset of EMRC participants and peer facilitators. These data provide insight into how students use mathematics while solving engineering problems, how they interpret the role of mathematics in those contexts, and how continued participation shapes their ability to articulate and justify their reasoning. Particular attention is given to instances where students describe changes in problem-solving approach, shifts in how they connect mathematical representations to physical systems, or increased clarity in their explanations.

Qualitative analysis follows an iterative coding process in which patterns are identified through repeated review of reflections, interviews, and observational notes. These analyses are used to inform ongoing program refinement and to generate hypotheses about how students use mathematics in engineering contexts. Any claims intended to contribute to broader theoretical understanding are reserved for analyses conducted under appropriate human subjects protocols.

Results from both quantitative and qualitative analyses are regularly shared with instructional staff and administrators, informing adjustments to peer leader preparation, session design, and alignment with engineering coursework. This feedback loop is central to the EMRC's design, allowing the Center to remain responsive to evolving student needs while maintaining coherence with curricular demands.

Assessment is an ongoing process for understanding how the EMRC supports students' use of mathematics within engineering coursework. As participation stabilizes and longitudinal cohorts mature, this exploratory foundation will support more rigorous analyses, including longitudinal modeling and cross-cohort comparisons, while preserving the adaptive structure that enables the EMRC to respond effectively to student experience.

Preliminary Findings

Preliminary analyses indicate that the EMRC is functioning in alignment with its intended design across several dimensions of student use and academic progression. Institutional participation records show sustained and increasing use of the EMRC across semesters, suggesting that students are incorporating the center into their regular academic workflow rather than accessing it only in response to acute difficulty. This pattern is consistent with the EMRC's role as embedded academic infrastructure within the College of Engineering, where mathematics support is integrated with ongoing coursework rather than as a separate, remedial service.

Disaggregated participation data show that EMRC use spans pre-major, first-year, and second-year engineering students, with the highest utilization among those enrolled in calculus, linear algebra, differential equations, and introductory statistics. These courses represent key transition points in the engineering curriculum, where mathematical demands often shape students' ability to continue in their programs. Appointment records further indicate that students use the center through both scheduled sessions and walk-in visits, suggesting that the EMRC functions both as a planned learning resource and as a just-in-time support mechanism within the flow of coursework.

Quantitative analyses show that EMRC participation is associated with favorable academic patterns. Across selected foundational mathematics courses, students who attended the EMRC earned higher average course GPAs than those who did not (3.13 compared with 2.96, $p = 0.02$), as shown in Figure 2[2]. While these differences cannot be interpreted causally due to voluntary participation and self-selection, they indicate a consistent association between EMRC use and performance in courses that are central to early engineering progression.

[2]Institutional data analysis for Figures 2–4 was conducted by Alessandro Rodriguez, USU College of Engineering Data Team, 2024.

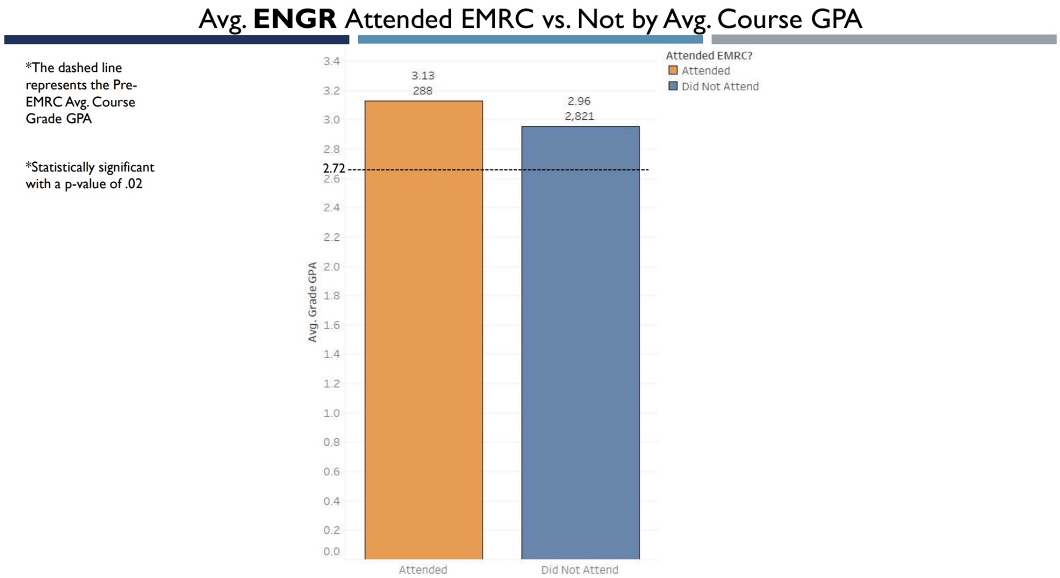

Figure 2: Average foundational mathematics course GPA for engineering students who attended the EMRC compared with those who did not attend.

Importantly, this pattern is not limited to course-level outcomes. Students who use the EMRC represent a broad range of academic profiles rather than a narrowly defined group of low-performing students. This interpretation is supported by the distribution of participants across courses, their continued enrollment in subsequent coursework, and their presence across multiple stages of the curriculum. Together, these patterns suggest that the EMRC is used for recovery from difficulty and additionally as a resource for maintaining progress and consolidating understanding in mathematically intensive courses.

A similar association is observed in broader academic performance. As shown in Figure 3, EMRC participants earned a higher average institutional GPA (3.54) than non-participants (3.34), with the difference reaching statistical significance ($p < 0.001$). Although this difference cannot be interpreted as evidence of a causal effect, it is consistent with the interpretation that EMRC use is associated with sustained academic performance across coursework rather than isolated gains in a single class.

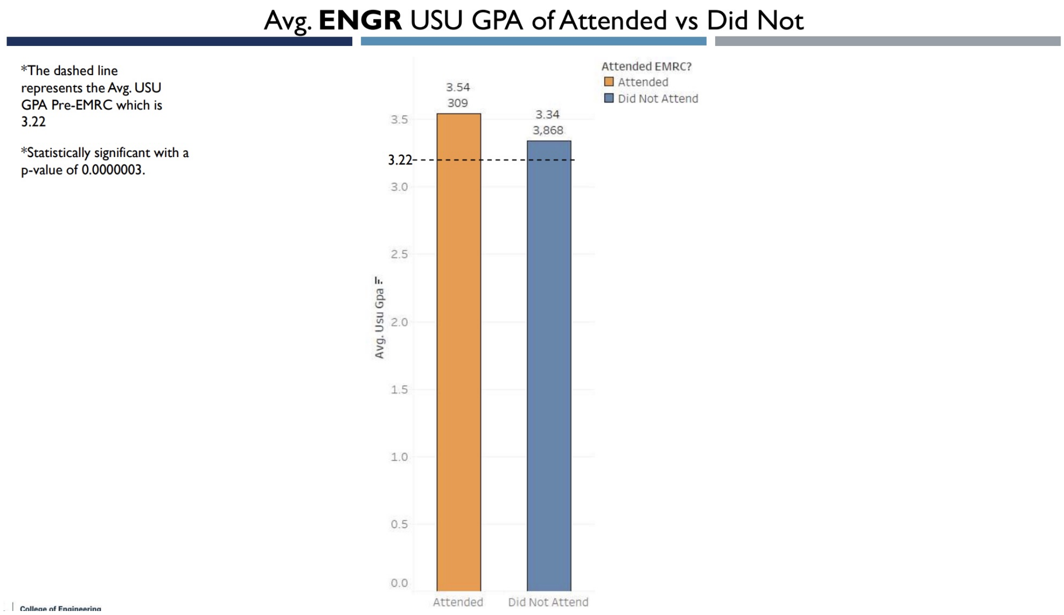

Figure 3: Average institutional GPA for engineering students who attended the EMRC compared with those who did not attend.

The consistency between course-level and institutional performance is important for interpreting where the EMRC functions within students' academic trajectories. If the center were functioning solely as a last-resort intervention, participation would be expected to concentrate among students experiencing significant academic difficulty. Instead, the observed patterns indicate that students use the EMRC while continuing through sequences of mathematically intensive courses, suggesting a relationship between participation and forward academic movement within the curriculum.

Retention data provide additional context for this interpretation. As shown in Figure 4, approximately 95.7% of EMRC participants remained within the College of Engineering in subsequent terms, while 4.3% transitioned out of the college. Although persistence is influenced by a range of academic and non-academic factors, this pattern is consistent with the EMRC's role in supporting students during early, high-risk stages of the engineering pathway.

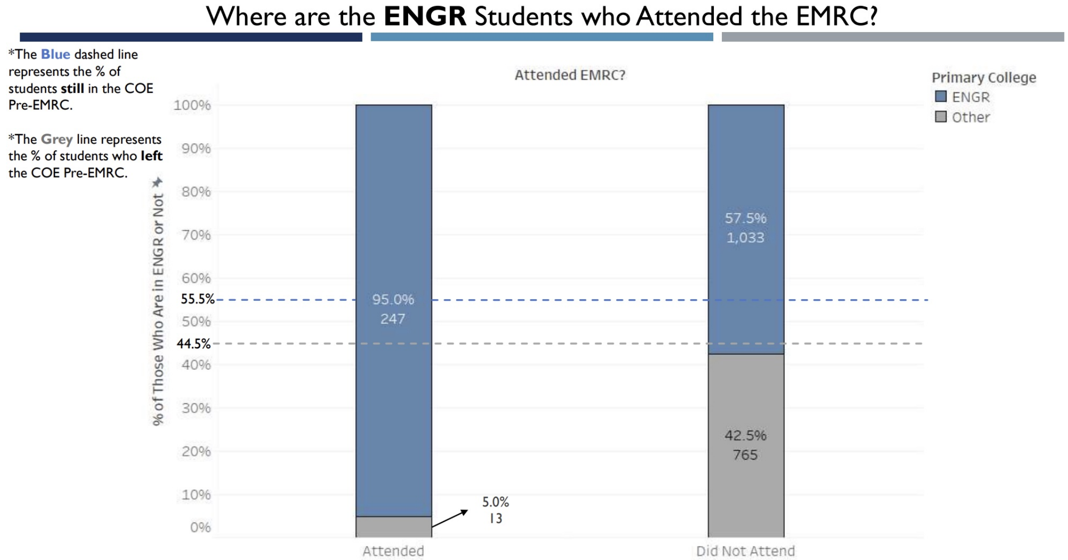

Figure 4: College of Engineering retention status for students who attended the EMRC.

These retention patterns are particularly relevant given that the EMRC serves students enrolled in gateway mathematics courses that strongly influence subsequent course-taking opportunities. Difficulty in these courses can delay progression or disrupt planned degree pathways. The observed persistence of EMRC participants, combined with their continued enrollment in subsequent coursework, suggests that participation may be associated with students' ability to remain on track within the engineering curriculum. As with the performance findings, these patterns are descriptive and require further analysis to account for differences in prior preparation, course sequencing, and frequency of participation.

Qualitative evidence complements these quantitative patterns by providing insight into how students describe their use of mathematics over time. Early reflections and observations often place mathematics as a procedural requirement or external constraint. In these accounts, students describe success in terms of completing steps, identifying formulas, or reproducing procedures from class. In contrast, students with sustained participation in the EMRC increasingly describe mathematics as a tool for interpreting physical behavior, evaluating assumptions, and reasoning about system dynamics. Mathematical expressions are discussed as representations that carry meaning within engineering contexts rather than singular-purpose computational tools.

Peer facilitators report parallel changes in the nature of student questions. Early interactions tend to focus on procedural execution, such as how to begin a problem or which formula to apply. Over time, questions more frequently center on interpretation, strategy selection, and justification of reasoning. Sessions similarly shift toward collaborative sense-making, with increased use of diagrams, graphs, units, and discussion of assumptions. These observed changes align with patterns of continued course progression, suggesting that participation is associated with how students approach mathematical problem solving .

The preliminary findings in this paper suggest that the EMRC is functioning as an integrated component of the engineering learning environment rather than as a narrowly targeted remedial resource. Participation patterns, performance indicators, retention outcomes, and qualitative shifts in student reasoning collectively point toward a relationship between EMRC use and continued movement through mathematically intensive coursework. As this Work-In-Progress study continues, future analyses will examine these relationships longitudinally and incorporate additional variables—such as prior preparation, course sequencing, and frequency of use—to better understand how EMRC participation relates to learning, persistence, and development within the engineering curriculum.

Discussion and Future Work

The EMRC represents an institutional effort to move beyond fragmented, course-specific support models towards the integration of mathematical reasoning within engineering practice. Unlike conventional engineering-owned mathematics tutoring centers, which typically focus on problem completion and short-term performance within individual courses, the EMRC is designed to support how students use mathematics to interpret systems, evaluate assumptions, and refine models over time. This distinction is reflected in both session design and evaluation: mathematical activity is treated as iterative and interpretive, and analysis focuses on how students engage with representations, reasoning, and disciplinary practices rather than on solution accuracy alone. In this sense, the EMRC functions as an academic infrastructure that connects peer-mediated learning, disciplinary norms, and curricular expectations across the engineering curriculum. This approach responds to longstanding critiques that isolated interventions, while locally effective, rarely produce sustained changes in instructional coherence or broader institutional culture [14].

Although preliminary findings indicate that the EMRC is operating in alignment with these design principles, ongoing work focuses on strengthening the resolution and structure of the data used to evaluate its impact. Participation is being tracked across courses and semesters to examine how students move through required mathematics sequences and whether engagement with the EMRC is sustained as students progress into upper-division engineering coursework. Planned analyses incorporate measures of prior preparation, frequency and timing of participation, and course-taking trajectories to account for selection effects and to identify patterns associated with continued engagement. In parallel, data collection within EMRC sessions is being expanded through facilitator logs, structured observations, and student reflections to capture how students interpret representations, frame problems, and revise solutions in context. These efforts shift the evaluation from descriptive participation patterns toward analysis of mathematical activity over time.

Expanding collaboration with engineering and mathematics faculty remains a parallel priority. Current coordination supports alignment with foundational coursework, and ongoing efforts focus on formalizing these relationships through the co-development of problem sets, modeling activities, and shared instructional materials. These materials are designed to make connections between mathematical techniques and engineering systems explicit within both EMRC sessions and course instruction. Establishing consistent expectations around interpretation, representation use, and justification across contexts supports coherence in how students encounter mathematics throughout the curriculum [13].

Future analyses will also examine how sustained participation in the EMRC relates to shifts in how students conceptualize the role of mathematics in engineering. Early qualitative evidence indicates that students increasingly describe mathematics as a tool for interpreting system behavior and supporting design decisions. Ongoing work will extend this analysis by examining how these changes relate to students' sense of belonging, academic confidence, and emerging professional identity. These dimensions are closely tied to persistence and success in engineering education and provide a basis for understanding how integrated mathematical support influences longer-term disciplinary development [16].

By combining iterative design, structured data collection, and cross-unit collaboration, this work advances an approach to mathematics support that operates within the core of the engineering learning environment. It provides a context for examining how representation use, peer-mediated learning, and institutional alignment interact to shape how students engage with mathematics across their academic trajectories.

Conclusion

This Work-in-Progress paper documents the early stages of an institutional effort to integrate mathematics within engineering education as part of disciplinary learning rather than as a prerequisite sequence completed in isolation. The Engineering Math Resource Center (EMRC) was developed around a set of design principles that emphasize alignment with engineering coursework, peer-mediated learning, and the use of mathematics as a tool for reasoning about systems. Within this structure, mathematical work is treated as interpretive and iterative in ways consistent with engineering analysis and design.

Preliminary findings suggest that embedding mathematical support within engineering-relevant contexts corresponds with differences in both academic performance patterns and in how students describe the role of mathematics in their disciplinary development. Students engaging with the EMRC more frequently describe mathematics as a means of interpreting system behavior, evaluating assumptions, and refining solutions, rather than as a sequence of procedures to complete. The EMRC reinforces this shift by centering sessions on explanation, representation use, and iterative refinement, mirroring how mathematics is used in engineering coursework and practice. This alignment supports persistence while maintaining rigor by keeping mathematical activity connected to disciplinary purpose.

As the initiative continues to evolve, the EMRC offers scaffolding for integrating mathematical support within the structure of engineering programs. Its design brings together peer-led facilitation, coordination with coursework, and ongoing refinement based on observed student use. These features address limitations identified in prior work, where support models often operate alongside instruction rather than within it. This approach extends existing models by embedding mathematical activity within students' ongoing academic work across courses.

More broadly, this work highlights the role of institutional structures in shaping how students engage with mathematics in engineering contexts. Treating mathematics as part of the core learning environment, rather than as an external service, creates conditions for students to develop the analytical capacity, confidence, and disciplinary orientation required for engineering work. Institutions that integrate mathematical reasoning with disciplinary practice through coordinated, practice-oriented structures may better support sustained engagement with mathematically intensive coursework.

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