2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #53331

Bridging the Preparation Gap: Assessing the Impact of Pre-Class Prerequisite Modules on Student Performance in a Sophomore-Level Linear Circuits Course

Dr. Ahmed Dallal, University of Pittsburgh

Dr. Ahmed Dallal is an Associate Professor in the Department of Electrical and Computer Engineering at the University of Pittsburgh, where he has been a faculty member since 2017. His scholarly work spans two interconnected areas: engineering education research and biomedical signal and image processing. In education, Dr. Dallal investigates pedagogical innovations, including blended learning, active learning, and gamification, with a focus on improving student performance and engagement in ECE courses. In his technical research, his interests include biomedical signal processing, neural data analysis, machine learning, computer vision, and networked control systems. Dr. Dallal is an active member of ASEE, where he has served in multiple leadership roles in the New Engineering Educators Division, including Division Chair.

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Abstract

A fundamental challenge in engineering education, particularly in sequential subjects like linear circuits, is ensuring students enter the classroom with the necessary prior knowledge to engage with new, complex material. When students lack fluency in prerequisite concepts, instructors often face the difficult choice of sacrificing pace to review foundational topics or proceeding while leaving a portion of the class behind. This study investigates the impact of a targeted instructional intervention designed to bridge this preparation gap in a sophomore-level Linear Circuits and Systems course. The intervention consists of pre-class modules that cover specific prerequisite mathematical and conceptual topics essential for upcoming lessons, including solving first and second-order ordinary differential equations (ODEs), complex numbers, and matrix algebra. Each module includes concise video lectures, annotated slides, and a mandatory, low-stakes readiness quiz to ensure accountability.

A quasi-experimental design compared student performance data from two semesters implementing the intervention (Spring 2025 and Fall 2025, n=91) against two prior semesters taught without the modules (Spring 2024 and Fall 2024, n=76). Quantitative analysis of total exam scores revealed that students in the experiment group achieved higher mean scores (M=151.13, SD=40.70) compared to the control group (M=138.35, SD=45.19), though this difference approached but did not reach statistical significance (t=-1.92, p=0.057, Cohen's d=0.30). Conceptual test scores showed no significant difference between groups. Qualitative data from student surveys (n=49) indicated positive perceptions, with 83.7% agreeing that modules effectively reviewed background knowledge, 85.7% finding video explanations clear, and 85.7% reporting the modules helped identify knowledge gaps. However, only 33.3% reported reduced anxiety, and 42.9% noticed no change in classroom behavior. These findings suggest that while pre-class prerequisite modules show promise for improving exam performance and are well-received by students, their impact on conceptual understanding and affective outcomes requires further investigation.

1. Introduction

Engineering education presents unique pedagogical challenges, particularly in courses that build upon foundational knowledge from multiple disciplines. Linear circuits courses, typically offered at the sophomore level, require students to integrate concepts from physics, mathematics, and introductory engineering to analyze complex electrical systems. The success of students in these courses depends heavily on their mastery of prerequisite material, including differential equations, complex number operations, and matrix algebra. However, research consistently demonstrates that students often arrive in these courses with significant gaps in their foundational knowledge, creating what educators term the "preparation gap" [1], [2].

This preparation gap poses a dilemma for instructors: spending valuable class time reviewing prerequisite material reduces the time available for new content and active learning exercises, while proceeding without review risks leaving underprepared students behind. The consequences of this gap extend beyond academic performance, as students who struggle with foundational concepts may experience decreased confidence, increased anxiety, and reduced engagement with course material [3]. Addressing this challenge requires innovative instructional approaches that can efficiently reinforce prerequisite knowledge without sacrificing the depth and rigor of the primary course content.

This study investigates a targeted intervention designed to address the preparation gap through pre-class prerequisite modules. Unlike comprehensive course redesigns such as fully flipped classrooms, our approach focuses specifically on reinforcing discrete prerequisite topics immediately before they are needed in the course sequence. The intervention consists of short video lectures covering essential mathematical and conceptual foundations (e.g., solving first and second-order ODEs, complex number operations, matrix algebra), accompanied by annotated slides and mandatory low-stakes readiness quizzes. By delivering this targeted review outside of class time, the intervention aims to ensure students arrive prepared to engage with new material while preserving valuable in-class time for active problem-solving and deeper exploration of circuit concepts. This study evaluates whether this focused, just-in-time approach to prerequisite reinforcement improves student performance and how students perceive its value for their learning.

2. Literature Review

Pre-Class Preparation and Just-in-Time Teaching

Just-in-Time Teaching (JiTT) represents a pedagogical strategy that uses feedback between classroom activities and pre-class assignments to enhance learning [4]. It has been used in numerous academic disciplines including physics, biology, chemistry, mathematics, computer science, and engineering [5]. The approach relies on pre-class assignments, known variously as "warmup exercises" or "readiness checks," completed by students before class meetings, with responses reviewed by instructors who then adjust classroom activities accordingly.

Marrs, Blake, and Gavrin [6] demonstrated that JiTT effectively identifies student misconceptions and prior knowledge gaps, synchronizes student responses with classroom instruction, and provides opportunities to confront misconceptions during class time. Their research showed increased retention, process skills, and content knowledge in STEM disciplines when JiTT was implemented. The combination of JiTT with peer instruction has proven particularly effective, producing high normalized gains on concept tests when both strategies are employed together [7].

The theoretical foundation for JiTT and similar pre-class preparation strategies draws from constructivist learning theories, which emphasize that students learn new concepts best when their pre-existing knowledge is identified and addressed. As Bransford, Brown, and Cocking [8] articulated in "How People Learn," effective instruction must consider students' prior knowledge and build upon existing conceptual frameworks. Pre-class activities serve this purpose by helping instructors understand where students are starting from and by preparing students cognitively for new material.

Video-Based Learning and Pre-Class Content Delivery

Research on instructional videos in higher education has demonstrated their effectiveness as learning tools, with meta-analyses showing positive effects on student learning outcomes. Noetel et al. [9] conducted a systematic review analyzing 105 randomized controlled trials involving 7,776 students, finding that pre-recorded videos lead to improved student learning compared to other teaching methods. Their analysis indicated that when video replaced face-to-face instruction, average grades increased from a B to a B+, and when videos were added to existing instruction, effects were even stronger. The authors attributed these benefits to the ability of video to be edited for clarity, to be paced by individual learners, and to capitalize on multimedia learning principles.

The cognitive theory of multimedia learning provides theoretical grounding for video-based instruction, proposing that human minds have distinct but connected neurological systems for processing auditory and visual information [10]. According to Mayer [10], effective multimedia instruction leverages both channels simultaneously while avoiding cognitive overload. Research has shown multimedia to be more effective when important details are highlighted (signaling effect), when words and pictures are presented simultaneously (temporal contiguity), and when verbal and visual information appear in the same visual field (spatial contiguity). Pre-recorded videos allow instructors to apply these principles deliberately, editing content for coherence and removing "seductive details" that may distract from core learning objectives.

Studies examining the relationship between pre-class video engagement and academic outcomes have found that timely completion of video assignments is a significant predictor of course achievement. Stöhr et al. [11] investigated this relationship in a statistics course, finding that students who consistently watched pre-class videos before the corresponding class sessions demonstrated better performance and knowledge retention. Their research controlled for prior achievement and motivation, suggesting that video engagement itself contributed uniquely to learning outcomes.

Scaffolding and Prerequisite Knowledge in STEM Education

Scaffolding, defined as temporary instructional support that helps students accomplish tasks they could not complete independently, has been extensively studied in STEM education contexts. A comprehensive meta-analysis by Belland et al. [12] synthesized 144 experimental studies examining computer-based scaffolding in STEM problem-based learning, finding a consistently positive effect on cognitive outcomes across various contexts. Notably, scaffolding showed higher effect sizes in engineering and mathematics education compared to science education, suggesting particular relevance for the current study's context.

The importance of addressing prerequisite knowledge gaps has been established across educational research. Studies on adaptive learning systems have documented that personalized remediation targeting specific prerequisite gaps provides especially valuable support for learners who enter courses with incomplete preparation [13]. Research on knowledge graphs in mathematics education has shown that students in lower performance quartiles make gains at twice the rate of higher-performing peers when using adaptive systems that diagnose and address foundational deficiencies.

Within engineering specifically, the sequential nature of curriculum creates cumulative dependencies where gaps in earlier courses propagate forward, creating compounding difficulties. Research on electrical engineering education has consistently identified mathematical preparation as a critical factor in student success, with studies showing strong correlations between mathematics background and performance in engineering courses [14].

Active Learning in Engineering Education

Research on active learning in engineering education has consistently demonstrated benefits over traditional lecture-based instruction. A comprehensive study by Cho et al. [15] investigated mechanical engineering undergraduate students' performance in active learning environments using self-determination theory as a theoretical framework. Their mixed-methods study demonstrated that students in active learning classrooms performed better academically and reported that the approach was useful and helpful in preparing for courses.

Pre-class preparation strategies support active learning by ensuring students arrive with the foundational knowledge needed to engage in higher-order activities during class time. When students complete prerequisite review before class, instructors can devote more classroom time to problem-solving, collaborative work, and application exercises rather than reviewing basic concepts [16]. This shift aligns with research indicating that active engagement with problem-solving and immediate feedback during class time produces better learning outcomes than passive lecture attendance [17].

3. Research Questions

Building on the literature reviewed above, this study addresses the following research questions: (1) Does the implementation of pre-class prerequisite modules improve student performance on exams in a linear circuits course? (2) Does the intervention affect students' conceptual understanding of circuit concepts as measured by a standardized conceptual test? (3) How do students perceive the usefulness and impact of the pre-class modules on their learning experience?

Based on the theoretical framework and prior research, we hypothesized that students in semesters with the prerequisite module intervention would demonstrate higher exam scores, particularly on questions requiring application of prerequisite knowledge. We further hypothesized that students would perceive the modules positively as valuable preparation for class and as tools for identifying their own knowledge gaps.

4. Methods

4.1. Research Design

This study employed a quasi-experimental design comparing student outcomes across four semesters of a sophomore-level Linear Circuits and Systems course at the University of Pittsburgh. The course is a required component of the electrical engineering curriculum and is typically taken in the second year of study. Two semesters served as control conditions (Spring 2024 and Fall 2024), during which the course was taught using traditional methods without the prerequisite module intervention. Two subsequent semesters served as experimental conditions (Spring 2025 and Fall 2025), during which the pre-class prerequisite modules were implemented. The in-class instructional format and active learning activities remained consistent across all four semesters. The only intentional difference between the control and experimental conditions was the addition of the pre-class prerequisite modules. The control group comprised 76 students from the combined Spring 2024 and Fall 2024 semesters, while the experimental group comprised 91 students from the combined Spring 2025 and Fall 2025 semesters.

4.2. Intervention Description

The intervention consisted of pre-class prerequisite modules designed to reinforce foundational mathematical and conceptual knowledge immediately before it would be needed for upcoming lessons. Each module addressed specific topics identified as critical prerequisites for the corresponding course content. All modules were posted on the course's learning management system, Canvas. Table 1 summarizes the prerequisite topics covered by the modules across the semester. The modules included the following components:

Video Lectures: Short (6 – 18 minutes long), focused video presentations covering prerequisite topics. Videos ranged from a single lecture to multiple lectures depending on topic complexity, with topics including cover math, physics, and early circuits topics, as detailed in Table 1.

Annotated Slides: Accompanying presentation slides provided visual support for the video content and served as reference materials for students reviewing the content.

Table 1. Pre-Class Module Topics by Week

Week	Course Topic	Prerequisite Topics Covered
1	Current, voltage, resistors, Ohm's law, energy and power	Units and decimal prefixes; Charge; Current and voltage; Resistance physics
3-4	Node voltage and mesh current analysis	Solving simultaneous equations; Setting up problems in matrix form; Inverse of a square matrix
5	Maximum power transfer, linearity, superposition	Max/min of a function; Linear systems
8	First-order circuits	Capacitor and inductor V-I relationships; Energy stored in capacitors and inductors; First-order ODE solution; Kirchhoff's laws review
9	Second-order circuits	Second-order ODE and its solution
11, 13	Phasors and AC power	Sinusoids; Complex numbers and their representation; Max power transfer review; Node voltage, mesh current, source transformation, superposition review

Readiness Quizzes: Each module included a mandatory low-stakes quiz assessing understanding of the prerequisite material. Quizzes typically contained 4-8 questions (multiple choice and algorithmic/formula questions). Quizzes were administered through the learning management system (Canvas) and were due before the relevant class session. Students received unlimited attempts to encourage mastery rather than penalize initial misunderstanding.

The modules are designed to accommodate students with varying levels of prerequisite preparation. Students who are confident in their mastery of the prerequisite topics may proceed directly to the readiness quiz without engaging with the videos or slides. Others may only read the slides, as a refresher, before the quiz. Thus, students who may already possess strong prerequisite knowledge will not be burdened with redundant instruction.

4.3. Data Collection

Three types of data were collected for this study:

Exam Scores: Total scores from three free-form examinations administered throughout each semester were summed to create a composite exam score (maximum possible: 217 points). These exams required students to show their problem-solving procedures and assessed their ability to apply concepts to novel circuit problems. Exams were remained the same throughout the study, and the student had no access to them outside the classroom.

Conceptual Test Scores: A multiple-choice conceptual test measuring understanding of DC and AC circuit concepts was administered at the end of each semester. This standardized test assessed conceptual reasoning, independent of mathematical problem-solving procedures.

Student Perception Survey: During the Fall 2025 semester, students in the experimental section completed a survey assessing their perceptions of the pre-class modules. The survey included questions about engagement with the modules, time spent, reasons for completing them, and Likert-scale items (1 = Strongly Disagree to 5 = Strongly Agree) assessing perceptions of module effectiveness and impact on learning experience. Open-ended questions solicited feedback about what students liked most and least about the approach, and suggestions for improvement.

4.4. Data Analysis

Quantitative data were analyzed using independent samples t-tests to compare mean scores between control and experimental groups. Effect sizes were calculated using Cohen's d to assess the practical significance of any observed differences. Mann-Whitney U tests were conducted as non-parametric alternatives given potential violations of normality assumptions. For survey data, descriptive statistics including means, standard deviations, and frequency distributions were calculated. The percentage of students responding "Agree" or "Strongly Agree" (ratings of 4 or 5) was calculated for each Likert-scale item to assess overall positive perception rates. Open-ended survey responses were analyzed for common themes. Human subjects' IRB exemption was secured for these various forms of student assessment.

5. Results

5.1. Exam and Conceptual Test Performance

Analysis of total exam scores revealed higher mean performance in the experimental group compared to the control group. Students in the experimental group ($n=91$) achieved a mean exam score of 151.13 ($SD=40.70$) out of 217 possible points, while students in the control group ($n=76$) achieved a mean of 138.35 ($SD=45.19$). This represents a difference of 12.78 points, or approximately a 9.2% improvement in the experimental group. An independent samples t-test indicated that this difference approached but did not reach conventional levels of statistical significance ($t=-1.92$, $p=0.057$). The effect size, calculated as Cohen's d, was 0.30, indicating a small-to-medium effect.

Conceptual test scores showed no meaningful difference between groups. Students in the control group ($n=75$) achieved a mean score of 18.53 ($SD=3.98$) out of 25 points, representing 74.1% correct. Students in the experimental group ($n=91$) achieved a mean score of 18.23 ($SD=4.20$), representing 72.9% correct. The independent samples t-test revealed no significant difference ($t=0.47$, $p=0.642$), with a negligible effect size (Cohen's $d=-0.07$). Table 2 presents the descriptive and inferential statistics for both assessments. Figure 1 presents box plots comparing the distribution of exam scores between the control and experimental groups. The experimental group shows a higher median and mean, with somewhat reduced variability compared to the control group.

Table 2. Comparison of Assessment Scores Between Control and Experiment Groups

Assessment	Group	N	Mean (SD)	Statistics
Exam Score (out of 217)	Control	76	138.35 (45.19)	t = -1.92, p = 0.057, d = 0.30
	Experiment	91	151.13 (40.70)	
Conceptual Test (out of 25)	Control	75	18.53 (3.98)	t = 0.47, p = 0.642, d = -0.07
	Experiment	91	18.23 (4.20)	

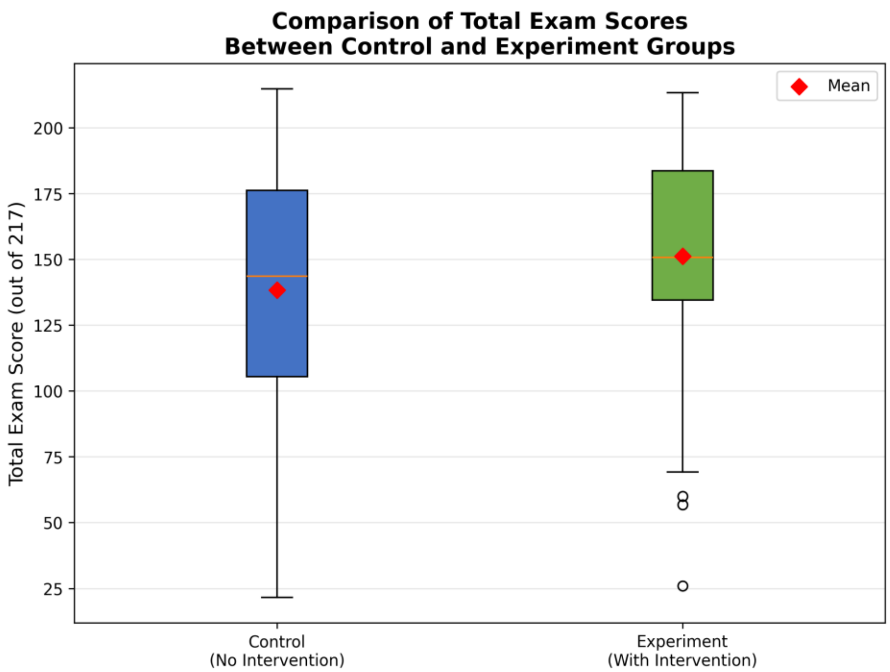

Fig. 1. Comparison of Total Exam Scores between Control and Experiment Groups

5.2. Student Engagement with Modules

Survey responses (n=49) indicated high engagement with the pre-class modules. The vast majority of students (89.8%) reported completing all or nearly all of the modules, with an additional 6.1% completing more than half and 4.1% completing about half. Most students (77.6%) reported spending 30-60 minutes on each module, while 22.4% reported spending 1-1.5 hours.

When asked about their primary reasons for engaging with the modules, the most commonly cited motivation was the readiness quiz points/grades, which appeared in the response combinations of nearly all students. Other frequently cited reasons included preparation for lecture, reviewing forgotten concepts, learning material not previously understood, and feeling it was expected by the instructor.

5.3. Student Perceptions of Module Effectiveness

Students generally perceived the modules positively, with mean ratings above the neutral point of 3 on all Likert-scale items. Table 3 presents the survey results for questions assessing perceived module effectiveness.

The highest-rated items were video clarity (M=4.24) and knowledge gap identification (M=4.14), with over 85% of students agreeing or strongly agreeing with these statements. Fig. 2 illustrates these results graphically.

Table 3. Student Perceptions of Module Effectiveness (n=49)

Survey Item	Mean (SD)	% Agree/Strongly Agree
Modules effectively reviewed background knowledge	4.06 (0.69)	83.7%
Modules improved understanding of circuit topics	3.90 (0.90)	67.3%
Video explanations were clear and easy to follow	4.24 (0.75)	85.7%
Slides were useful supplement to videos	4.00 (0.87)	77.6%
Quizzes accurately assessed understanding	3.92 (0.91)	71.4%
Modules helped identify knowledge gaps	4.14 (0.82)	85.7%

5.4. Impact on In-Class Experience

Students' perceptions of how the modules affected their in-class experience were more mixed. While 68.8% agreed that the modules allowed the instructor to spend less class time on basics, only 47.9% reported feeling more prepared to participate in class. The lowest-rated item concerned anxiety reduction, with a mean of only 3.08 and just 33.3% agreeing or strongly agreeing that the modules helped them feel less anxious. Fig. 3 displays the distribution of students’ responses.

When asked about behavior changes during lecture, 42.9% reported no significant change, while 30.6% indicated they were able to listen more and take notes less frantically, and 24.5% reported being more engaged in discussions and asking more questions.

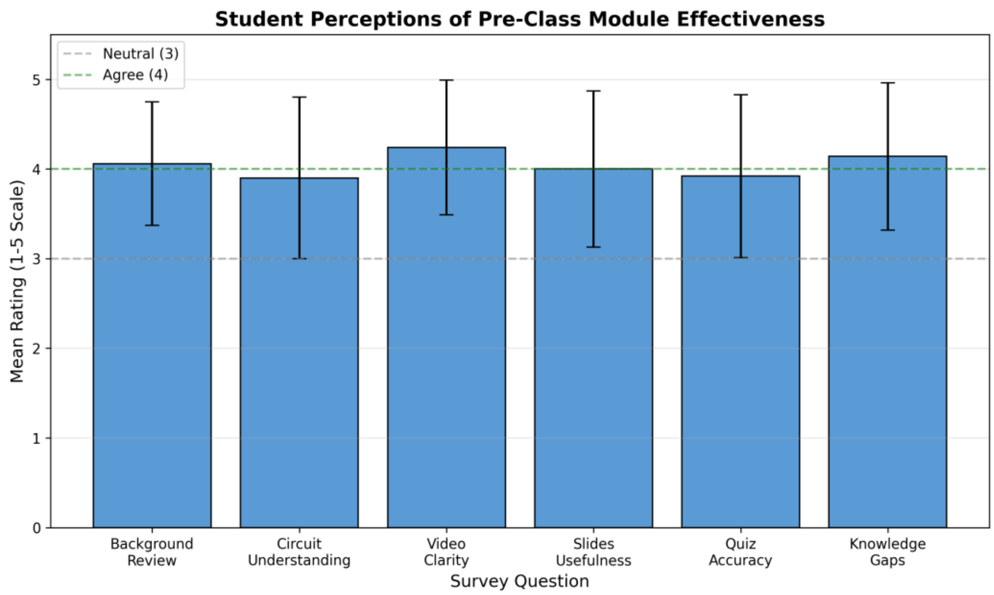

Fig. 2. Student Perceptions of Pre-Class Module Effectiveness

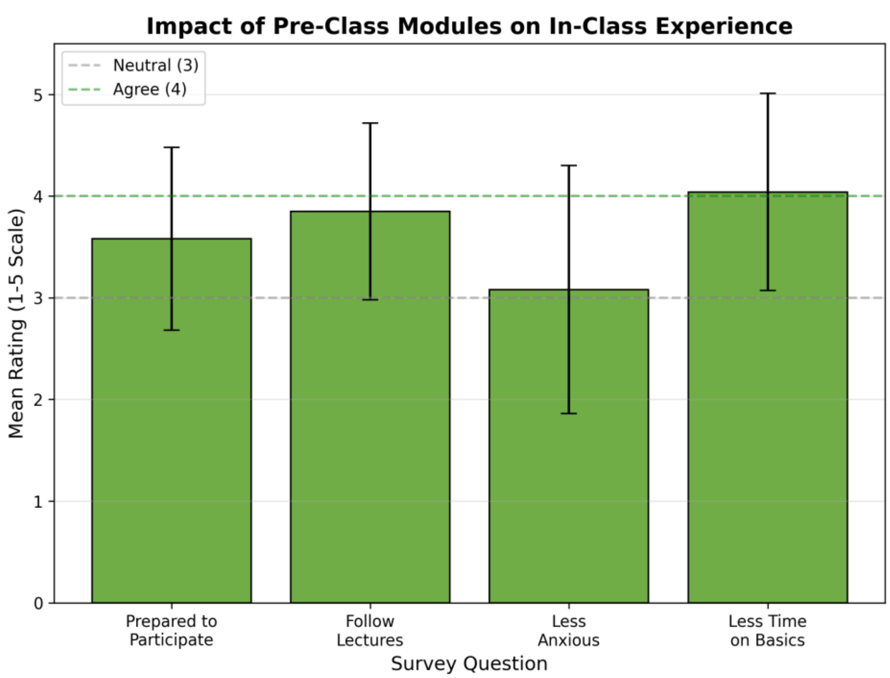

Fig. 3. Impact of Pre-Class Modules on In-Class Experience

5.5. Overall Value

Students' assessments of overall module value were moderate. When asked to rate the value of the pre-class modules, 46.9% selected "Moderately valuable," 28.6% selected "Very valuable," 22.4% selected "Slightly valuable," and only 2.0% selected "Extremely valuable." When comparing their learning experience to a traditional course, 51.0% indicated "About the same," 40.8% indicated "Somewhat better," 4.1% indicated "Much better," and 4.1% indicated "Somewhat worse."

Regarding recommendations for future use, 38.8% of students said "Yes, but with some improvements," another 38.8% were indifferent, and 22.4% said "Yes, definitely" when asked if this approach should be used in other engineering courses.

5.6. Qualitative Feedback

Open-ended responses revealed several themes. Students appreciated that the modules provided a preview of upcoming material, helped with forgotten concepts, allowed for self-paced learning, and contributed to their grades. As one student noted, the modules allowed them to "come to class prepared and the class felt like refining the knowledge which is better than building from zero." Another appreciated "not wasting time in class" and preferred "active problem solving the most."

Criticisms centered on video length, with multiple students requesting shorter videos or noting that lengthy videos reduced retention. Several students mentioned that some material felt like unnecessary review of previously learned content, while others noted time constraints given other coursework. Concerns about quiz difficulty and time limits were also raised, with students suggesting more consistent quiz lengths and the provision of answer explanations. One student noted that "quiz difficulty varied dramatically" and called for "more consistency."

6. Discussion

This study investigated the impact of pre-class prerequisite modules on student performance and perceptions in a sophomore-level linear circuits course. The results provide a nuanced picture of both the potential benefits and limitations of this targeted intervention approach.

The exam score analysis revealed a positive trend favoring the experimental group, with students who received the prerequisite module intervention achieving mean scores approximately 9.2% higher than the control group. While this difference did not reach conventional statistical significance ($p=0.057$), it approached the threshold and yielded a small-to-medium effect size (Cohen's $d=0.30$). These findings are consistent with prior research on pre-class preparation interventions, which typically report modest but meaningful improvements in student achievement [4], [6].

The lack of statistical significance may be attributable to several factors. First, the natural variability in student preparation and ability across semesters introduces noise that may mask intervention effects. Second, the sample sizes, while adequate, may have limited statistical power to detect small-to-medium effects. Third, as noted by a reviewer of the initial abstract, some students would likely perform well regardless of the intervention, potentially diluting the observed effect. Future research should consider stratifying analyses by students' prior preparation levels to better understand for whom the intervention is most beneficial.

The conceptual test results showed virtually no difference between groups, which was expected given the intervention's focus on foundational knowledge. Several explanations are possible. The conceptual test assess aspects of circuit understanding and reasoning that are not directly addressed by the prerequisite modules, which focused primarily on mathematical foundations rather than circuit-specific concepts. Conceptual understanding require deeper engagement with the class lectures. Thus, the transfer from prerequisite knowledge to conceptual application may not be straightforward. If future iterations aim to improve conceptual performance, modules should be extended beyond prerequisite skill review to include conceptual scaffolding that directly targets circuit reasoning, such as guided questions asking students to interpret circuit behavior before class.

The survey results paint a generally positive picture of student perceptions, with strong agreement that the modules effectively reviewed background knowledge, provided clear explanations, and helped identify knowledge gaps. These findings align with research on JiTT showing that pre-class activities help students identify their own understanding levels and prepare cognitively for new material [6], [8].

However, the more modest ratings on in-class impact items suggest that the connection between pre-class preparation and classroom experience may not be as strong or as evident to students as hoped. The finding that only 33.3% of students reported reduced anxiety is particularly notable, as anxiety reduction was one of the hypothesized benefits of the intervention. This may indicate that prerequisite review alone is insufficient to address the affective dimensions of learning in challenging courses, or that students' anxiety is driven more by course-specific content than by prerequisite gaps.

The qualitative feedback highlighted a tension between comprehensiveness and time efficiency. While students appreciated the content coverage, many found the videos too long and felt burdened by additional pre-class work on top of existing coursework. This suggests a need to optimize module design for efficiency, perhaps by creating shorter, more focused videos or by reducing redundancy with material students already know.

The findings of this study align with the broader literature on pre-class preparation strategies in engineering education. The positive trend in exam performance is consistent with previous research showing that students in active learning environments tend to perform better academically [15], [18]. Similarly, the high student engagement rates (89.8% completing all or nearly all modules) echo findings from JiTT research showing that meaningful pre-class assignments with accountability mechanisms can promote consistent student preparation [4], [5].

The mixed findings on affective outcomes parallel observations in the literature about individual differences in response to self-directed pre-class learning. The relatively high percentage of students (42.9%) who noticed no change in their classroom behavior suggests that for many students, the modules may have served primarily as a compliance activity rather than a transformative learning experience.

The finding that video clarity was highly rated (M=4.24, 85.7% agreement) supports research by Noetel et al. [9] demonstrating the effectiveness of well-designed instructional videos. However, student complaints about video length suggest the need to apply principles of cognitive load theory more rigorously, keeping videos concise and focused on essential content [10], [19].

Several limitations should be acknowledged. First, the quasi-experimental design means that differences between groups could be influenced by cohort effects unrelated to the intervention. While the comparison spans multiple semesters to reduce single-cohort effects, systematic differences in student preparation levels across years cannot be ruled out. Second, the study was conducted at a single institution with a single instructor, limiting generalizability. Third, the survey was administered only in the Fall 2025 semester, so we lack perception data from the Spring 2025 experimental cohort.

Additionally, the study could not isolate intervention effects by student preparation level. The hypothesis that prerequisite modules are most beneficial for underprepared students, while plausible, could not be tested without baseline data such as prerequisite course grades, incoming GPA, or a pre-semester diagnostic. Future research should collect such measures at the start of the semester to enable stratified analysis, which would clarify both the intervention's target population and its practical magnitude for students who most need support.

Despite the limitations, several practical implications emerge from this study. First, pre-class prerequisite modules appear to be a feasible and generally well-received approach to addressing the preparation gap in engineering courses. The high completion rates demonstrate that students will engage with pre-class materials when there is appropriate accountability. Second, video quality matters: clear, well-organized explanations were among the highest-rated aspects of the intervention. Third, module design should prioritize efficiency, as students expressed concerns about time demands. Shorter, more targeted videos with clear learning objectives may be more effective than comprehensive reviews. Fourth, the modest impact on anxiety suggests that prerequisite review alone may be insufficient to address affective barriers to learning, and additional support structures may be needed.

7. Conclusion

This study investigated the impact of pre-class prerequisite modules on student performance and perceptions in a sophomore-level linear circuits course. The intervention consisted of video lectures, annotated slides, and readiness quizzes covering mathematical and conceptual prerequisites essential for upcoming course content. Comparison of student outcomes across two control semesters and two experimental semesters revealed a positive trend in exam performance (approximately 9% improvement), though this difference did not reach statistical significance. Conceptual test scores showed no meaningful difference between groups.

Survey data indicated that students generally perceived the modules positively, particularly valuing the clarity of video explanations and the opportunity to identify knowledge gaps. However, the impact on in-class experience and anxiety reduction was more modest than anticipated. Students appreciated the concept of the intervention but called for improvements in video length and quiz consistency.

These findings suggest that targeted pre-class prerequisite modules represent a promising approach to addressing the preparation gap in engineering education, though their impact may be more subtle than dramatic. The intervention appears most valuable as a mechanism for ensuring baseline preparation and helping students identify their own knowledge gaps, rather than as a transformative restructuring of the learning experience. Future iterations should focus on optimizing module efficiency, potentially incorporating adaptive elements that allow students to skip content they have already mastered, and exploring additional strategies to address the affective dimensions of learning.

For engineering educators considering similar interventions, this study offers evidence that pre-class prerequisite modules can be implemented feasibly and will be generally well-received by students. However, expectations should be calibrated: while such modules may contribute to improved performance, they are unlikely to be a complete solution to the challenge of heterogeneous student preparation. The most effective approaches will likely combine prerequisite review with other evidence-based strategies including active learning during class time, timely feedback, and attention to students' affective experiences.

Acknowledgement

This material is based upon work supported by the National Science Foundation under Grant Numbers 2335802. Any opinions, findings, and conclusions or recommendations expressed are those of the author(s) and do not necessarily reflect the views of the NSF.

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