RIEF: Exploring Students' Utilization and Views of Generative AI, Online Videos, and Solution Sets in their Engineering Studies (Years 1 and 2)

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Context of the Project

This Research in Engineering Formation (RIEF) project examines how engineering students use external resources, including solution manuals and homework help websites (e.g., Chegg, Course Hero), video platforms, and generative AI tools, to support their studies. Undergraduate students increasingly rely on external online resources to support their coursework, often more than the materials provided in class. Although these tools can be powerful, especially AI, students must independently assess their accuracy and usefulness because instructors rarely curate them. For example, students have often sought solution manuals to help them study. However, this has relatively low effectiveness [1, 2], and often leads to academic integrity issues [3], even though students generally do not believe that using them constitutes academic misconduct [4]. Alternatively, resources like Khan Academy, which started as a platform for math tutoring videos, boast over 137 million users [5]. Even larger platforms like YouTube offer numerous videos across various topics in multiple languages, increasing accessibility and shareability [6]. Students find these videos helpful and easy to use [7], with features such as pausing, slowing down, speeding up, rewinding, and skipping content as needed. However, students must find a suitable video to help understand a specific topic and trust the resource. Still, faculty have found valuable ways to integrate these into their courses as assessments of professionalism [8], pre-class lectures [9], or as activities, such as developing homework problems based on a video [10]. After the release of ChatGPT, students now have a more powerful resource at their disposal than they did before. These tools offer several opportunities but also pose headaches for engineering faculty, as students can leverage them to solve many engineering problems or explain basic concepts at a level consistent with undergraduate textbooks.

Research Aims

Given the availability of these varied external resources to engineering students, there is a need to understand how students perceive and engage with them. In this study, the team sought to answer three interrelated research questions: (1) "How do engineering students use external resources for problem-solving assistance in their coursework?"; (2) "Why do engineering students engage with specific external resources over others, such as ChatGPT, with respect to the resource's perceived ease of use and usefulness?"; and (3) "What metacognitive strategies do students employ when collaboratively problem-solving with external resources, especially generative AI?"

Summary of Project Activities

Year One

In the first year of the project, we focused on instrument development to address RQ1 and RQ2. The items forming our instrument were selected through an iterative process within our research group – which included two faculty members, a post-doc, and four graduate and four undergraduate students – by combining custom items with existing scales. One key result of this discussion was the conclusion about the intention behind using a resource. The students felt there was a distinction between using a resource to complete a task, such as a project or homework assignment, and studying to learn a topic, such as exam preparation. Throughout the instrument, items are used to distinguish between "completing assignments" and "studying for an exam."

Ultimately, the instrument included the following sections: (1) overview of instructor-provided resources students have access to, (2) questions about usage of different types of external resources, (3) motivation (using the MUSIC model [11]), (4) metacognition [12], (5) perceptions of plagiarism and AI misuse (called AI-giarism) [13], (6) items aligned with the technology acceptance model to understand students' perceptions of usefulness and ease of use for each external resource [14], and (7) demographics.

The questions about the usage of different types of external resources were used to identify a student as an adopter (i.e., one who has included the resource as part of their workflow), a rejector (i.e., one who has tried the resource but no longer uses it), or a candidate (i.e., one who has not fully tried or incorporated the tool into their workflow) for each resource. Based on their response to the usage question, the participant would have a different version of the technology acceptance questionnaires. After the items were developed, cognitive interviews (n = 11) were conducted to ensure that the question wording made sense to the target audience. In these interviews, students took the survey instrument in a think-aloud setting. Their feedback was used to clarify questions and eliminate questions they felt were redundant. The full development of the instrument is described in [15].

Year Two

The instrument was administered to engineering students at a large public Midwestern university (n = 149). The population comprised 14 majors and students, ranging from first-year undergraduates to final-year undergraduates. To this point, we have conducted descriptive analyses of the data.

Rates of Adoption for Each Resource. Our descriptive analyses show that online video platforms were the most widely used resource, with nearly 96% having tried them and about 75% of students using them to supplement their studies. Conversely, 42% of students reported using AI tools or solution manuals for their studies. The number of AI adopters nearly equaled the number of rejectors, and only about 16% of students reported not having tried AI. In the case of solution manuals, users who tried them continued using them, as about 29% rejected them after trying. The use of generative AI seems to increase as students continue in their undergraduate programs, as few of the first-year students (16%) considered themselves adopters of these tools in their studies, whereas 69% of students in their final year of study identified as adopters. It is noted that the school these students attend has a mandatory co-op requirement of 5 semesters, so it should not be said that time in classes drove the increased use without considering potential exposure in industrial settings. Overall, AI use did not seem to depend on the major. The two largest majors, Mechanical Engineering and Computer Science, had similar AI adoption rates: 27 out of 50 versus 12 out of 23, respectively.

Student Perceptions of Resource Usefulness. In the survey, participants reported having enough time to study (5.21 out of 7) and to complete their assignments (5.42 out of 7). They also generally agreed that instructor-provided resources were sufficient to complete coursework (4.42 out of 7). However, they had slightly less confidence that the provided resources were sufficient to learn the course material (4.49 out of 7). In another item, participants ordered a list of instructor-provided resources by their usefulness for exam preparation and assignment completion. Table 1 presents the students' perception of the 5 options provided. It is clear that students prefer problem solutions and dislike using textbooks for their learning. There was a shift in the average ranking of items between exam preparation and assignment completion, but the average order was maintained.

Table 1. Comparison of Average Rank of Instructor-Provided Resources

Resource	Exam Preparation	Assignment Completion
Problem Solutions	2.0	2.4
Course Notes	2.8	2.7
Videos	3.5	3.6
PowerPoints	3.7	3.5
Office Hours	4.0	4.2
Textbooks	5.0	4.6

Note: Lower numbers mean the resource is more useful (rank-ordered 1-5)

Motivation. The MUSIC model of motivation proposes that students are more likely to engage when they perceive that they are empowered (empowerment), that the content is useful (usefulness), that they can succeed (success), that they are interested in the content (interest), and that their instructor cares about them (caring) [11]. Empowerment refers to the degree to which students feel they have autonomy and control over aspects of their learning. Usefulness reflects students' beliefs that the content or activities are relevant to their current or future goals. Success involves students' perceptions that they can succeed if they put in effort, supported by clear expectations and appropriate levels of challenge. Interest captures whether the learning experience is engaging, enjoyable, or stimulating to students' curiosity. Finally, caring emphasizes that students feel their instructor and peers genuinely care about their learning and well-being. Together, these dimensions shape the motivational climate and influence students' willingness to invest effort in learning. The items in these constructs are reported on a seven-point Likert scale. Composite scores indicated strong perceptions of empowerment ($M = 5.12$, $SD = 1.25$), usefulness ($M = 5.61$, $SD = 1.14$), success ($M = 5.88$, $SD = 0.91$), and caring ($M = 5.56$, $SD = 1.02$), with interest somewhat lower but still moderate to high ($M = 4.69$, $SD = 1.29$).

Perceived Usefulness of Resources. Technology perceptions were also favorable: students tended to view GenAI as useful ($M = 5.98$, $SD = 0.88$), and they rated video-based platforms as more helpful ($M = 5.70$, $SD = 0.98$) than online solution resources overall ($M = 4.86$, $SD = 1.30$). Together, these patterns suggest that students felt they were learning effectively and that commonly used course supports - especially videos - were perceived as valuable.

Plagiarism and AI-giarism. To gauge how students perceive AI-generated academic misconduct relative to traditional plagiarism, we used Chan's [13] "AI-giarism" instrument. The initial item represents the most severe form of AI-giarism, the final item represents no AI-giarism, and the intervening items decrease gradually in severity. The second part of the instrument outlines various forms of plagiarism, which students evaluate using the same Likert scale. Students drew a sharp ethical boundary between traditional plagiarism and AI-related misuse; students held much stronger opinions about plagiarism than about AI-giarism. Notably, the highest mean among the

AI-giarism items (M = 4.59) was still lower than the lowest mean among the plagiarism items (M = 5.22), indicating that students viewed these behaviors quite differently.

Future Work

In our initial analyses, the team was most struck by the responses to the AI-giarism results, which showed considerable variance. Moving forward, we plan to shift from identifying the metacognitive strategies students use to instead focus on the mixed results of the AI-giarism items. Further cognitive interviews will be conducted to better understand students' mindsets when tackling ethical dilemmas in the use of generative AI tools. The expectation was that the first item would be clearly academic misconduct (i.e., "The student input a prompt into an AI system, copied the generated response, and submitted it to the teacher. The student acknowledged the use of AI tools"), then progressively less egregious. Still, students were more mixed in opinions about this than anticipated (M = 4.49, seven-point scale). We plan to employ cluster analysis to identify candidates to interview [16, 17], a mixed methods strategy connecting our quantitative phase to a qualitative phase [18]. After the interview, the AI-giarism section will be reworked to reflect the new insight and administered at another institution [19].

Conclusion

Through the second year of the NSF-funded RIEF project, we have made significant progress toward our research goals. We have compiled an instrument to assess undergraduate engineering students' use and application of external resources to aid their studies and have deployed it to 149 engineering students from a single university across multiple majors and at various stages of their programs. Preliminary analysis showed that Generative AI use is growing, but students employ online videos/tutorials more frequently than using either generative AI or online solution manuals. Finally, the AI-giarism items provided a fruitful line of inquiry for us to pursue to dig deeper into students' views on the ethics of using generative AI tools in their academic pursuits.

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