BOARD # 89: WIP: Developing an Instrument to Understand Engineering Student uses of Digital External Resources from Solution Manuals to Generative AI

Christopher Allen Calhoun, University of Cincinnati
Dr. David Reeping, University of Cincinnati

Dr. David Reeping is an Assistant Professor in the Department of Engineering and Computing Education at the University of Cincinnati. He earned his Ph.D. in Engineering Education from Virginia Tech and was a National Science Foundation Graduate Research Fellow. He received his B.S. in Engineering Education with a Mathematics minor from Ohio Northern University. His main research interests include transfer student information asymmetries, threshold concepts, curricular complexity, and advancing quantitative and fully integrated mixed methods.

Mr. Siqing Wei, University of Cincinnati

Dr. Siqing Wei received a B.S. and M.S. in Electrical Engineering and a Ph.D. in Engineering Education program at Purdue University as a triple boiler. He is a postdoc fellow at the University of Cincinnati under the supervision of Dr. David Reeping. His research interests span three major research topics, which are teamwork, cultural diversity, and international and Asian/ Asian American student experiences. He utilizes innovative and cutting-edge methods, such as person-centered approaches, NLP, ML, and Social Relation Models. He studies and promotes multicultural teaming experiences to promote an inclusive and welcoming learning space for all to thrive in engineering. Particularly, he aims to help students improve intercultural competency and teamwork competency through interventions, counseling, pedagogy, and mentoring. Siqing received the Outstanding Graduate Student Research Award in 2024 from Purdue College of Engineering, the Bilsland Dissertation fellow in the 2023-24 academic year, and the 2024 FIE New Faculty Fellow Award.

Aarohi Shah, University of Cincinnati

Aarohi Shah is a third-year Computer Science student at the University of Cincinnati. She is an undergraduate research assistant in the Department of Engineering and Computing Education.

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Introduction

The overall structure of the higher education system has not changed in quite some time, especially in engineering education. As Sorby et al. astutely observe, *"Over the years, we educators have done some tinkering around the edges, such as adding in a capstone design project, or replacing Fortran with other programming languages—but the basic structure of the curriculum remains unchanged even though our students can now find information on their phones that might have taken us hours to track down in the library."* [1, p. 1]. This newfound instantaneous access to information has provided students with significantly more online resources, some provided by the instructor and others discovered by the students. As instructors often lament, students seldom used their textbooks [3] and did not frequently visit office hours [4] to help develop their problem-solving skills - even before this explosion of learning supplements. Perhaps now more than ever, with the various resources at their disposal, students must leverage considerable metacognitive skills to navigate them, as students cannot rely on the filtering provided by the instructor's expertise and must experiment with different types of assistance to find the right fit for their needs. We can categorize the popular digital external resources students use beyond what instructors provide into three groups: (1) Problem Solutions (like Chegg), (2) Video Platforms, and (3) generative AI tools like ChatGPT.

Problem Solutions. On many online platforms, students can search catalogs of solutions with step-by-step guides of varying quality, including manuals from textbook problems, or even post their own questions to have an "expert" post a solution to their problem. These platforms are prevalent, but studying solution manuals has relatively low effectiveness [5], [6], and it often leads to threats of academic integrity violation [7] (although students do not generally believe using them is a form of academic misconduct [8]). Little contemporary work exists examining how students interact with problem solutions, which is mainly centered on instances or perceptions of cheating [8], [9], [10] and methods to thwart students' attempts to use them [11], [12].

Video Platforms. Resources focused on recorded lectures, like Khan Academy, boast over 137 million users [13]. Even larger platforms like YouTube provide numerous videos across various topics in multiple languages, increasing accessibility and shareability [14]. Students find these videos helpful and easy to use, with benefits like stopping, slowing down, speeding up, rewinding, and skipping any content in the video based on what they need [15]. However, finding a suitable video to help a student understand a specific topic and trusting the resource poses a challenge. Still, faculty have found useful ways to integrate these into their courses as assessments for professional development [16], pre-class lectures [17], or as an activity like developing homework problems based on a video [18].

Generative AI tools. Beyond traditional outside resources like problem solutions and videos, modern large language models (LLMs) are quickly gaining popularity in engineering education [19]. As with other technologies, there is speculation on where generative AI fits in education. At face value, generative AI tools are the next step in on-demand help provided by problem-solution websites, and it is not difficult to see why, given the focus of the literature. Within the first months of its launch, it was found that ChatGPT could pass law school exams, though it only managed a

C+ [20]. This is just one example of the deluge of papers describing how large language models can perform reasonably well on traditional examinations (e.g., [21], [22], [23], [24], [25]). These models are trained using large and diverse sets of writing and employ statistical procedures to predict a response to a statement or question, which can lead to surprising coherence and the appearance of analytical reasoning.

In STEM fields, where communication is less in written short responses and more often a combination of diagrams and equations, generative AI tools have seen uneven success in problem-solving. For standard assessments (that may well be in the training set), such as the Force Concept Inventory, ChatGPT could score approximately 50% by the authors' assessment, excluding questions requiring graphical understanding [26]. With some additional structuring, performance on simplistic physical problems improves but is still not entirely accurate [27]. For STEM students, these tools seem most effective at divergent thinking tasks like brainstorming [28], supplementing writing, and programming tasks (e.g., debugging [29]).

Research Aim

Given the range of digital resources available to students, there is a need to understand what resources students use and how they use them. Accordingly, this WIP paper outlines our efforts to develop an instrument to explore two research questions: (1) How do engineering students use external resources, including generative AI, to assist in problem-solving within their coursework? (2) What factors drive their preference for certain tools over others?

Theoretical Framework

The model we chose to frame the research questions was the revised technology acceptance model (TAM) [30]. The TAM primarily focuses on two factors, which are based on the user's attitude toward using the system (called *intentions to use*): *perceived ease of use* (the extent to which using the system would be free from effort) and *perceived usefulness* (the extent to which the person thinks the system would improve their [job] performance) [31]. As the TAM became more popular for explaining how individuals integrate new technologies into their workflows, additions to the model tease out the nuances of the dominant constructs of perceived ease of use and perceived usefulness. After reviewing the development of the TAM from 1986 to 2013, Marangunić and Granić [30] present a revised model to address weaknesses in the more simplistic models of the past, which include external predictors influencing perceived usefulness, perceived ease of use, contextual factors, factors from other theories that could be moderating variables for intentions to use, and explicit usage measures for actual system use. The revised TAM is shown in Figure 1.

Here, the contextual factors would be associated with the courses students are currently enrolled in at the time of the study, such as the types of courses they are taking and the available resources as part of the courses. Hilliger et al.'s [32] grounded theory model of what makes courses demanding to students provides a suite of contextual and external variables that could impact perceived usefulness and perceived ease of use, such as content complexity, faculty support, workload, and student interests. This work fits into a larger project on how students use metacognitive strategies with these external resources, especially large language model-based technology like ChatGPT, so metacognitive strategies will be explored as a potential moderating variable for the intentions to use and elements of actual system usage. Motivation will be added as a possible moderator for intentions to use, primarily because of its strong connection to metacognition [33].

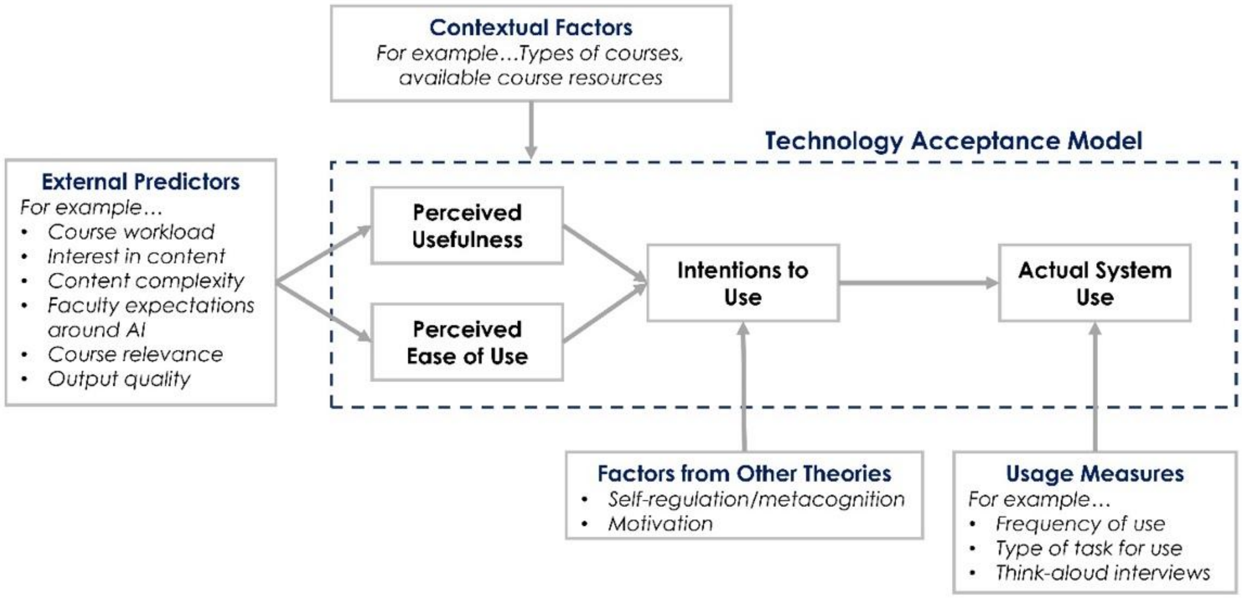

Figure 1. Technology Acceptance Model (TAM) adapted from *[30]* and *[32]* to this study

Survey Development

We began by sourcing items related to the technology acceptance model and the constructs of interest in our theoretical model. Table 1 outlines existing scales that we included in our instrument.

Table 1. Existing scales adopted for our instrument

Instrument or Measure	Description
Metacognitive Activities Inventory [34]	General diagnostic tool for evaluating students' metacognitive strategies, initially developed for chemistry context but no prompts are content dependent.
Technology Acceptance Questionnaire [35]	A questionnaire initially designed to measure dimensions of technology acceptance for game-based learning. It will be modified for the different external resources.
Academic Motivation [36]	A well-established scale created by Jones for probing student motivation in academic settings around five dimensions: (1) empowerment, (2) usefulness, (3) success, (4) interest, and (5) caring. This is chosen due to the relationship between metacognition and motivation [33].
Perceptions of 'AI-giarism' [37]	A newer instrument meant to probe what students believe to be AI plagiarism (given by 'AI-giarism'). We contend that the students' beliefs about generative AI tools might be a predictor of perceived usefulness.

To increase our findings' content and construct validity [38], the remaining items were curated through an iterative process within a research group of four undergraduate students, four PhD students, a post-doc, and two faculty members. One key discussion point that emerged was a distinction between using a resource to complete a task, such as a project or homework assignment, versus studying to learn a topic, like for exam preparation. Therefore, consolidating this perspective into the item-building process, we refined the items throughout the instrument to distinguish between "completing assignments" and "studying."

We grouped the scales and new items into sections to allow us to direct survey participants to respond to relevant items based on their responses to screening questions at the beginning. The instrument sections include background information, general resource-specific questions for each resource type, and questions based on the participant's usage of each resource, motivation, and demographics. Below is a description of each of the sections. Appendix A contains sample items for the categories and their elements presented in Figure 1, which we developed.

Background and Instructor-Provided Resources

This section collects information on which instructor-provided resources students prefer and how they use them. For this section, students will be tasked with ranking different resources regarding their usefulness and perceived ease of use for studying and completing assignments. For this section, the team considered: (1) textbooks (electronic or physical), (2) PowerPoint Presentations, (3) course notes, (4) problem solutions, (5) past exams, and (6) lecture videos. Students will rank choices for completing assignments and for studying. The team also wanted further evidence of the decreased usage of textbooks [3], so there is a question directly soliciting how often students employ their textbooks.

Technology Overview Questions

The three resource types have common questions to see students' exposure to each one (e.g., Do your peers use [resource] in their coursework?). Of most interest will be exposure to generative AI tools in an industrial setting for those who have participated in a co-op or internship, as more and more employers are employing generative AI software to increase employee productivity.

Usage-level Question Blocks

Students will be asked to self-identify their usage level of each resource. Because students use resources in different capacities or at all, not all questions may be relevant. Therefore, we intend to segment the questions for students into three categories: candidate, adopter, or rejector. A *candidate* will be considered someone who does not feel they have tried the resource. An *adopter* is a student who feels the resource is part of their current workflow. Lastly, a *rejector* is considered a student who used a resource in the past to some extent but no longer uses it for their studies. From there, there are three question blocks for each resource group. Students will answer questions from one of the blocks for the three technology groups.

Candidate: The TAM model is classically intended for this group of students. Hence, this section draws from the TAM model to pose questions about a student's perception of the technology and its usefulness. Questions are also focused on the intention to use. Of note is that this group's view of generative AI tools will be a big part of the takeaway from the project. This will give insights into how instructors can present generative AI to help teach students how to interface with generative AI.

Adopter: Based on discussions within the research group, we compiled a list of tasks that could be completed with each technology. A naturally wider array of tasks was identified for generative AI compared to other digital resources, such as summarizing content, code development, and composing reports and emails. As such, users will be asked about the uses of the different resources and the user strategies with open-ended questions like "If you were talking to a younger student about streaming videos, how would you recommend them to find a relevant YouTube video?"

Rejector: The questions here will be aimed at deciphering (1) how a resource was used and (2) why they stopped using the resources. In the discussion of the research team, it was felt that available resources are useful based on the level of the student and course topics. For instance, students could rely on YouTube videos to aid in their introductory calculus and physics courses. However, as they got into more advanced, major-specific courses, YouTube videos became more challenging to find. Hence, they had to shift their study and work habits.

Demographics

This portion aims to understand whether there is any relation between demographic data and resource usage. Of particular note, asking the year or number of semesters until graduation will allow the team to see if there is an evolution of the resources students employ as they progress into more major-specific courses.

Cognitive Interviews

We recruited undergraduate engineering students to complete the survey while being asked to elaborate on their thinking verbally to ensure the intention and reception of the questions aligned. This specific process is often called a *cognitive* interview, which is a crucial step in improving the validity and reliability of the instrument's results while the items are being developed [39].

Our sample of students for the cognitive interviews (n = 11) contained a variety of engineering disciplines, including aerospace (1), chemical (1), computer science (4), electrical (3), and mechanical (2). The sample was primarily represented by students identifying as Asian (7), with the remaining students identifying as White (2), Black (1), and Mixed Race (1). Most of the students were Male (9). Moreover, in terms of academic standing, we had the most representation from middle-year students (starting year was 2021 = 2; 2022 = 5; 2023 = 3, 2024 = 1).

After completing all the items, students provided no negative feedback on the survey length. Aside from minor typos and small clarifying text in select items, the students reported that the items were coherently posed. Regarding visual design, it was noted that some sets of items had anchors that were not visible on their screens as they scrolled to respond to later prompts. This issue is a pitfall of the matrix-table style items we used in Qualtrics, which required us to break the larger matrices into several smaller matrices. There were no other substantial edits to note from the interviews.

Next Steps

During Summer 2025, the instrument will be revised based on the feedback and be used to collect data from at least 200 undergraduate students from the same Midwest University. Based on the initial 200 responses, students will be invited to participate in another phase of the study that focuses more specifically on using generative AI as a resource. Students will be given an open-ended problem to be solved using generative AI tools in a think-aloud interview. The interviews aim to get insights into students' successful metacognitive strategies to maximize generative AI tools' strength.

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References

[1] S. Sorby, N. Fortenberry, and G. Bertoline, "Stuck in 1955, Engineering Education Needs a Revolution," Issues in Science and Technology. Accessed: Nov. 13, 2023. [Online]. Available: https://issues.org/engineering-education-change-sorby-fortenberry-bertoline/

[2] S. Sorby, N. L. Fortenberry, and G. Bertoline, "Stuck in 1955, engineering education needs a revolution," *Issues Sci. Technol.*, 2021.

[3] C. S. Lee, N. J. McNeill, E. P. Douglas, M. E. Koro-Ljungberg, and D. J. Therriault, "Indispensable Resource? A Phenomenological Study of Textbook Use in Engineering Problem Solving," *J. Eng. Educ.*, vol. 102, no. 2, pp. 269–288, Apr. 2013, doi: 10.1002/jee.20011.

[4] D. Harris, "Office Hours Are Not Obsolete: Fostering Learning Through One-on-One Student Meetings," *Duq Rev*, vol. 57, p. 43, 2019.

[5] J. Widmann, K. Shollenberger, and J. Kennedy, "Student use of author's textbook solution manuals: Effect on student learning of mechanics fundamentals," in *2007 Annual Conference & Exposition*, 2007, pp. 12–1319. Accessed: Jan. 09, 2025. [Online]. Available: https://peer.asee.org/1877.pdf

[6] A. Karimi and R. D. Manteufel, "Does Student Access to Solution Manual Pose a Challenge?," presented at the 2011 ASEE Annual Conference & Exposition, Jun. 2011, p. 22.512.1-22.512.19. Accessed: Jan. 09, 2025. [Online]. Available: https://peer.asee.org/does-student-access-to-solution-manual-pose-a-challenge

[7] K. Reid and M. Mikel-Stites, "'Keep Your Eyes on Your Own Paper' - Academic Dishonesty in the Era of Online Homework Assistance," presented at the 2020 ASEE Virtual Annual Conference Content Access, Jun. 2020. Accessed: Jan. 09, 2025. [Online]. Available: https://peer.asee.org/keep-your-eyes-on-your-own-paper-academic-dishonesty-in-the-era-of-online-homework-assistance

[8] J. Widmann and K. Shollenberger, "Student use of textbook solution manuals: Student and faculty perspectives in a large mechanical engineering department," in *2006 Annual Conference & Exposition*, 2006, pp. 11–1168. Accessed: Jan. 09, 2025. [Online]. Available: https://peer.asee.org/student-use-of-textbook-solution-manuals-student-and-faculty-perspectives-in-a-large-mechanical-engineering-department

[9] S. Marx, *Qualitative research in STEM: Studies of equity, access, and innovation*. Routledge, 2016. Accessed: Jan. 09, 2025. [Online]. Available: https://books.google.com/books?hl=en&lr=&id=GkaTDAAAQBAJ&oi=fnd&pg=PP1&dq=Qualitative+Research+in+STEM:+Studies+of+Equity,+Access,+and+Innovation.&ots=WBqDJY5uim&sig=_772GNzIiWHfP7IzvI1SPbQH6Pk

[10] S. W. Tabsh, H. A. El Kadi, and A. S. Abdelfatah, "Faculty perception of engineering student cheating and effective measures to curb it," in *2019 IEEE Global Engineering Education Conference (EDUCON)*, IEEE, 2019, pp. 806–810. Accessed: Jan. 09, 2025. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/8725199/?casa_token=iN2QmiVVNVMAAAAA:X1GRG9aX8BkH2Jg3d56YHarCGv8k_9IlMwNVOO545dyQqfklqb5MsKyRxPLQJB3CSEcoW-HNSw

[11] E. F. Gehringer and B. W. Peddycord, "Teaching strategies when students have access to solution manuals," in *2013 ASEE Annual Conference & Exposition*, 2013, pp. 23–1151. Accessed: Jan. 09, 2025. [Online]. Available: https://peer.asee.org/22536.pdf

[12] L. G. Bullard, "Guest Editorial: The Case Against the Use of Solution Manuals," *Chem. Eng. Educ.*, vol. 47, no. 1, p. Back-Cover, 2013.

[13] B. Herold, "Khan Academy Founder on How to Boost Math Performance and Make Free College a Reality," *Education Week*, Apr. 12, 2022. Accessed: Jan. 09, 2025. [Online]. Available: https://www.edweek.org/technology/khan-academy-founder-on-how-to-boost-math-performance-and-make-free-college-a-reality/2022/04

[14] D. Topps, J. Helmer, and R. Ellaway, "YouTube as a platform for publishing clinical skills training videos," *Acad. Med.*, vol. 88, no. 2, pp. 192–197, 2013.

[15] E. T. Maziriri, P. Gapa, and T. Chuchu, "Student Perceptions towards the Use of YouTube as an Educational Tool for Learning and Tutorials," *Int. J. Instr.*, vol. 13, no. 2, pp. 119–138, Apr. 2020.

[16] S. Nikolic, D. Stirling, and M. Ros, “Formative assessment to develop oral communication competency using YouTube: self- and peer assessment in engineering,” *Eur. J. Eng. Educ.*, vol. 43, no. 4, pp. 538–551, Jul. 2018, doi: 10.1080/03043797.2017.1298569.
[17] C. Furse, “Lecture-free engineering education,” *IEEE Antennas Propag. Mag.*, vol. 53, no. 5, pp. 176–179, 2011.
[18] M. W. Liberatore, D. W. Marr, A. M. Herring, and J. D. Way, “Student-created homework problems based on YouTube videos,” *Chem. Eng. Educ.*, vol. 47, no. 2, pp. 122–132, 2013.
[19] D. Reeping and A. Shah, “Board 50: Work in Progress: A Systematic Review of Embedding Large Language Models in Engineering and Computing Education,” presented at the 2024 ASEE Annual Conference & Exposition, Jun. 2024. Accessed: May 01, 2025. [Online]. Available: https://peer.asee.org/board-50-work-in-progress-a-systematic-review-of-embedding-large-language-models-in-engineering-and-computing-education
[20] J. H. Choi, K. E. Hickman, A. Monahan, and D. B. Schwarcz, “ChatGPT Goes to Law School,” *SSRN Electron. J.*, 2023, doi: 10.2139/ssrn.4335905.
[21] P. M. Newton and M. Xiromeriti, “ChatGPT Performance on MCQ Exams in Higher Education. A Pragmatic Scoping Review,” Feb. 21, 2023, *EdArXiv*. doi: 10.35542/osf.io/sytu3.
[22] S. Bordt and U. von Luxburg, “ChatGPT Participates in a Computer Science Exam,” Mar. 22, 2023, *arXiv*: arXiv:2303.09461. doi: 10.48550/arXiv.2303.09461.
[23] J. de Winter, *Can ChatGPT pass high school exams on English Language Comprehension?* 2023.
[24] T.-L. Weng, Y.-M. Wang, S. Chang, T.-J. Chen, and S.-J. Hwang, “ChatGPT failed Taiwan’s Family Medicine Board Exam,” *J. Chin. Med. Assoc.*, vol. 86, no. 8, p. 762, Aug. 2023, doi: 10.1097/JCMA.0000000000000946.
[25] L. Zhu, W. Mou, T. Yang, and R. Chen, “ChatGPT can pass the AHA exams: Open-ended questions outperform multiple-choice format,” *Resuscitation*, vol. 188, p. 109783, Jul. 2023, doi: 10.1016/j.resuscitation.2023.109783.
[26] C. G. West, “AI and the FCI: Can ChatGPT Project an Understanding of Introductory Physics?,” Mar. 26, 2023, *arXiv*: arXiv:2303.01067. doi: 10.48550/arXiv.2303.01067.
[27] Y. Liang, D. Zou, H. Xie, and F. L. Wang, “Exploring the potential of using ChatGPT in physics education,” *Smart Learn. Environ.*, vol. 10, no. 1, p. 52, Oct. 2023, doi: 10.1186/s40561-023-00273-7.
[28] L. Schmidt, A. Piazza, and C. Wiedenhoft, *Augmented Brainstorming with AI”–Research Approach for Identifying Design Criteria for Improved Collaborative Idea Generation Between Humans and AI*. in HHAI 2023: Augmenting Human Intellect: Proceedings of the Second International Conference on Hybrid Human-Artificial Intelligence. IOS Press, 2023.
[29] N. M. S. Surameery and M. Y. Shakor, “Use Chat GPT to Solve Programming Bugs,” *Int. J. Inf. Technol. Comput. Eng. IJITC ISSN 2455-5290*, vol. 3, no. 01, Art. no. 01, Jan. 2023, doi: 10.55529/ijitc.31.17.22.
[30] N. Marangunić and A. Granić, “Technology acceptance model: a literature review from 1986 to 2013,” *Univers. Access Inf. Soc.*, vol. 14, no. 1, pp. 81–95, Mar. 2015, doi: 10.1007/s10209-014-0348-1.
[31] F. D. Davis, “Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology,” *MIS Q.*, vol. 13, no. 3, p. 319, Sep. 1989, doi: 10.2307/249008.
[32] I. Hilliger, C. Melian, J. Meza, G. Cortés, and J. A. Baier, “Work in Progress: What Makes Courses Demanding in Engineering Education? A Combination of Mixed Methods and Grounded Theory Research,” presented at the 2020 ASEE Virtual Annual Conference Content Access, Jun. 2020. Accessed: Feb. 10, 2022. [Online]. Available: https://peer.asee.org/work-in-progress-what-makes-courses-demanding-in-engineering-education-a-combination-of-mixed-methods-and-grounded-theory-research
[33] B. J. Zimmerman and A. R. Moylan, “Self-regulation: Where metacognition and motivation intersect,” in *Handbook of metacognition in education*, in The educational psychology series. , New York, NY, US: Routledge/Taylor & Francis Group, 2009, pp. 299–315.

[34] M. M. Cooper and S. Sandi-Urena, “Design and Validation of an Instrument To Assess Metacognitive Skillfulness in Chemistry Problem Solving,” *J. Chem. Educ.*, vol. 86, no. 2, p. 240, Feb. 2009, doi: 10.1021/ed086p240.
[35] M. T. A. Ghani *et al.*, “A questionnaire-based approach on technology acceptance model for mobile digital game-based learning,” *J. Glob. Bus. Soc. Entrep.*, vol. 5, no. 14, 2019.
[36] B. D. Jones, “Motivating Students to Engage in Learning: The MUSIC Model of Academic Motivation,” *Int. J. Teach. Learn. High. Educ.*, vol. 21, no. 2, pp. 272–285, 2009.
[37] C. K. Y. Chan, “Is AI Changing the Rules of Academic Misconduct? An In-depth Look at Students’ Perceptions of ‘AI-giarism,’” arXiv.org. Accessed: Jan. 15, 2025. [Online]. Available: https://arxiv.org/abs/2306.03358v2
[38] B. M. Moskal, J. A. Leydens, and M. J. Pavelich, “Validity, Reliability and the Assessment of Engineering Education,” *J. Eng. Educ.*, vol. 91, no. 3, pp. 351–354, 2002, doi: 10.1002/j.2168-9830.2002.tb00714.x.
[39] L. M. Desimone and K. C. Le Floch, “Are We Asking the Right Questions? Using Cognitive Interviews to Improve Surveys in Education Research,” *Educ. Eval. Policy Anal.*, vol. 26, no. 1, pp. 1–22, Mar. 2004, doi: 10.3102/01623737026001001.

APPENDIX A Summary of Dimensions and Items

Dimension	Description	Example Item
Exposure	Exposure to different resources through different social, educational and professional influences	• My peers use generative AI tools to complete homework assignments. • I used generative AI tools while I was working at a job
Perceived Usefulness	The degree to which a candidate thinks a resource will help them as a student	• Using online solutions will help me complete my solutions quickly • Using generative AI tools will help me learn a concept quickly
Perceived Ease of Use	Using statements from the technology acceptance model aims to see if students think a resource will be useful or not	• Finding online solutions would be simple • Writing the right question for generative AI would be easy to help solve a homework assignment • It would be easy to evaluate the accuracy of a response from a generative AI tool
Intention to Use	Assessment of a candidate's inclination to use a resource	• I intend to use ChatGPT to aid in my future assignments • I intend to use online videos to aid in my future assignments
Actual System Use	Assessment of how adopters and rejectors have employed a resource	• I use a generative AI tool like ChatGPT to help compose emails • I use online video tutorials to prepare for an exam
Contextual Factors	The factors in which a student may be more inclined to a specific resource	• Generative AI tools would be useful for writing-intensive courses • Online published solutions are useful for technical courses • Online tutorials are useful in early engineering courses
External Predictors	Factors will show a student's likeliness to rely on additional resources	• My instructors clearly define the acceptable use of generative AI in my courses • Knowing course concepts will prepare me for my career
Ethical Concerns	Evaluation of a student's views of acceptable and unacceptable behavior	• A student uses a published online solution to a homework problem to determine how to solve a problem • A student directly copies a homework solution found online and not provided by the instructor to a homework problem and submits it • A student uses online published problem solutions not provided by an instructor to prepare for an exam • A student completes an assignment without using any resources beyond what was provided by the instructor