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WIP: A Novel Learning Log Application for Classifying Learning Events Using Bloom's Taxonomy

Dr. Alex M. Phan, University of California, San Diego

Dr. Alex Phan is the inaugural Executive Director for Student Success in the Jacobs School of Engineering at UC San Diego. Prior to his appointment, he has served as a project scientist, engineer, and lecturer, teaching across multiple divisions, including the Jacobs School of Engineering (Dept. of Electrical and Computer Engineering, Dept. of Mechanical and Aerospace Eng., Dean's Office Unit) and UC San Diego Division of Extended Studies. His teaching interests and expertise are in experiential learning, holistic education models, active learning environments, and metacognition. In his current role, he leads the IDEA Student Center, a prolific student-centered resource hub at the Jacobs School of Engineering.

Jenna Metera, University of California, San Diego

Jenna Metera is a 6th year PhD candidate at the University of California, San Diego and an instructor for the course "Engineer Your Success", a two credit course offered by the IDEA Center. The course focuses on helping students develop their personal and study skills in the realm of time management, communication, prioritization, and self-assessment of themselves, including their way of learning. When Jenna is not teaching, she is developing her thesis on the synthesis of morphology controlled bismuth ferrite for enhanced electrical applications. She aims to work for a national lab following her defense to bolster the basic sciences in government operations.

Sonia Fereidooni, University of California, San Diego

Sonia Fereidooni is an undergraduate researcher and Computer Science student with UC San Diego's Computer Science and Engineering Department, where she explores her burgeoning interest in artificial intelligence and machine learning. With a focus on collaboration and learning, Sonia contributes to projects with profound impact. Her journey is marked by her dedication to making a meaningful contribution in her field through continuous learning and research.

Cham Yang, University of California, San Diego

Cham Yang is a Web Development Supervisor and an Applications Programmer at the Jacobs School IT Team, Office of Engineering Computing OEC). His experience as a web/app developer ranges from creating campus wide web applications to developing e-commerce solutions or small businesses.

Dr. Minju Kim, University of California, San Diego

Minju Kim is a postdoctoral scholar at the Engaged Teaching Hub at the UCSD Teaching+Learning Commons. Minju received her Ph.D in Experimental Psychology at UC San Diego. With Engaged Teaching Hub, Minju has designed TA training materials for oral exams and have conducted quantitative analysis on the value of oral exams as early diagnostic tool (Kim et al., ASEE 2022). Minju is interested in designing assessments that can capture and motivate students' deep conceptual learning, such as oral exams and the usage of visual representations (e.g., diagrams and manual gestures).

Dr. Carolyn L. Sandoval, University of California, San Diego

Dr. Sandoval is the Associate Director of the Teaching + Learning Commons at the University of California, San Diego. She earned a PhD in Adult Education-Human Resource Development. Her research interests include adult learning and development, faculty development, qualitative methods of inquiry, and social justice education.

Dr. Phuong Truong, University of California, San Diego

Phuong Truong is a Lecturer and Staff Research Associate at UC San Diego and an Engineering Adjunct Faculty at the San Diego Mesa College. She received her B.S. (2016) in structural engineering, M.S. (2018) in mechanical engineering, and Ph.D. (2023) in mechanical engineering from Jacobs School of Engineering. Her primary education research interests include experiential learning, holistic modeling, and active learning practices.

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Alex Phan, Jenna Metera, Sonia Fereidooni, Cham Yang,
Minju Kim, Carolyn Sandoval, Phuong Truong

Abstract: Learning can be a daunting and challenging process, particularly in engineering. While cognitive models for learning such as Bloom's taxonomy have been developed since the 1950s and evidenced to be useful in designing engineering courses, these models are not commonly explicitly taught in classrooms to help students manage and regulate their own learning. In highly demanding curriculum such as engineering, ineffective strategies can lead to poor academic performance that cascades throughout a student's academic career. Feedback from traditional examinations often do not provide personalized and actionable changes to study habits (i.e., with suboptimal scores, students may know they need to study more, but whether "more" is effective is often unclear). There is a pressing need to bridge the gap between study practices and learning outcomes that enable students to regulate and improve their own learning strategies in engineering. This work in progress paper presents initial data from a novel "learning log" application that allows students to enter their studying activity (e.g., timed practice exam, redoing homework, reading the textbook, practice problems), and labels the cognition level (using Bloom's taxonomy: remember, understand, apply, analyze, evaluate, create). We present initial data from students' logged studying activities using the application. The logging allows students to track their cognition distribution over time, providing data about how they engaged with course content.

Introduction

Assessment is a cornerstone of the educational process, deriving from defined learning objectives that outline how students should engage with course material. The importance of assessment to learning is underscored by the recognition that it serves as a guiding force for both educators and students. The clear definition of learning objectives, as discussed in the literature [1-2], aids instructors in selecting appropriate course content, planning lectures, designing assignments, and writing tests. The relevance of assessment to engineering education is further highlighted by the role of accreditation, particularly through the Accreditation Board for Engineering and Technology (ABET). ABET, as detailed in the literature [1], conducts reviews of engineering programs in the United States to ensure they meet specific standards. This involves a comprehensive evaluation process, where faculty formulate educational objectives, program outcomes, course learning objectives, and a continuous improvement process. The focus on assessment has intensified over the past decade, particularly with the ABET Engineering Criteria directing attention toward these aspects [3]. This highlights the importance of the relationship and alignment between program educational goals, learning objectives, course contents, activities, and assessment within engineering classrooms.

At the student level, metacognition, or thinking about one's own thinking processes, plays a crucial role in the learning experience for students. Without a feedback mechanism or data on their learning progress, students may indeed study tirelessly without effectively reaching target levels. Metacognitive skills involve the ability to plan, monitor, and evaluate one's own learning. Metacognition is implicitly addressed through the exploration of factors influencing students' decisions to leave engineering [4]. Metacognition can be examined through the student lens through their planning and decision making, monitoring their own academic success, evaluation of their learning strategies, self-regulation and adjustment, and how all of that influences their academic performance. Effective metacognition leads to self-regulation, enabling students to adjust their learning strategies based on feedback and experiences. The link between metacognition to academic performance has been clear since there are correlations between students' decisions to leave engineering and their GPAs [5-6] . Students with higher GPAs found academic factors to be less influential, indicating a potential link between metacognitive skills, academic success, and persistence in engineering [4, 7]. Metacognition is essential for students to optimize their learning experiences, make informed decisions, and adapt to challenges. Without a feedback mechanism or data on their progress, students may struggle to develop effective metacognitive skills, hindering their ability to navigate the complex demands of academic programs such as engineering. Addressing both academic and emotional factors through improved metacognitive skills, ultimately contributes to better retention and success in engineering education. While the teaching community continues to evolve pedagogical practices [8], learning environments [9-10], and cognitive frameworks [11] within their classrooms, student study habits and engagement with the material outside of the classroom have largely been left to their own devices [12-13]. Despite the existence of cognitive models for learning such as Bloom's taxonomy since the 1950s [14, 1] and their evidence to be useful in engineering courses [15, 2, 4], students have not widely adopted these models in their own study habits, affecting their metacognition and engagement with course material in alignment with course objectives.

To address the challenges in alignment between learning objectives and student studying activities this paper reports on a novel "learning log" application aimed at optimizing students' learning experiences. The application allows students to meticulously document their study endeavors, offering a comprehensive overview of their cognitive engagement. The "learning log" application incorporates a user-friendly interface that enables students to input diverse study activities. These activities range from timed practice exams and homework revisions to textbook reading and practice problems. The application's distinguishing feature lies in its integration of Bloom's Taxonomy, a renowned framework for categorizing cognitive skills. Each recorded activity is accompanied by a cognitive level from Bloom's Taxonomy. Students have the option to designate whether their engagement corresponds to remembering, understanding, applying, analyzing, evaluating, or creating. By categorizing activities into specific cognitive domains, students gain clarity on the nature of their learning experiences. Preliminary findings shed light on the distribution of cognition levels across different study activities. This data offers valuable insights into the cognitive strategies employed by students during their learning journey. This taxonomy empowers students to discern the complexity of their study efforts and encourages a diversified approach to learning. The "learning log" application marks an advancement in educational technology, providing a personalized and categorized record of students' cognitive engagement. The integration of Bloom's Taxonomy adds a layer of sophistication, enabling students to meaningfully reflect on their learning processes. As a work in progress, this paper anticipates further exploration of the application's impact on student outcomes and continuous refinement based on user feedback.

Background on Bloom's Taxonomy

Bloom's Taxonomy, a widely used framework in education, was originally proposed by Benjamin Bloom in 1956 [16]. It classifies educational objectives into six hierarchical levels within the cognitive domain, representing a progression from lower-order thinking skills to higher-order thinking skills. The taxonomy provides a structured way to design, assess, and evaluate learning outcomes. We summarize Bloom's Taxonomy and its role in assessment and learning, based on the literature provided by Tatyana V. Ramirez in 2017 [17]:

> Initially, students will begin a new subject by merely recalling information, concepts, and recognizing facts through repetition, mnemonic devices, and homework exercises. Then the student should be able to comprehend the topic enough to discuss its basic principles through examples. Soon after, the instructor may want the student to approach the assessment from an evaluation point of view, where the instructor is looking for the student to have acquired adaptive competence and critical thinking skills. Gradually, the student will be able to apply the concepts learned processing from basic to complex skills through activities like laboratories with specific feedback with the sole intention for improvement. The application of the knowledge might also then lead to analysis by exploring connections and organizing information into meaningful domains similar to writing a report. This also might include discussing discrepancies in cases and the student might explore other personal variables through their increased critical thinking [17].

The taxonomy introduces a new dimension, highlighting four types of knowledge—factual, conceptual, procedural, and metacognitive—aimed at addressing diverse facets of knowledge in learning activities. Additionally, Krathwohl's revision of Bloom's Taxonomy [14] emphasizes the evolution of the framework, underlining the significance of metacognitive knowledge. This newly introduced category reflects advancements in cognitive psychology, stressing the importance of students' awareness of their own cognitive processes—an aspect crucial for effective learning. Building on Bloom's Taxonomy, which originated in 1956 [16], the end goal has always been to contribute to the development of students' learning facilitated through a taxonomy of educational objectives and in this case, specific to engineering education. The taxonomy not only classifies educational goals but also provides precision in discussing curricular and evaluation problems. As highlighted by Bloom, the taxonomy aids teachers in defining and exchanging information about educational goals, facilitating curriculum development, and planning learning experiences and evaluation devices. It aligns with the historical context, originating from a 1948 meeting of college examiners at the American Psychological Association Convention, emphasizing the need for a theoretical framework to enhance communication among examiners and stimulate research on examining and education.

Background on Constructivist Theory of Learning

When receiving an education in engineering, students are not passive recipients of information but rather active participants in their own learning process. Constructivist Theory of Learning emphasizes that learners actively construct knowledge and understanding through their experiences and interactions with the environment. The learning log reflects a constructivist approach by empowering students to take charge of their learning experiences, providing a tool for them to actively engage with course content and reflect on their cognitive processes. Learning objectives are also critical in the constructivist approach, as they serve as guiding principles for both educators and students. There has been emphasis placed on educators defining clear learning objectives in advance [1, 15, 7]. Clear learning objectives help instructors in selecting appropriate teaching methods, planning activities, and designing assessments that align with the intended educational outcomes.

In the Constructivist Theory of Learning, the alignment between learning objectives, activities, and assessment is essential for meaningful learning experiences. This alignment with objectives that students' engagement with course content through various activities is directed towards achieving the intended learning outcomes. It also allows students to self-regulate and monitor their cognitive processes over time, contributing to a deeper understanding of the material. The collaborative and cooperative learning approaches discussed in the literature [15] emphasize the importance of teamwork and interaction among students, aligning with the social constructivist aspect of learning. Constructivist theories posit that learners not only construct knowledge individually but also socially, through interactions with peers and instructors. Activities that promote collaboration and interaction, as well as the assessment of teamwork skills, contribute to a holistic approach aligned with constructivist principles [17]. Moreover, problem-based learning and project-based learning resonate with constructivist theory [2, 7]. These approaches provide students with real-world problems, prompting them to actively seek solutions, acquire knowledge, and apply skills in a contextualized manner. This aligns with the constructivist idea that learning is most effective when individuals perceive a clear need for new information to solve a problem.

Learning Log Application

Grounding the work on the revised Bloom's Taxonomy model and the Constructivist Theory of Learning, the authors have developed a learning application that facilitates congruence between student study activities and the intended engagement with the course material. The pilot application for the learning log is a simple web-based interface that allows students to log into their student account, add courses, enter the corresponding learning activities, and time spent on the study activity. It features pre-classified learning activities for each level of Bloom's Taxonomy to aid students in labeling their study session (Figure 1).

The Constructivist Theory of Learning aligns well with the emphasis on active student engagement, self-regulation, and meaningful learning experiences. Learning objectives, activities, and assessment must align cohesively to create a conducive learning environment, as seen in the integration of the learning log with Bloom's taxonomy and the broader constructivist-oriented approaches discussed in the literature. This alignment ensures that students actively construct knowledge, develop problem-solving skills, and engage in collaborative learning experiences that go beyond rote memorization [2].

The learning log uniquely bridges the gap between metacognition, assessment, and study techniques, allowing students to track their cognition distribution over time. By doing so, students gain valuable insights into how their studying activities align with assessment requirements and learning objectives. In essence, the learning log becomes a tool for effective self-regulation, empowering students to be proactive and intentional learners in the field of engineering education.

Using the Revised Bloom's Taxonomy, recommended activities for each cognitive level were created and pre-categorized. Examples of these activities are listed in Table 1. Prior to utilizing the application, students were provided background information on metacognition, Bloom's taxonomy, and the importance of intentional learning through meaningful activities that target specific cognitive levels. With this awareness, students utilized the learning log to record the activities of the study session and duration throughout the quarter. The application provided a number of recommended pre-classified activities with the option for students to enter their own activities (to be manually classified by the instructor) if it did not exist on the list. The application was designed with the goal of enhancing engineering students' studying activities, and thus, activities that facilitated learning in engineering were prioritized and selected to be featured on the application for students. This encouraged students to participate in practices that helped them build skills within a specific cognitive level, and to enhance their learning by conciously changing activities to a higher cognitive level.

Table 1. Cognitive Levels with Example Activities Labeled.

Cognitive Level	Study Activity or Task Description
Remember	• Reread or rewrite notes or class material • Perform note recall by recalling sections of notes and concepts as a form of review • Summarize chapter, section of notes or textbook
Understand	• Using flashcards or quizzes to test your understanding of key theories or concepts • Explaining a problem or concepts to a classmate(s) (in a study session, at office hours, in class, Piazza, discussion board, etc.) • Solving practice problems with guidance and support from notes and examples
Apply	• Represent a concept or problem in a different form (graphically, equation, diagrams, explanation, verbally, etc.) • Lead and facilitate group study session to work out problems or organize concepts • Solving practice problems (from the book, notes, etc.) with minimal or no support from notes and examples
Analyze	• Classify and organize problems by concepts • Analyze case studies or real-world examples of engineering problems, identifying key factors that contributed to success or failure. • Compare and contrast different engineering theories, models, or approaches to understand their strengths, limitations, and applicability. • Create a concept map between major theories in the course and other courses
Evaluate	• Engaging in a conversation about the course topic (at office hours, with a classmate), regarding what-if scenarios and using how/why leading questions • Engage in peer review activities, providing constructive feedback and evaluating the quality and validity of classmates' work. • Evaluate the impact of different assumptions or parameters on the overall validity and reliability of theoretical models or simulations.
Create	• Creating new assumptions or new problems and solving them • Create diagrams that highlight interrelationships between concepts in class • Design an experiment to test a theory • Build a model based on design principles learned in class • Create an operations manual designed for non-experts • Design and facilitate a group study session that applies metacognitive learning activities to the content.

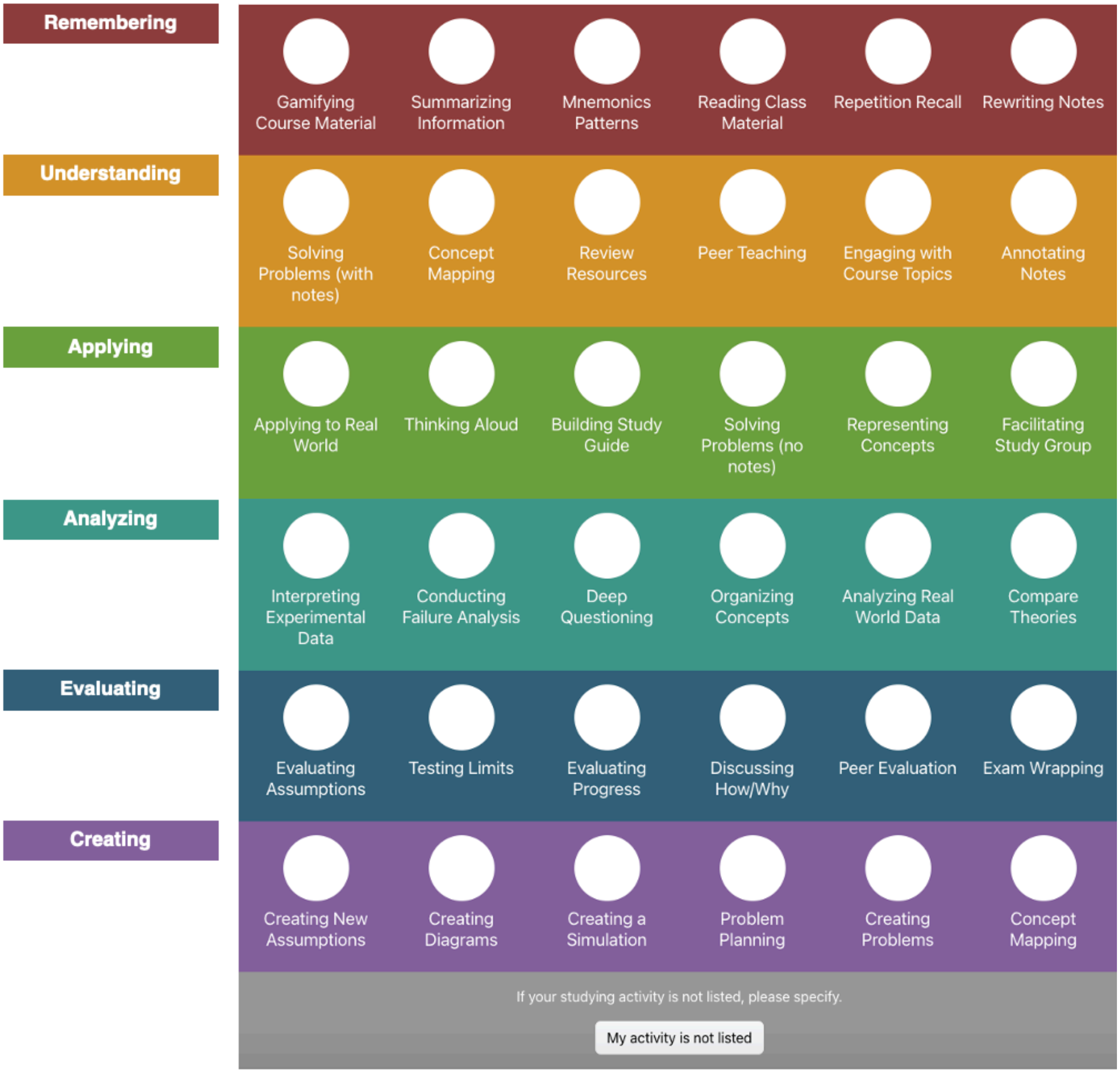

Figure 1. An image of the pilot learning application used by engineering students to track and improve studying activities.

Initial Results

120 incoming freshmen, who participated in the summer transition program, were introduced to the Learning Log in their Engineer Your Success (ENG 15) course, an academic component of the program. Students who were enrolled in the program were simultaneously enrolled in their first engineering course based on their engineering major. As an assignment in ENG 15, students logged their study activities for their engineering course over the span of two weeks (students can log more if they prefer). Figure 2 shows learning activities recorded by two different students from the same course. Figure 3 shows learning activities from groups of students in different courses. In terms of

engagement with the application, analysis showed the following statistics of student use of the application:

- Percent students logging between 0-5 days: **37%**
- Percent students logging between 6-10 days: **44%**
- Percent students logging between 11-15 days: **19%**

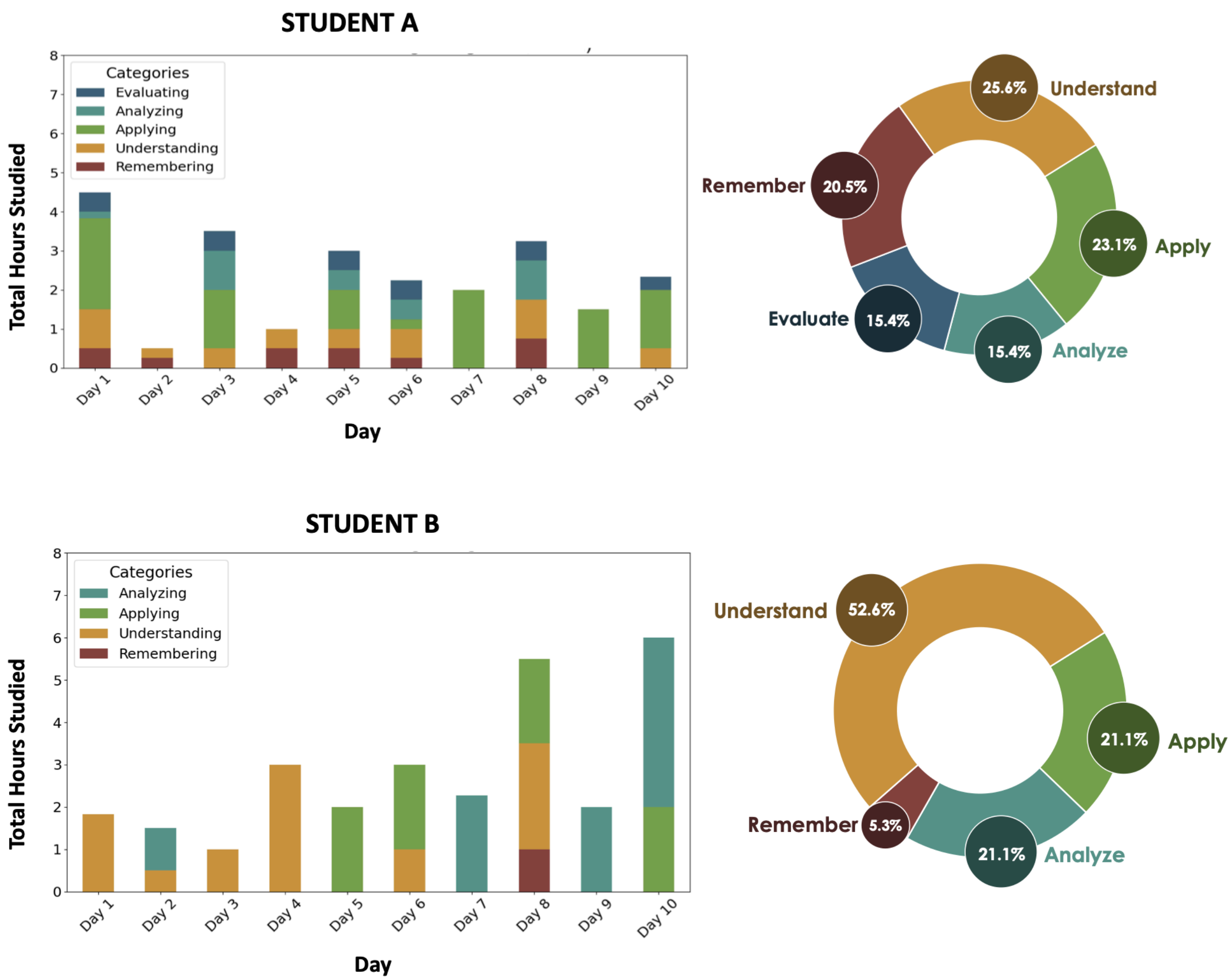

Figure 2. Learning activities from Student A (above) and Student B (below) show the differences in the amount of time spent studying over 10 days and also the different levels of cognitive engagement based on Bloom’s taxonomy.

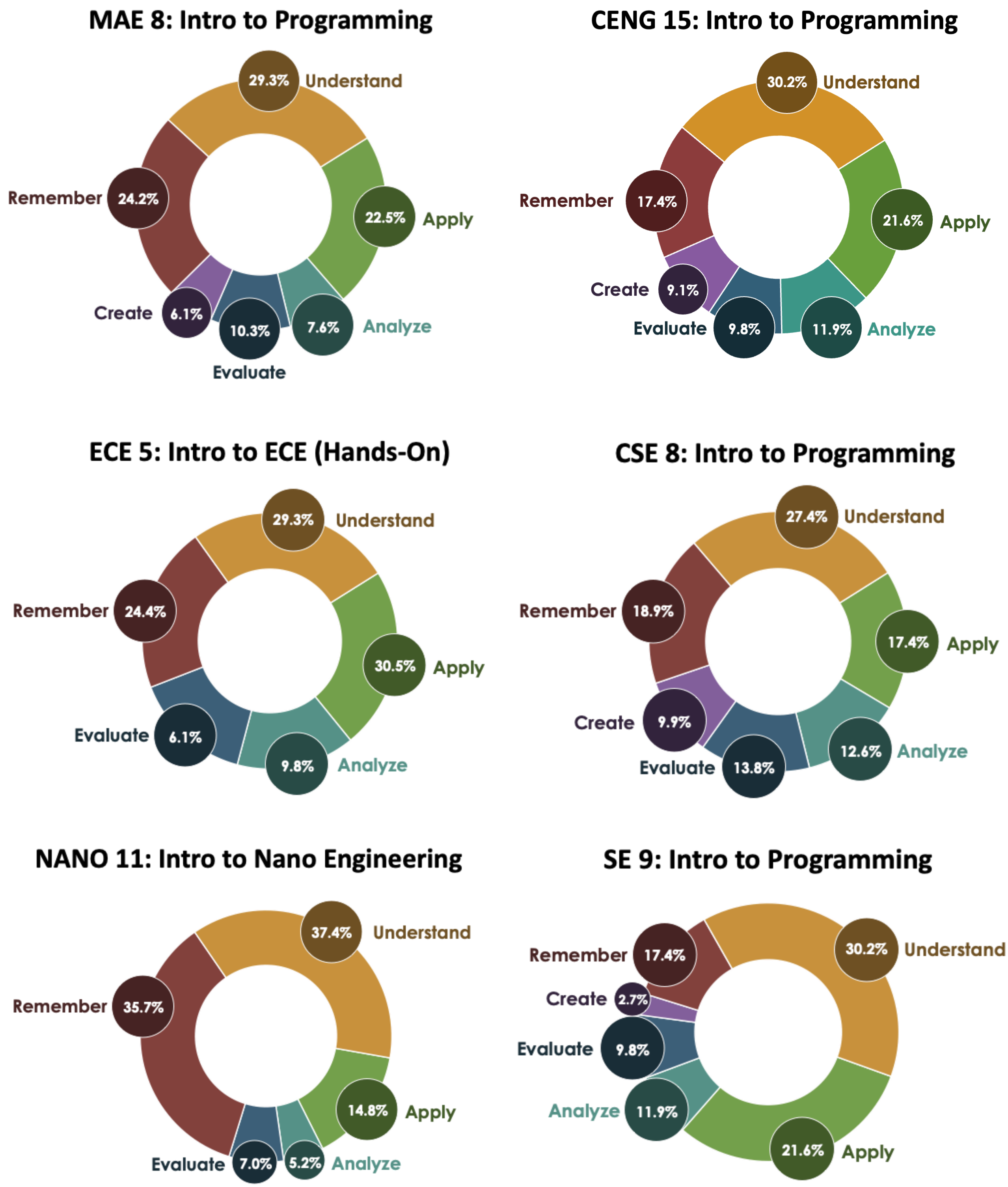

Figure 3. Distribution of different Bloom's taxonomy levels across different courses. MAE 8, CENG 15, CSE 8 and SE 9 are introduction courses to programming across four different engineering departments. ECE 5 is an introduction to electrical and computer engineering with hands-on projects and labs. Nano 11 is a lecture based introduction course to Nano Engineering.

Preliminary Feedback from Students

The preliminary student feedback has centered around the productivity and effectiveness of the app on their specific study habits. However when the students reflect and provide their feedback, they mainly focus on the interface. Initially, the interface the students were using was deemed "clunky" at best, as some students advised. The students felt that the application was not user-friendly and also noted that no clear directions were initially provided. Another point of contention was the emphasis on STEM classes with this application, rather serving the greater community. Since the first months of introducing the students to this application, there have been many improvements made. For example, the activity input times have been modified to only include a total work time per activity, as well as the ability to fully edit or remove activities that were incorrectly input. These changes had great effects on the student's cooperation to use the application. On a more positive note, the initial application presented data in an organized categorized manner. The data is presented in a color-coded chart divided by class and date. The students have reflected that the categorization and time spent per category shows what is effective on their study habits. Some suggestions for improvements have been to continue user interface improvement and provide more implications for their continued learning. This suggestion could be to include a questionnaire at the end of each entry to rate this study session's effectiveness.

Discussion

While the learning log addresses the challenges of student learning outside of the classroom and activities in alignment with learning objectives, there are many improvements to be made based on initial results. As this is a work in progress paper, we address the current challenges and lay the groundwork for future work.

Student compliance was one of the biggest challenges of the learning application. While the user interface is intuitive, compliance remains an issue as the platform (web-app) makes it difficult for students to remember to record and track. To improve compliance, a phone application or browser extension may be improved to reduce barriers and make the application more accessible. To increase student engagement with the application, gamification, notifications, or peer progress sharing may help support more consistent use of the application. Future iterations of the application to leverage personalized feedback from artificial intelligence can further support student engagement.

In terms of the categorization and labeling of the activities, certain activities are complex and may engage multiple cognitive levels of Bloom's taxonomy. The application is limited to labeling one cognitive level per activity and future improvements require more nuanced classification for blended activities. The integration and use of AI (artificial intelligence) as the backend of the application may help with improving categorization of complex activities. The current interface pre-labels activities–future iterations may evolve to allow students to enter any activity and use AI classification to distinguish cognitive levels. This significant change may improve compliance and robustness of the application.

We recognize the importance of supporting students' self-regulation and metacognition to improve their study strategies and learning approach. As a tool, the learning log will need to evolve to include reflection [18] to provide a framework for students to interpret the study data and make the adjustments to improve their learning outcomes. We anticipate incorporating reflection models such as the "What, So What, Now What, Critical Reflection Model" [18] in the form of tips, notifications, reminders to help students further align their activities with course learning objectives.

We also acknowledge the limitations of self-reporting and challenges of student-self assessment. As a tool, the learning log app is a first step to understanding students' learning outside the classroom. We anticipate for the application to be placed within the context of the classroom, where feedback and quality control from the instructional team will support students' understanding of their progress in the courses. Additional future studies to monitor student metacognitive understanding of their study practices can potentially provide clarity on student perception of learning strategies and the quality of student-led study sessions.

Lastly, another significant improvement to advance the goals of the research would be to develop an instructor-facing user interface that allows the instructors to enter their class syllabus along with their learning objectives. This facilitates alignment between the progress of the students with the course to the learning objectives. Early intervention or notification from the application to provide feedback to the students of whether they are on track to meet learning objectives in time for examinations can help students pace, focus, and redirect their learning towards more productive activities.

Conclusion

Assessment is crucial to learning as it provides a roadmap for both educators and students to navigate the educational journey effectively. Within an engineering program and its courses, degree of alignment between learning objectives and students' engagement with the material can significantly impact assessment performance results. The learning log introduced in this work offers an approach to help students target specific learning levels and to align study practices with intended learning outcomes. The learning log enables students to systematically record their studying activities, ranging from timed practice exams and homework redoing, to textbook reading and practice problems.

Most importantly, the learning log incorporates Bloom's taxonomy to label the cognition level associated with each activity, emphasizing the importance of various cognitive processes in learning. This alignment becomes particularly significant in the context of engineering education, where accreditation standards, such as those set by ABET, emphasize the integration of assessment with educational objectives to ensure the quality and effectiveness of engineering programs.

References

1. R. M. Felder and R. Brent, "The ABC's of engineering education: ABET, Bloom's taxonomy, cooperative learning, and so on," in Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition, vol. 1. American Society for Engineering Education, 2004.
2. A. J. Swart, "Evaluation of final examination papers in engineering: A case study using Bloom's Taxonomy," IEEE Transactions on Education, vol. 53, no. 2, pp. 257-264, 2009.
3. Accreditation Board for Engineering and Technology (ABET), "Criteria for Accrediting Engineering Programs 2023-2024."
4. M. Meyer and S. Marx, "Engineering dropouts: A qualitative examination of why undergraduates leave engineering," Journal of Engineering Education, vol. 103, no. 4, pp. 525-548, 2014.
5. K. Ohtani and T. Hisasaka, "Beyond intelligence: A meta-analytic review of the relationship among metacognition, intelligence, and academic performance," Metacognition and Learning, vol. 13, pp. 179-212, 2018.
6. M. Meyer and S. Marx, "Engineering dropouts: A qualitative examination of why undergraduates leave engineering," Journal of Engineering Education, vol. 103, no. 4, pp. 525-548, 2014.
7. R. M. Marra et al., "Leaving engineering: A multi‐year single institution study," Journal of Engineering Education, vol. 101, no. 1, pp. 6-27, 2012.
8. M. Hernández-de-Menéndez et al., "Active learning in engineering education. A review of fundamentals, best practices and experiences," International Journal on Interactive Design and Manufacturing (IJIDeM), vol. 13, pp. 909-922, 2019.
9. J. L. Saorín et al., "Makerspace teaching-learning environment to enhance creative competence in engineering students," Thinking Skills and Creativity, vol. 23, pp. 188-198, 2017.
10. P. Taheri, P. Robbins, and S. Maalej, "Makerspaces in first-year engineering education," Education Sciences, vol. 10, no. 1, pp. 8, 2019.
11. J. Buckley, N. Seery, and D. Canty, "Spatial cognition in engineering education: developing a spatial ability framework to support the translation of theory into practice," European Journal of Engineering Education, vol. 44, no. 1-2, pp. 164-178, 2019.
12. J. M. Laguador, "Engineering Students' Level of Study Habits and Factors Affecting Them," International Journal in IT and Engineering, vol. 1, no. 3, pp. 1-13, 2013.
13. S. A. Nonis and G. I. Hudson, "Performance of College Students: Impact of Study Time and Study Habits," Journal of Education for Business, vol. 85, no. 4, pp. 229-238, 2010.
14. D. R. Krathwohl, "A Revision of Bloom's Taxonomy: An Overview," Theory Into Practice, vol. 41, no. 4, pp. 212-218, 2002. DOI: 10.1207/s15430421tip4104_2.
15. R. Britto and M. Usman, "Bloom's taxonomy in software engineering education: A systematic mapping study," 2015 IEEE Frontiers in Education Conference (FIE), El Paso, TX, USA, 2015, pp. 1-8, doi: 10.1109/FIE.2015.7344084.
16. B. Bloom, "Taxonomy of Educational Objectives. Book I: Cognitive Domain," New York: David McKay, 1956.
17. T. V. Ramirez, "On Pedagogy of Personality Assessment: Application of Bloom's Taxonomy of Educational Objectives," Journal of Personality Assessment, vol. 99, no. 2, pp. 146-152, 2017.
18. Adams NE. Bloom's taxonomy of cognitive learning objectives. J Med Libr Assoc. 2015 Jul;103(3):152-3. doi: 10.3163/1536-5050.103.3.010. PMID: 26213509; PMCID: PMC4511057.
19. B. Brown, S. Holt-Macey, B. Martin, K. Skau, and E. M. Vogt, "Developing the reflective practitioner: what, so what, now what," Currents in Pharmacy Teaching and Learning, vol. 7, no. 5, pp. 705-715, 2015.