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WIP: Flexible Assessment Design in Engineering

Dr. Carol Subiño Sullivan, Georgia Institute of Technology

Carol Subiño Sullivan is the associate director for the Center for Teaching and Learning (CTL). In this role she supports educators through a broad portfolio of programs including workshops, short courses, consultations, learning communities and fellows groups, special events, grants, scholarship of teaching and learning, digital resources, awards and recognitions, and partnerships. In all of her efforts, her goal is to support educators in creating learning environments that support all students success. Dr. Subiño Sullivan earned her Ph.D. in cultural anthropology from Indiana University in 2012 and had taught courses in anthropology, near peer mentoring and teaching and learning in higher education at multiple institutions in the US.

Dr. Lakshmi Raju, Georgia Institute of Technology

Lakshmi Raju is the Director of Student Engagement and Well-Being, and a faculty member in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. Her focus is on initiatives and programs that foster a welcoming and inclusive student community while expanding their academic, professional, and personal development.

Ellie Madeline Pond, Georgia Institute of Technology

Ellie Pond is a PhD student at the Georgia Institute of Technology in the Electrical and Computer Engineering department. Her focus is on the implementation of new teaching strategies and course designs.

Jacob Tjards, Georgia Institute of Technology

Flexible Assessment Design in Engineering: Piloting in Undergraduate Engineering Courses

Anonymous Submission

Abstract

This Work in Progress (WIP) introduces the work of a newly formed faculty learning community (FLC), comprised of faculty and graduate students from three engineering disciplines and co-facilitated by a faculty member from the campus center for teaching and learning. Our goal is to design, implement, and evaluate the impact of flexible assessments in three large enrollment undergraduate engineering courses in Mechanical Engineering, Electrical and Computer Engineering, and Industrial and Systems Engineering. The motivation for our work stemmed from a faculty member's experience with students who, despite earning low grades on exams, demonstrate mastery of course content in other ways and later succeed in their careers. Concerned that other students might not persist after poor exam performance but still have the potential to succeed as professional engineers, our FLC formed to develop and pilot flexible assessment plans. These plans aim to give students the opportunity to demonstrate mastery over course material in multiple, substantial ways, minimizing the negative impact of poor exam scores on their grades and self-confidence. While we begin with this select group of three courses, our goal is to influence other colleagues at our institution and beyond to adopt this assessment approach. In Fall 2025, we studied the literature on flexible assessment and identified successful experiences in the field, before designing the assessments. In Spring 2026, one course piloted the flexible assessment plan, whereas the plans for the other two courses underwent further refinement. In this work-in-progress paper, we will share our insights into flexible assessments based on the literature, the three flexible assessment design plans, the one pilot and our approach to evaluating their impact. We invite dialogue on how to share our experience and expected success in order to influence other colleagues' approach to assessment.

Introduction

In this paper, we describe the ongoing work of a faculty learning community (FLC) on flexible assessment in undergraduate engineering. The FLC's purpose was to design and pilot a flexible assessment plan for three undergraduate courses in the College of Engineering. This FLC includes faculty members from Electrical and Computer Engineering (ECE), Industrial and Systems Engineering (ISyE), and Mechanical Engineering (ME) who each teach one of three undergraduate courses (2000 level courses in ECE and ISyE and a 3000 level course in ME), a faculty member from the Center for Teaching and Learning who lead the group's biweekly meetings, and three graduate students each assigned to support the development, teaching and analysis of results of one of the three courses.

One of the faculty members in our FLC had personal experiences with prior students who did poorly on traditional assessments (e.g. exam-based) but went on to lead successful engineering careers. Troubled by the misalignment between course and long-term success, this faculty member called on colleagues to consider developing an alternative approach to assessment that would support the success of a broader range of students by allowing them to demonstrate their mastery of course content through more forward-facing, realistic assessments (Fink 2003).

The group met throughout Fall 2025 to examine literature on flexible assessments and to develop the alternative assessment plans for each course. Below we describe key insights from this work and describe the three flexible assessment plans.

Flexible Assessment Design-definition, options, and impact from literature

In their meta-analysis of *Flexible Assessment in Higher Education*, Barua and Lockee (2025) synthesize the work from over 50 published articles on this topic to define flexible assessment as a learner-centered approach to assessment that offers various forms of choice to students in order to allow them to demonstrate their learning in ways that best fit their learning needs (301-302). They identify 4 approaches to flexible assessments based on cases that have been described in the literature.

1. Flexibility in Assessment Tasks: Offering students a variety of assessment tasks and models that students can choose from to make up at least a portion of the course grade.
2. Flexibility in Weighting: Students have varied degrees of control over how much each of their assessment tasks contribute to the final grade.
3. Flexible Deadlines and Number of Attempts: Students can negotiate deadlines and/or resubmit assignments based on feedback.
4. Flexible Feedback: Students choose the format for the feedback for their work.

Barusa and Lockee note that while each of these approaches has potential affordances, they warn that extra communication for clarity and planning for the extra workload on faculty are keys to successful implementation. Among our group, the first approach for providing students with flexibility in assessment tasks was most appealing because it allowed for a mix of assignments, including both exam and non-exam-based assessments (Cowan 2024, Jopp and Cohen 2022, and Garside et al 2009). Our group felt this approach would allow instructors to introduce additional ways for students to showcase their mastery while still allowing the instructor to control how much each assignment was weighted in the final grade.

In addition to flexibility in tasks, we explored the benefits of combining flexibility with gamification. Gamification refers to introducing game-like elements, such as aesthetic elements, leaderboards, quests, and points often found in video games, into non-game, including educational, contexts (Deterding et al 2011). Zhu and Baumann (2022) reported on their experience gamifying two technical courses, a freshman level Digital Design Fundamentals course and a junior level Principles of Mechanical Design Course. They administered the Situational Motivation Scale (SIMS) and found that students from all backgrounds and identities were motivated to engage in the gamified course elements because they believed them to be beneficial to their learning. and to alleviate stress and anxiety because they offset lower performance. However, they found that lower-performing students generally engaged with the gamified elements less than higher-performing students. In their review of the literature, they found that a broad range of gamification designs could be effective, from the simple use of an educational gaming tool like Kahoot to a more complex game design incorporating completion of both individual challenges and social learning activities. However, gamification is most motivating when it is tied into grading and poses less of a barrier when students can complete the game elements in their own time. Two of the course designs in our project include gamified elements and apply insights from this study.

Pilot flexible assessment designs in undergraduate engineering courses

Our group includes faculty and graduate student teams who are teaching three courses in Spring 2026:

- An Electrical and Computer Engineering (ECE) course on the Fundamentals of Digital Design (2000 level)
- An Industrial and Systems Engineering (ISyE) course on Probability with Applications (2000 level)
- A Mechanical Engineering (ME) course on Machine Design (3000 level)

One of the faculty members (from ISyE) developed the project idea and proposal and secured funding for the pilot project. He also personally invited the faculty from ECE and ME as well as the faculty member from the Center for Teaching and Learning (CTL) to join the FLC. The four faculty then collaborated to identify and recruit three graduate students to support the development, implementation, and study of the pilot flexible assessment design in each course. After spending the Fall 2025 semester studying the literature on flexible assessment in higher education, a flexible assessment plan was developed for each course.

ECE Fundamentals of Digital Design

This is a required 2000-level electrical engineering course for students majoring in Industrial and Systems Design, many of whom find the course intimidating and are often not enthusiastic about taking it. The course introduces students to the logic of digital systems present in all computers from the ground up from logic, through electricity, logic gates, and top-level design with assembly programming. The course strives to help ISyE students understand how they can apply their understanding of digital systems to their future work as Industrial and Systems engineers. This course was taught by one of the graduate students in our FLC.

The traditional assessment plan for this course includes 8 homework assignments together worth a total of 10% of the final grade, 2 labs each worth 6% of the final grade, 3 exams each worth

16% of the final grade, and 1 final exam worth 30% of the final grade. The homework assignments are done collaboratively and graded for completion. The labs require students to design a digital system to address a real-world problem and are graded for accuracy. All exams are closed book and have been traditionally used to measure how student mastery over the course material.

Flexibility is added to the assessment plan through *Pixel Pilgrimage*, an educational game that includes a menu of optional formative assessments that students can elect to complete throughout the semester. In *Pixel Pilgrimage*, each student is a pixelated avatar whose computer home crashed and ejected them from their home. They must navigate through the *Glitchlands* by completing assignments that let them collect tools to navigate through four zones each tied to one of the course modules:

1. Logic Labyrinth (Digital Logic) – A maze of flickering circuits and broken gates. Students need to solve puzzles using logic gates to find their way through the labyrinth.
2. Binary Basin (Number Systems) – A shimmering basin made up of streams of numbers, all in different bases (binary, decimal, hexadecimal). The clash of these streams yields dangerous waters, impossible to cross. It is their job to learn how to convert and manipulate the numbers so that they can pass to the other side in peace.
3. State Machine Stronghold (Finite State Machines) – A fortress whose doors only open in specific sequences. Finite state machine stand guards, demanding that students design and predict state transitions to progress.
4. Assembly Arena (Basic Assembly Programming) – A gladiatorial arena filled with corrupted code. They must wield the language of the land, assembly programming, to rewrite instructions and vanquish your enemies.

Each *Pixel Pilgrimage* assignment that students choose to complete earns them *Pixel Points* (PP). The syllabus details how many PPs each type of assignment is worth (ranging from 1 for participation question to 60 for boss battles (multi-step problems that incorporate information from the whole zone). These assignments are based on well-established active learning and formative assessment exercises in the literature on teaching in higher education.

Students earning 90% of total *Pixel Points* can replace their lowest exam score with their highest exam score. Students earning 70% of total Pixel Points can replace their lowest exam score with their second lowest exam score. While the final exam score cannot be replaced (even if it was the lowest exam score), the final exam score can replace another exam score. In addition, the top three ranked students on the leader board earn bonus points on the final exam score.

ISYE Probability with Applications

This is a required, 2000-level course for students pursuing a degree in Industrial and Systems Engineering. The course introduces students to topics including conditional probability, density and distribution functions from engineering, expectation, conditional expectation, laws of large numbers, central limit theorem, and introduction to Poisson Processes. Students learn to define and compute probabilities, measures of location and spread, and distribution functions for functions of random variables; compare and contrast the basic probability distributions; use and justify the Central Limit Theorem to approximate probabilities related to sums of independent, identically distributed random variables; analyze and discuss how randomness affects a system's behavior and performance; and model and analyze probability problems at the level of the news-vendor problem.

The traditional assessment for this course includes *Fun Quizzes* worth 20% of the final grade, 3 *Midterm Exam Reflections* together worth 5% of the final grade, *3 Midterm Exams* (MTE1, MTE2, and MTE3) each worth 15% of the final grade and the *Final Exam* worth 30% of the final grade. Students are also assigned problem sets to complete outside of class, but these assignments are not graded or reviewed by the teaching team. Instead, students have access to the rubrics online in order to self-correct their work.

For the flexible assessment design, the instructor wanted to ensure the new assessment had the following characteristics: (1) students can complete the assignment outside the classroom to reduce exam pressure, (2) students demonstrate their understanding of the content by explaining it to others, and (3) assignments include a more applied component that connects to their future work.

In the flexible assessment design, students could choose from three different paths:

- Path A: Replaces part of their quiz grade with smaller assignments
- Path B: Replaces **one** Midterm Exam with an applied assignment.
- Path C: Replaces MTE2, MTE3 and the Final Exam with a Progressive Probability Project

Table 1 shows the details of the suggested paths and assignments. It is important to note that students cannot combine Path B and Path C.

Table 1: Proposed Alternative Assessment Plan for ISyE Probability with Combinatorics

Pathway	Student Option	Weight	Format	Replaces	Timing
A	A1. Probability in Action Video Explainer	5%	Pairs	5% of Fun Quizzes	Early semester
A	A2. Probability in the News	5%	Individual	5% of Fun Quizzes	Early semester

A	Complete both quiz alternatives (A1+A2)	10%	Mixed	10% of Fun Quizzes	Early semester
B	B1. Applied Combinatorics & Conditional Probability Challenge	15%	Individual or pairs	Exam 1	Week 6
B	B2. News-Vendor Problem Challenge	15%	Individual	Exam 2	Mid-semester
B	B3. Discrete RV Interactive Tool	15%	Pairs	Exam 2	Mid-semester
C	Progressive Probability Project	60%	Groups (max. 3)	Exam 2 + Exam 3 + Final Exam	Across semester

Although students who took this class in Spring 2026 were offered these alternative assessment paths, no students chose to take the opportunity. All students chose to complete the traditional, exam-based assessment plan. The instructor plans to revisit these plans and consider how to better engage students in considering the benefits of alternatives in the next offering of the course.

ME Machine Design

Building on prerequisite introductory courses on stress/strain analysis, materials, and structures, this 3000-level course (required for students pursuing the Design Concentration of the Bachelor of Science in Mechanical Engineering) introduces methods for analysis that answer questions of why and how components fail in general before shifting to focus on modes of failure of specific components and considerations for component selection.

The traditional assessment plan of this course includes 2 midterm exams, each worth 20% of the final grade, 1 final exam worth 25% of the final grade, 10 quizzes worth 2% each for a total of 20% of the final grade, and 10 homework assignments worth 2% each for a total of 20% of the final grade.

Three flexible assessment options were integrated into the course:

1. While homework is still mandatory, a student can boost their scores with "Core Concept Games." This game includes questions that students answer on a digital platform (very similar to the popular platform, Kahoot). Students can complete these games at a student's convenience and can be retaken as many times as they want. If students make perfect score on one of these games, they will add ~30% to a homework grade.

2. The quizzes can be replaced with "Real-World Analyses."* These are representations of the quiz problems based on situations that one could find out and about in their daily lives. The process to solve them is very similar to each of the quizzes, but they require a bit of additional thought and analysis than simply getting the correct answer.
3. Lastly, a student can opt out of an exam to complete a "large scale independent project" instead. These projects include very involved problems that allows for complete, cumulative demonstration of understanding the material. Submissions could either be a report or a recorded presentation.

These options provide students with both flexibility to replace traditional quizzes and exams as well as provide strategic practice for assessments and future careers. The tasks are generally more difficult than what would be covered on exams, however it is the authors' belief that the removal of a time limit, unlimited attempts, and access to external resources that would be available in a workplace will allow students to demonstrate mastery over the material without having to take a traditional assessment. This course was not piloted in Spring 2026 in order to allow more time for the alternative assessment items to be developed.

Concerns regarding misuse of AI to complete flexible assessments

As we considered flexible assessment design options, serious concerns about the negative impact of student use of artificial intelligence emerged. We are concerned that students will use AI dishonestly in order to complete the flexible assessments, thus artificially boosting their grade. We discussed options for preventing students from using AI in this way, with few satisfying options, even though our institution has developed guidelines for ethical use of AI. We had difficulty moving past the real possibility that many students will choose to cheat in this way when completing assignments outside of class and thus artificially boosting their grades. Corbin, Dawson and Liu (2025) lend support for this concern, urging instructors to accept that even the best written policies on artificial intelligence use are ultimately unenforceable and that we should assume students are using AI to some extent in take-home assignments (which they dub, “open.”). Instead, they argue that instructors should build validity into assessment architecture by including secure (proctored) assessments to motivate student integrity on open assessments.

Next steps

For the one class we were able to pilot in Spring 2026, we will invite students who consent to participate in our study will be invited to complete a survey following the course* where they answer questions about how the flexible assessment options impacted their learning experience, including interest, motivation, clarity, stress and final course grade. A select number of students will also be asked to participate in a focus group. Results that are available by the conference deadline will be shared in our poster.

We will also include reflections from the instructor of the ECE course on how the flexible assessment plan approach associated grading impacted workload. We will share strategies that we identified to make the workload sustainable as well as any further changes we make to the assessment plans because of concerns over workload.

For the courses that we have not yet piloted, we will continue to develop the alternative assessments. In addition, we will further explore the question of how to make flexible assessment workable given the concerns about student use of AI discussed above. We will need to develop assessment plans that are not only flexible but that still provide validity in assessing student learning.

We plan to share our experiences, including useful models of flexible assessment, with colleagues in order to promote broader adoption of flexible assessment in order to better support student success in the College of Engineering.

*A QR code will be placed on the poster that links to a DropBox folder that includes examples of the flexible assessments as well as the survey and focus group questions.

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