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AI in Teaching: Evaluating Open-Ended Projects Using an AI Chatbot

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TT&T: AI in Teaching: Evaluating Open-Ended Projects Using an AI Chatbot Quiz

Abstract

A senior level Mechatronics Design course in the Department of Mechanical Engineering was launched in Fall 2025 and organized around the 2026 ASME Student Design Competition. Because students worked on distinct subsystems within open ended team projects, consistent formative evaluation of individual understanding was challenging. To support this need, an AI assisted “AI Chatbot Quiz” was implemented using a custom chatbot built on the Google Gemini API and guided by course materials, student project proposals, and competition rules. During a timed conversational quiz, the chatbot asked probing questions, provided supportive hints when needed, and encouraged reflection on design decisions. Chat transcripts were submitted for review, and six students completed an immediate post quiz survey. Results suggest the format was engaging and supported critical thinking, while student comfort and preference relative to traditional evaluations were mixed. Lessons learned highlight the feasibility of AI assisted conversational evaluation in design courses, along with practical needs for clear expectations, subsystem alignment, and transparency in grading.

Introduction and Motivation

Open ended design courses are essential to mechanical engineering education, yet they present persistent challenges for fair and meaningful evaluation [1], [2]. In senior level mechanical and mechatronics design projects, students often pursue highly diverse technical pathways that span mechanical design, controls, sensing, machine vision, and embedded programming. While this diversity is pedagogically valuable, it complicates evaluation. Traditional approaches such as standardized rubrics, final demonstrations, and written reports can struggle to capture individual understanding, contribution, and conceptual mastery across varied subsystems [2], [3]. These challenges are further compounded by time constraints and the instructional effort required to provide detailed, individualized feedback at scale. As a result, instructors are often required to balance depth of evaluation against feasibility, sometimes at the expense of student engagement or perceived fairness.

To explore alternative approaches, a senior level Mechatronics Design course experimented with AI assisted conversational evaluation as a supplement to traditional methods. Rather than serving as an automated grader, a custom AI chatbot was designed to function as a personalized reviewer and advisor. The chatbot engaged students in dialogue about their chosen subsystem, posed probing conceptual questions, provided guidance when students encountered difficulties, and offered hints grounded in relevant engineering principles. This approach was implemented as a formative evaluation activity, structured as a quiz, and assessed using a four level alternative grading scale (Exemplary, Meets Standards, Revision Needed, Not Assessable). The primary goal of this pilot effort was not to validate grading accuracy, but to examine the feasibility of integrating AI assisted conversational evaluation into an open ended design course and to observe student engagement and perceptions. This paper describes the design and implementation of the approach, reflects on its successes and limitations, and shares lessons learned for educators considering AI assisted evaluation in similar instructional contexts.

Course and Project Context

The Mechatronics Design course is a senior level elective offered by the Department of Mechanical Engineering that was launched in Fall 2025 and structured around participation in the 2026 ASME Student Design Competition[4]. The competition task required teams to design, fabricate, and test a device capable of autonomously collecting, sorting, and delivering colored cube shaped waste within a constrained environment. Due to course time constraints, the project scope was adapted to focus only on the collection and sorting functions rather than a full end to end competition implementation. The open ended nature of the competition still allowed for multiple viable system architectures and design strategies, encouraging creativity while introducing substantial variability in technical focus.

Two student teams were organized, with each team addressing distinct subsystems within its project. Common focus areas included mechanical structure and gantry design, actuation and motion control, sensing and machine vision, and embedded system programming. While teams collaborated toward an integrated system, individual students assumed primary responsibility for one or more subsystems. This structure was intentionally adopted to promote depth of learning and individual ownership, but it also created challenges for evaluation, as student contributions and learning outcomes differed significantly across teams and technical domains.

Course assessment traditionally relied on a combination of design reviews, final system demonstrations, and written documentation. While these methods effectively captured overall system performance, they provided limited insight into individual conceptual understanding and decision making, particularly for students working on less visible subsystems such as sensing algorithms or embedded software. To address this gap, the course incorporated an AI assisted conversational evaluation activity as a formative assessment. The activity was implemented mid semester as a quiz focused on each student's designated subsystem, with the goal of eliciting reasoning, design rationale, and conceptual understanding in a pressure reduced setting. Immediately after the quiz, students completed a brief survey to capture perceptions of the chatbot experience, including engagement, fairness, and usefulness.

AI Chatbot Design and Implementation

A custom AI chatbot was developed using the Google Gemini API (gemini 2.5 flash). The chatbot was configured to support formative evaluation in an open ended design setting by conducting a timed, structured conversation with each student. To align the chatbot's questioning with the course and competition context, it was provided with course specific reference materials, including student project proposals (an earlier course assignment), candidate design descriptions, and the ASME Student Design Competition rules and rationale.

The conversational quiz was delivered through a web based chatbot interface accessed via a link. Students completed the evaluation within a 30 minute time limit, followed by an additional 5 minute window to download the chat transcript and upload it to Canvas as their quiz submission. This workflow ensured that each student's interaction could be reviewed consistently and archived for later analysis, while keeping the assessment process feasible within a standard class period.

The chatbot's role was explicitly framed as an experienced, supportive mechatronics design engineer and an official style reviewer for the ASME Student Design Competition. Its primary objective was to assess student understanding while also providing actionable mentorship. The conversation was designed as a learning exercise, with questions distributed across subsystems and follow up questions used to probe reasoning and design rationale. The chatbot maintained a professional and encouraging tone and included a mentorship rule: when a student provided a weak or incomplete response, the chatbot gently guided the student by asking a leading question or referencing an appropriate engineering principle, then continued probing with additional questions. Students were also allowed to type "skip" or "move on" at any time, in which case the chatbot acknowledged the request and transitioned to a different topic.

The overall intent of this design was not only to collect evidence of understanding, but also to promote student critical thinking and learning through iterative questioning and guided explanation. Screenshots of the chatbot interface and an example conversation are provided to illustrate the student experience and the style of interaction.

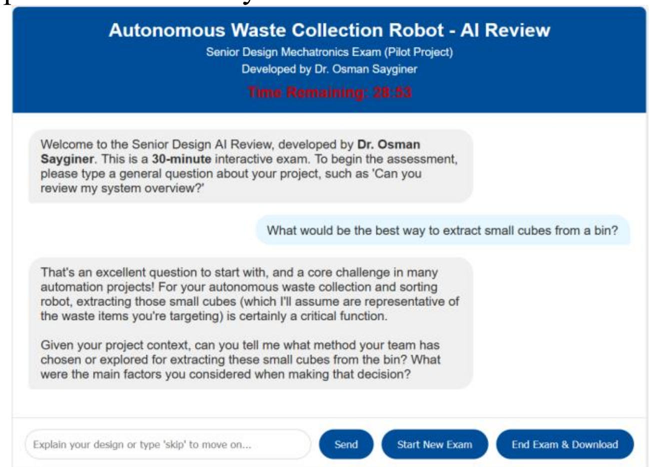

Figure 1 Graphical User Interface of the AI Chatbot

Results and Discussion

Six students completed the post quiz survey immediately after the AI Chatbot Quiz, with quantitative results summarized in Figure 2. Overall, responses indicate that students found the AI assisted evaluation usable and engaging, while expressing more mixed views regarding comfort and preference compared to traditional assessments. As shown in Figure 2, most students agreed that the conversation pace was appropriate and that questions were clear and spanned relevant project subsystems. Students also agreed that the conversational format encouraged critical thinking and reflection on design choices, and most reported that the AI provided useful, actionable guidance when they struggled. In contrast, comfort interacting with the AI compared to a professor or teaching assistant was split across disagree, neutral, and agree, and preferences for the AI format over written or oral exams were similarly divided. No students disagreed that the AI treated them fairly, although responses clustered around neutral and agree, suggesting cautious acceptance during a first exposure to this evaluation format.

Consistent with the Tinkerer's Triumphs and Tragedies format, these results are framed as early lessons learned from a first implementation rather than generalizable findings. The main "triumph" was that the Chatbot Quiz supported a structured, subsystem focused dialogue that many students found engaging and helpful for clarifying reasoning. The main "tragedy" involved expectation setting, including uncertainty about how much detail to provide, how broadly the chatbot might probe beyond a student's subsystem, and how performance would be evaluated.

Open responses reinforced these trends and provided examples of how the AI's follow up questioning supported learning. Students reported that the chatbot helped them identify weaknesses and strengthen arguments by prompting clarification of subsystem decisions and by encouraging systems level connections, such as tradeoffs between IR and ultrasonic sensing, the role of backlash in mechanical transmission, and links between software algorithms, motor microstepping, and hardware behavior. Several students also described the experience as low pressure and less anxiety inducing than traditional evaluations. Reported frustrations were primarily related to scope and expectations rather than technical issues. Students noted uncertainty about how much to proactively explain beyond what the AI asked, and in some cases the chatbot pursued questions outside a student's primary subsystem, which revealed knowledge gaps but also created uncertainty about what was expected within the time limit. Most students stated they would recommend the AI Chatbot Quiz because it was interactive and allowed them to express their subsystem knowledge in writing, but responses also suggested that transparency about grading and repeated exposure may be needed for broader acceptance. Preferences for the most accurate senior design evaluation remained mixed across live oral exams, AI conversational review, and written reports, supporting the use of AI assisted conversational evaluation as a complement to instructor led assessment in open ended design courses.

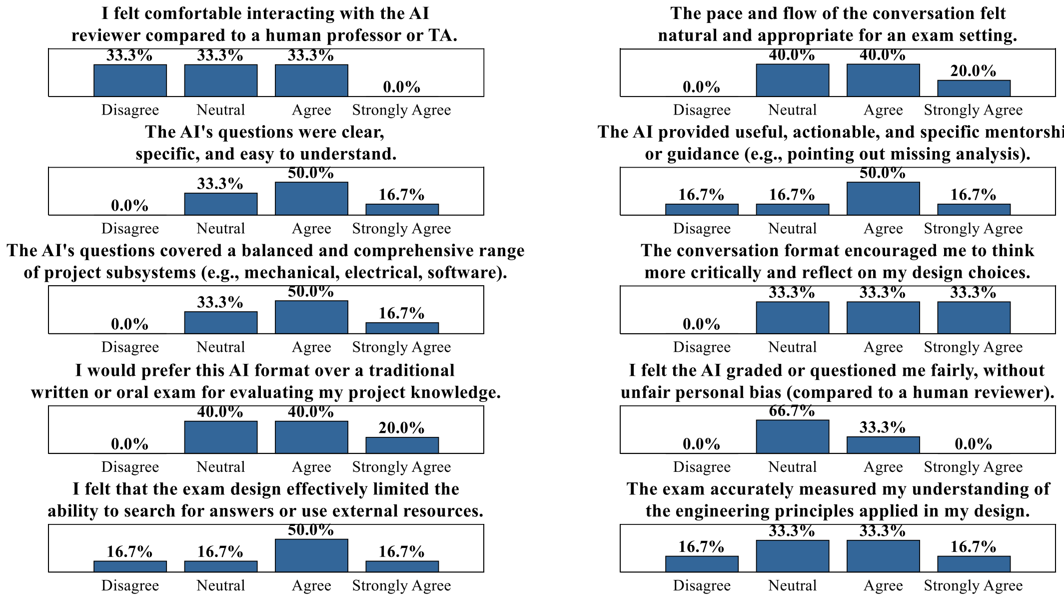

Figure 2 Student responses to survey questions on the AI Chatbot Quiz.

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