Design of Effective Case Studies and Reflections Using AI for Higher-order Skills

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***Abstract*— Modern classrooms are shifting toward active, problem-based learning to prepare students for complex, interdisciplinary challenges, emphasizing higher-order thinking skills such as analysis, evaluation, and creation. Integrating AI in case study design enables dynamic, real-world scenarios, personalized feedback, and adaptive exploration, helping students move beyond rote knowledge to applied understanding and professional problem-solving. This study employs a model for AI-assisted case study design centered on threshold concepts, where faculty identify known and unknown aspects of a concept, its applications, and relevant principles, which are then used as prompts for LLM-generated case studies. Reflection questions are generated using Bloom's Taxonomy to assess individual understanding, engagement, and higher-order thinking. Short assessments ensure that all students actively participate and internalize the concepts. The research investigates: How does AI-supported, threshold-concept-based case study design impact student engagement, reflection, and higher-order cognitive skill development in complex learning scenarios? Faculty workshops across India trained educators to use AI for designing case studies in diverse disciplines, reaching around 500 participants. Feedback collected from one of the workshops indicated high satisfaction, with participants gaining confidence in applying AI tools and reflection-based assessments. Case study assessments, guided by taxonomies, promoted real-world application, higher-order thinking, and collaborative engagement, enabling faster evaluation of student competence.**

***Keywords*—Artificial Intelligence; Case Studies; Problem Solving; Reflections; Taxonomies.**

***ICTIEE* Track— Emerging Technologies and Future Skills**
***ICTIEE Sub-Track*—Incorporating GenAI Era competencies into assessments**

I. INTRODUCTION

CLASSROOMS have shifted from passive knowledge delivery to active, inquiry-driven learning. The swift growth of technology and interconnected systems has created problems that are complex, dynamic, and interdisciplinary (Nokes, 2022). Traditional textbook exercises fall short in preparing students for such realities. Problem-based and case study approaches bring real-world challenges into classrooms, encouraging critical thinking, creativity, and decision-making. Engineers of the future must handle uncertainty, incorporate diverse knowledge areas, and design solutions that balance the efficiency with ethical and social responsibility. Classrooms that engage with authentic problems create learners who are adaptable, resilient, and capable of addressing evolving global level challenges.

Artificial Intelligence (AI) is transforming classrooms by making complex, real-world problem scenarios more accessible and engaging. Large-scale data analysis, intelligent simulations, and adaptive platforms allow students to explore diverse perspectives and test multiple solution pathways. Case studies enriched with AI tools reflect the uncertainty and interconnectedness of actual engineering challenges. Personalized feedback supports deeper understanding and automated systems free time for higher-order exploration. Engineers of tomorrow will be expected to design, analyze, and refine solutions with AI as a collaborative partner. Integrating AI into problem-based learning assures that students gain both technical expertise and the capacity to adapt to evolving complexities (Dimitriadou & Lanitis, 2023).

Higher order thinking skills are essential in preparing students for the complexity of modern challenges. Bloom's taxonomy highlights analysis, evaluation, and creation as the three key levels that drive advanced learning. Analysis allows learners to break down problems and recognize hidden patterns, evaluation builds the ability to judge alternatives with clarity, and creation empowers them to design innovative solutions. When classrooms use real-world problems and AI-driven tools, these skills become central to the learning experience. In professional life, engineers must constantly analyze systems, evaluate trade-offs, and create solutions that are sustainable, ethical, and effective in dynamic environments (Lewis & Smith, 1993).

Designing effective case studies is essential because they direct learners toward specific outcomes and higher order thinking. Case studies bridge theory with practice, enabling students to engage with real contexts that demand analysis, evaluation, and creation (Yin, 2003). With vast information readily available through LLMs, the emphasis must shift from recalling facts to interpreting, questioning, and applying knowledge. AI can support this shift by helping educators craft scenarios aligned with learning goals, simulate complex environments, and provide adaptive feedback. Case studies that integrate AI tools reshape the classroom into a space where learners build judgment, creativity, and the professional

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problem-solving capacities. The changing nature of classrooms, the rise of AI-driven learning, and the demand for higher order skills make it essential to rethink instructional practices.

Real-world problems require engineers who can analyze, evaluate, and create solutions with agility and responsibility. AI provides the tools to design case studies that are dynamic, targeted, and relevant, helping learners move beyond information recall toward meaningful application. Reflections built into these case studies deepen understanding and encourage critical self-assessment. Effective integration of AI ensures that education aligns with the complexity of modern challenges, preparing students to excel in professional and societal problem-solving. And this, stands as a motivation for this presented work. Designing case studies around challenging ideas helps students engage more deeply with course content. When paired with data-driven course design and continuous feedback, this approach ensures learning is guided by real student needs, supports steady progress, and creates a curriculum that adapts to improve both understanding and skill development. The changing nature of classrooms, the rise of AI-driven learning, and the demand for higher order skills make it essential to rethink instructional practices. Case studies designed with AI can focus on future skills, guaranteeing learners practice problem-solving.

II. Literature Survey

This section presents the literature survey on the areas of case study design, usage of AI in classrooms, higher order thinking and different taxonomies that can guide us.

Many engineering programs miss addressing several ABET 3(a–k) criteria, even though good assessment methods are widely encouraged. Case studies have been shown to build higher-level thinking, and the discussions have been happened on ways to measure their impact, the challenges involved, and the need for more research to find the best approaches (Shankar et al., 2008). Case studies in engineering help students connect theoretical concepts with real-world applications, making learning more practical and engaging. They also encourage independent thinking, teamwork, and problem-solving skills that are vital for professional practice (Davis & Wilcock, 2004). A study comparing case study and lecture-based approaches in software engineering education found that case studies are more effective and engaging for achieving cognitive, skill, and metacognitive goals. The findings highlight how case studies bridge the industry-academia gap, prepare students for real-world practice, and provide strong evidence for their inclusion in the curricula (Garag & Varma, 2007). The way a problem is first defined shapes the solutions that are considered and the results that follow. Errors in problem identification can limit effective interventions, especially when the framing is too broad or mismatched to the real issue. Greater attention to problem framing is essential in any problem-solving process, as it directly affects both understanding and action (Payne et al., 2013). Design of case studies and reflections for a problem based learning course has been studied (Hegade & Shettar, 2024) and has also been experimented using Dublin Descriptors (Hegade & Shettar, 2024).

AI can help teachers use proven teaching methods that usually take a lot of time and effort to apply. It can make tasks like giving examples, fixing misconceptions, small quizzes, checking learning, and practice over time easier, becoming a useful tool when used carefully (Mollick & Mollick, 2023). AI changing classroom practices has improved both teaching and administration, with tools like chatbots, robots, and automated grading helping teachers save time and increase efficiency. It also personalizes lessons for individual students, leading to stronger engagement, better learning, and higher overall quality of education (Pasham, 2024). AI in Education has grown greatly over the past 25 years, with research showing how teaching methods, teacher collaboration, and new tools continue to evolve (Harry, 2023). Studies have reviewed what current AI in education can realistically achieve, how different systems are understood and used, and where misconceptions and roadblocks continue to limit their impact (Holmes & Tuomi, 2022). Future directions include improving current practices and creating innovative ways to integrate AI into students' daily lives, making learning more connected to their communities and goals (Tulli, 2022).

Taxonomies can guide case study design by clearly outlining levels of learning, helping educators target skills like analysis, evaluation, and creation. When AI is used to generate case studies, these taxonomies confirm the content aligns with specific learning goals and supports higher-order thinking. Taxonomies provide a strong base for designing meaningful case studies, as they guide learning at different levels and ensure structured growth. Bloom's taxonomy helps case studies move from remembering concepts to analyzing, evaluating, and creating solutions to complex problems (Forehand, 2010). Fink's taxonomy adds dimensions like caring, human interaction, and learning how to learn, making case studies connect knowledge with personal growth and real-world values (Barnes & Caprino, 2016). The SOLO taxonomy shows how understanding develops from simple recall to deep, connected knowledge, which case studies can gradually build (Bigg & Collis, 2014). Marzano's taxonomy highlights processes such as classifying, comparing, and decision-making, encouraging practical and action-oriented thinking within cases (Marzano & Kendall, 2006). Anderson and Krathwohl's revised taxonomy clarifies stages like applying and analyzing, which case studies can map into activities that push learners toward deeper engagement (Wilson, 2016). Miller's pyramid of clinical competence demonstrates progression from knowing to doing, and case studies can simulate real practice to strengthen competence (Al-Eraky & Marei, 2016). These taxonomies can ensure that case studies designed can target higher-order skills while staying structured, meaningful, and relevant to professional growth.

AI can support the creation of case studies that build higher-level thinking, problem-solving, and decision-making skills while keeping learning structured and meaningful. Well-designed cases can engage learners with real challenges, encourage reflection, and prepare them for professional growth. There is a strong need to use a conceptual framework that guides how to design such case studies effectively. Most existing studies highlight the value of case studies and the promise of AI in education, but there is limited evidence on how AI can systematically support threshold-concept-based case study design to deepen engagement and higher-order thinking. There is also little research on how educators actually adopt and implement such AI-supported designs at scale, especially across diverse Indian classrooms, leaving a clear gap for investigation.

III. Methodology Design

This section outlines the methodology adopted for the study, detailing the conceptual framework, the model applied, and the specific methods employed to carry out the work.

A. Liminality - Conceptual Framework

Liminality, as a conceptual framework, provides a powerful way to design case studies that guide learners through the space between the known and the unknown (Thomassen, 2015). In this transitional zone, students confront uncertainty, reflect on prior understanding, and build new perspectives. Case study design can deliberately create these in-between experiences by starting with familiar contexts and gradually introducing complex, unfamiliar elements. AI can be used to generate prompts that extend this journey, posing layered questions and scenarios that challenge learners to cross thresholds of understanding by mixing with right taxonomy. This approach can strengthen higher-order thinking.

B. Threshold Concepts

Threshold concepts are important ideas in a subject that, once understood, completely change how students see and think about the topic (Cousin, 2006). They are often tricky, confusing, or uncomfortable at first, but crossing them opens the door to new ways of problem-solving and deeper learning. Because of this, case studies are very useful for teaching threshold concepts. When students work on a case, they deal with real or realistic situations where the difficult idea is hidden within the problem. This gives them space to struggle, reflect, and slowly move from confusion to clarity. Designing case studies in this way helps students move past surface learning, build confidence with complex ideas, and prepare for professional challenges that demand flexible and deeper thinking. This journey from confusion to clarity connects directly to the idea of Liminality, where learning happens in the space between the known and the unknown.

C. Research Question

Designing case studies around threshold concepts allows students to navigate the space between known and unknown ideas, enabling deeper understanding and higher-order cognitive skills such as analysis, evaluation, and creation. Integrating AI into this process provides a powerful tool for faculty, enabling rapid generation of contextually relevant, student-centered case studies while saving significant time and effort. These AI-supported case studies also encourage active engagement, reflection, and collaboration among students, promoting the transfer of knowledge to new and unfamiliar contexts. Combining thoughtful pedagogy with AI efficiency, educators can better align learning activities with desired outcomes and ensure meaningful, measurable learning experiences. And this motives to articulate the research question as presented below.

Research Question: "How does AI-assisted case study generation, guided by threshold concepts and appropriate taxonomies, impact students' higher-order cognitive skills, engagement, and understanding of complex concepts in a course?"

This research explores how AI-assisted, taxonomy-driven case studies based on threshold concepts affect students' higher-order thinking, engagement, and understanding of complex concepts. It examines whether such case studies enhance analysis, evaluation, creation, and real-world problem-solving while bridging known and unknown knowledge. Different taxonomies guide AI-generated case studies to target varying cognitive levels, influencing how students engage with and understand complex concepts.

D. Model Design

The model deigned can be seen in Figure 1 below, inspired by the need and conceptual framework.

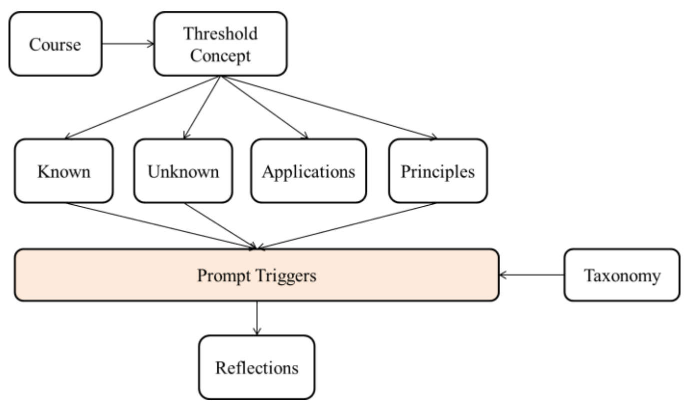

Fig. 1. Model for the design of Case Studies

Course faculty begins by identifying all threshold concepts relevant to the course they are teaching. A case study is then designed around a selected threshold concept based on instructional needs. For the chosen concept, faculty lists its known aspects, unknown aspects, real-world applications, and underlying principles. These elements, together with an appropriate taxonomy, serve as prompts for generating the case study using a large language model (LLM). Table I provides descriptions for each component.

TABLE I
Model Components

Item	Description
Course	The course for which the case studies will be designed
Threshold	The threshold concepts of the course and

Concept	select one for case study generation
Known	What do students know about this concept? This can be technical or non-technical. What social concepts can they relate to? If we think of this concept with respect to real world phenomenon, what do they already know? Is there any already known concept of the course that can help? Make list of all such known elements.
Unknown	What are the concepts and areas that students will have to explore? What is that they do not understand?
Applications	List all the real world applications of the selected concept.
Principles	List all the principles that relate to the concept under study.
Taxonomy	Select the right taxonomy for the case study generation.
Reflections	Reflection questions to ensure proper understand of the case study and course concept.

Table II below presents on how each of the element will be used for the case study generation.

TABLE II
COMPONENT USAGE

Item	Written by	Place Holder ID
Course	Faculty	P1
Threshold Concept	Using LLM	P2
Known	Faculty	P3
Unknown	Faculty	P4
Applications	Faculty + LLM	P5
Principles	LLM	P6
Taxonomy	Faculty	P7
Reflections	LLM	NA

P1 denotes the course name specified by the faculty, with subsequent placeholders adjusted accordingly. To identify threshold concepts, the faculty is required to provide the following prompt to the LLM:

"List all the threshold concepts for the course [P1]. Only make a list. Do not provide description."

From the generated list, the faculty selects one concept and articulates its known and unknown aspects, as outlined in Table I. While potential applications may also be obtained through the LLM, these serve only as supplementary references and are not directly employed in case study construction. The subsequent step involves issuing the prompt:

"List all the principles related to the concept P2."

The LLM typically returns an extensive list of principles, from which the faculty must identify the most relevant (denoted as P6). For instance, when the concept Depth First Search is provided, the LLM may generate more than twenty associated principles. Faculty judgment is therefore essential in selecting the most meaningful principles, whether singular or multiple, as this decision significantly shapes the formulation and effectiveness of the case study.

Once all the components are ready, we give the final prompt to LLM as:

"Generate me a case study for the concept [P2].Here is what my students know: [P3] and here is what they don't know: [P4]. Use [P6] principles for the case study. Use the [P7] taxonomy for the case study generation. The case study must be relatable to current generation students. Do not use any technical terms".

The prompt may be modified as necessary to align with the specific course requirements and intended learning outcomes. It serves only as a template for generating a suitable case study. In instances where the generated case study is not contextually relevant, one of the listed applications may be chosen instead. Case study generation may also be explored using different taxonomies. It is recommended that Bloom's taxonomy not be employed for this purpose; alternative frameworks such as SOLO or Fink are suggested.

The flow of the process is presented in Figure 2 below.

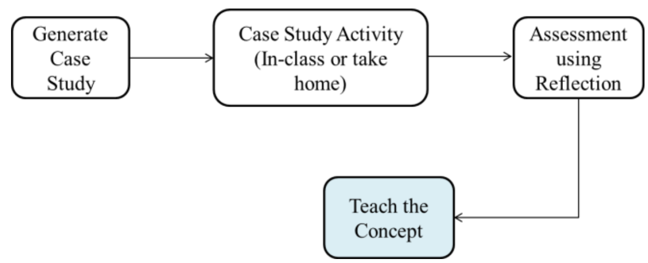

Fig. 2. Activity Process Flow

As illustrated in the figure, the process begins with presenting the designed case study as take-home or in-class activity. To ensure that all team members have understood it, a short assessment test is conducted. For this purpose, Bloom's taxonomy can be applied, as it aligns with the intended learning outcomes and facilitates attainment mapping. The prompt used for generating reflection questions is: "I want to make sure that my students have understood the case study well. Give me 3 short reflection questions and use Bloom's taxonomy for this." Following this activity, the related concept can be introduced. This approach provides an effective way to address the threshold concept.

IV. RESULTS AND DATA ANALYSIS

Workshops were organized across India to train faculty in applying this process and effectively integrating AI into diverse disciplines such as Engineering, English, Law, Management, Pharmacy etc. Over a period of six months, approximately seven workshops were conducted, reaching around 500 faculty members. One such workshop held at KLE Technological University, Hubli had 63 participants from five different universities, of who 43 provided the feedback. The feedback questions were collected on a five point Likert scale and the questions are presented in Table III below.

TABLE III
FEEDBACK QUESTIONS

SI. No.	Question
Q1	The workshop objectives were clearly defined and effectively communicated.
Q2	The content was relevant and applicable to my teaching or

	research needs
Q3	I learned how to use AI tools to generate case studies tailored to student needs.
Q4	The workshop enhanced my understanding of reflection design using AI-generated prompts.
Q5	The session provided clarity on using taxonomies for case study development.
Q6	I feel confident in applying AI tools to improve student engagement and learning outcomes.
Q7	The facilitators explained concepts effectively and encouraged active participation
Q8	The hands-on activities and discussions helped in better understanding of AI applications in pedagogy.
Q9	The workshop provided actionable strategies that I can implement in my teaching or course design.
Q10	I would recommend this workshop to other educators interested in innovative teaching practices.

The descriptive statistics for the questions can be seen in Table IV below. The descriptive statistics reveal consistently high mean scores across all ten questions, ranging from 4.33 to 4.48, with medians uniformly at 5. This indicates a generally positive response pattern among participants. The standard deviations, all close to 1, suggest moderate variability around the mean. Skewness values are strongly negative for all items, indicating that responses are skewed toward the higher end of the scale, with most participants selecting favorable ratings. The high kurtosis values further suggest a peaked distribution, reflecting clustering of responses near the maximum value.

TABLE IV
DESCRIPTIVE STATISTICS

SI. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
N	42	42	42	42	42	42	42	42	42	42
Mean	4.48	4.48	4.40	4.48	4.38	4.33	4.45	4.43	4.36	4.48
Median	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Std. Dev.	1.09	0.994	1.01	0.969	0.936	0.954	0.968	0.991	0.92	0.943
Variance	1.18	0.987	1.03	0.938	0.867	0.911	0.937	0.983	0.869	0.890
Skewness	-2.51	-2.36	-2.24	-2.46	-2.35	-2.15	-2.40	-2.24	-2.31	-2.58
Kurtosis	5.77	5.72	5.05	6.52	6.66	5.55	6.29	5.31	6.54	7.45

Standard skewness error for all was 0.365 and standard error of kurtosis for all was 0.717. The data demonstrate a strong positive tendency with limited dispersion. The consistently high means, medians at 5, negative skewness, and peaked distributions all point to the conclusion that participants overwhelmingly rated the workshop positively. In other words, all ten questions collectively indicate that the workshop conducted was highly satisfactory.

The feedback collected for question 9, “The workshop provided actionable strategies that I can implement in my teaching or course design” is presented in Figure 3 below. The numbers are promising.

Fig. 3. Workshop feedback - if it provided actionable strategies

The reliability analysis of the 10 feedback questions revealed exceptionally high internal consistency, with both Cronbach’s alpha and McDonald’s omega values at 0.979. This indicates that the items consistently measure the same underlying construct, reflecting strong reliability of the instrument. This was done to assess the internal consistency of the feedback instrument, ensuring that the ten questions reliably measure the same underlying construct. The result is presented in Table V.

TABLE V
RELIABILITY ANALYSIS

Test	Value
Cronbach’s Alpha	0.979
McDonald’s Omega	0.979

V. DISCUSSION

The workshop has been implemented under a government initiative across multiple cohorts from IIT Ropar, consistently yielding positive feedback. Although specific data are not reported due to the absence of consent for research use, the repeated delivery across cohorts provides evidence of its quality and favorable reception. The training workshop has also been delivered over different states of India, receiving a positive feedback. The workshop conducted at KLE Technological University, where data is collected and presented, the participants were also asked to note the difference in the kind of assessments that was asked on the concept before and after the case study. A study was also made on kind of reflection questions that were asked. This section presents the discussion on both.

A. Case Study Assessments

The assessments with case studies highlighted the change in nature of questions, cognitive skill development, contextual relevance, interdisciplinary integration, skill transfer, depth of understanding and analytical skills. The description is presented below. The dimensions are presented in Figure 4 below.

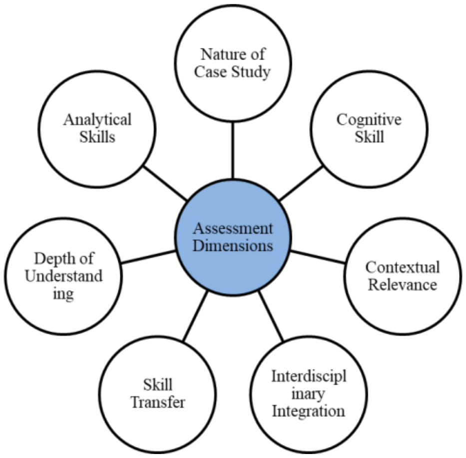

Fig. 4. Assessment dimensions

In the first version of assessments, questions were largely direct, fact-based, or procedural. Students were asked to write algorithms, compute statistical values, or explain theoretical concepts such as ISO 9001 or memory usage. The emphasis was primarily on recalling knowledge, demonstrating procedural skills, or producing correct outputs. While this approach effectively tested foundational understanding, it offered limited opportunities for students to apply their learning to real-world scenarios.

The initial assessments mainly evaluated comprehension and basic application skills. Students were expected to reproduce definitions, solve standard problems, or write code that produced correct results. Higher-order cognitive skills, such as critical thinking, reasoning, or synthesis, were minimally addressed. The focus remained on correctness and completeness rather than on analytical or evaluative processes.

The assessment questions asked before and after case study were qualitatively analyzed and theme generated are presented below. The data from faculty responses was analyzed using thematic coding (Gibbs, 2007). Patterns in the types of questions asked earlier and the focus of newly designed case studies were compared, and recurring ideas were clustered into four themes.

1) Theme 1: From Knowledge Recall to Conceptual Understanding

Previous questions focused on recalling definitions, naming concepts, or reproducing formulas. For example, students were asked "What is book-keeping?" or "What is confinement in quantum realm?" The redesigned case studies now expect students to go beyond recall and build relational understanding. They connect abstract concepts (like dual effects in transactions, resistance in superconductors, or averages in statistics) to real-world contexts, analyze their meaning, and recognize their broader significance. This moves learning from memorization to deeper conceptual grasp.

2) Theme 2: From Procedural Tasks to Analytical Problem-Solving

Initially, tasks were procedural, requiring students to apply set methods such as minimizing DFAs, explaining divide-and-conquer or solving standard numerical. The new case studies engage students in analyzing, breaking down, and justifying solutions. For instance, scaling up a protein purification protocol or designing care plans for scoliosis patients requires decomposition, evaluating trade-offs, and structured reasoning. Students learn to handle complexity through analysis rather than following a fixed procedure.

3) Theme 3: From Isolated Knowledge to Real-World Relevance

Earlier assessments treated subjects in isolation, often disconnected from practical life. For example, CPU scheduling techniques, SHM equations, or workplace policies were tested as standalone ideas. The case studies now place concepts in real-world scenarios: pizza delivery linked to Lean principles, sustainability framed as progressive habits, or communication modeled through digital networks. This approach makes knowledge contextual, relatable, and relevant to societal and personal decision-making

4) Theme 4: From Single-Domain Learning to Interdisciplinary Integration

The earlier approach confined students within disciplinary boundaries like algorithms, finance, biology, or HR were taught separately. The case study design mergers perspectives across domains. Students explore cyber-physical systems, health pathways, and HR's strategic role in business by integrating technical, social, and ethical dimensions. This interdisciplinary framing allows learners to see patterns across fields, transfer ideas, and prepare for complex, multi-faceted challenges.

With respect to the research question, this work demonstrates how the move from fact-based and procedural assessments to AI-assisted, threshold-concept–driven case studies supports higher-order thinking, engagement, and deeper understanding of complex concepts. The shift highlights how carefully designed case studies encourage analysis, evaluation, creation, and real-world problem-solving while connecting known and unknown knowledge. AI assistance further strengthens this process by allowing rapid development of relevant, student-centered scenarios across domains. This connection establishes a strong basis for investigating how AI-guided case study generation influences learning outcomes aligned with analysis, reflection, and meaningful knowledge transfer.

B. Reflection Assessments

The reflection questions were used in short, 15-minute assessments to ensure that students had actively engaged with and solved the case study independently. Each student was required to contribute, confirming full team participation. The questions were designed following Bloom's Taxonomy, spanning levels from application and analysis to evaluation and creation, ensuring a structured assessment of higher-order cognitive skills. The key terms of the reflections are summarized in the Table VI below.

TABLE VI
REFLECTION KEY TERMS

Term	Description
Engagement	active participation and accountability
Analysis	reasoning and critical evaluation
Application	real-world problem solving
Collaboration	teamwork and shared contribution
Reflection	thinking about processes and outcomes

These assessments focused on practical application, analytical reasoning, and critical thinking. Students applied concepts from the case study to real-world scenarios, justified their decisions, compared alternatives, and proposed improvements. Emphasizing higher-order thinking rather than recall, the assessments provided insight into each student's ability to generalize and transfer learning to unfamiliar contexts.

Students were prompted to observe systems, identify patterns, analyze outcomes, and relate theoretical principles to real-life situations within the constrained assessment period. The use of Bloom's Taxonomy ensured intentional scaffolding of cognitive complexity. Lower-order questions required students to recall or understand basic concepts, while higher-order prompts challenged them to apply, analyze, and evaluate information from the case study. In some instances, students were asked to create solutions, prototypes, or flowcharts, helping with both critical and creative thinking.

The short-format assessment enabled instructors to confirm individual understanding and team collaboration, minimizing the likelihood of passive participation. Each student had to articulate their reasoning, apply learned principles, and contribute to the team's solution, allowing a rapid yet meaningful evaluation of engagement and competence.

Overall, the 15-minute case study assessments, guided by Bloom's Taxonomy, effectively can measure individual engagement, team participation, and higher-order cognitive skills. They provided a reliable snapshot of both conceptual understanding and practical problem-solving, highlighting the value of concise, structured, and reflective assessment in collaborative learning environments.

VI. CONCLUSION

The implementation of case study-based and reflection assessments using a designed model of case study generation with AI and appropriate taxonomies significantly enhanced student understanding of threshold concepts. Compared to initial fact-based assessments, the case study approach developed higher-order cognitive skills, including critical thinking, problem-solving, and analytical reasoning, while encouraging interdisciplinary understanding and real-world applicability. Short, structured reflection assessments ensured active individual engagement and team participation, with Bloom's Taxonomy guiding cognitive scaffolding from application to creation. This approach shifted learning from rote knowledge recall to reflective, practical, and transferable skills, showing that well-designed assessments can effectively cultivate deeper understanding and competence in collaborative learning environments.

The use of AI in this model significantly streamlines the case study design process, reducing the time and effort required from faculty. Providing structured prompts based on threshold concepts, known and unknown elements, applications, principles, and the selected taxonomy, the LLM generates contextually relevant and pedagogically sound case studies. Faculty judgment remains central in selecting the most meaningful principles and refining outputs, but AI accelerates content creation, ensures consistency, and provides diverse, creative scenarios that would be time-consuming to develop manually. This integration of AI demonstrates how technology can enhance educational design and maintaining instructional quality and alignment with learning objectives.

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