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Clarifying Adaptive Reasoning as Process in Engineering Capstone Design.

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Introduction

This empirical research full paper examines adaptability as a core component of engineering practice by analyzing how undergraduate engineering students articulate it in capstone design courses. Engineers rarely encounter fully specified problems; instead, they work in contexts where requirements evolve, constraints emerge over time, and initial assumptions must be revisited. Progress under these conditions depends on recognizing when an approach is no longer viable, interpreting new information, and adjusting subsequent action. Consistent with Individual Adaptability (I-ADAPT) theory, which conceptualizes adaptability as performance adjustment to changing demands through processes such as situation perception, appraisal, strategy selection, and self-regulation [1], [2], we view adaptability in engineering design as a process of detecting misalignment, making sense of disruption, and strategically revising strategies or goals. This process-oriented perspective has made adaptability an increasing focus in engineering education and workforce development [3], [4].

Despite this attention, adaptability remains difficult to study and assess in ways that reflect how engineering work actually unfolds, particularly within undergraduate academic settings. Much of the existing research treats adaptability as a general personal attribute or relies on self-report measures of perceived flexibility [1], [2], while other approaches infer adaptability from task outcomes, such as whether a design ultimately functions. These approaches provide limited insight into the reasoning processes through which engineers perceive constraints, interpret disruption, and regulate their responses. In addition, many measures are only loosely connected to engineering contexts, where problems are often ill-defined, shaped by multiple stakeholders, and constrained by competing technical and practical considerations [5], [6]. As a result, it remains unclear which behavioral or cognitive indicators engineering-focused measures should capture, or how adaptability can be distinguished from related constructs such as persistence, effort, or general problem-solving ability [2], [7].

One way to address this gap is to examine adaptability as it emerges in authentic engineering learning environments. Senior capstone design courses require students to engage in extended design work, often in collaboration with industry partners, in which project goals, constraints, and expectations evolve across multiple project phases [8], [9]. These courses expose students to sustained uncertainty rather than isolated moments of change [10], [11]. Written reflections produced in these courses provide insight into how students perceive, interpret, and respond to evolving conditions, offering a window into adaptive processes that are difficult to infer from outcomes alone [12], [13].

To clarify this process in context, we analyze undergraduate engineering students' capstone reflections to examine how adaptability is articulated in the context of design work. Rather than applying predefined behavioral indicators, we examine how students describe moments of misalignment, interpretative evaluation, and regulatory revision, as well as instances in which these processes appear incomplete or to break down. By grounding construct clarification in patterns across reflections, this study elaborates how the mediating processes described in I-ADAPT theory unfold in an authentic engineering context and provides a foundation for developing context-sensitive assessment approaches. More broadly, it contributes to ongoing engineering education research efforts to move from abstract construct definitions toward measurement approaches grounded in authentic, context-sensitive engineering practice [6], [14]. Accordingly, this study addresses the following research question: “How do undergraduate engineering students articulate adaptive and non-adaptive reasoning in reflective accounts of their capstone design experiences?”

Conceptual Background

Prior work conceptualizes adaptability primarily as either an individual difference or adaptive performance in response to change. Pulakos et al. [2] define adaptability as performance adjustments to changing task, social, or environmental demands, while Ployhart and Bliese [1] frame it as a developable meta-competency that supports effective functioning across situations. In I-ADAPT theory, adaptability operates through mediating processes including situation perception and appraisal, knowledge acquisition, strategy selection, and self-regulation that link individual characteristics to adaptive performance outcomes [1], [2]. These perspectives have shaped both the definition and operationalization of adaptability.

Empirically, adaptability is most often measured through self-report instruments or inferred from task outcomes. Measures such as the I-ADAPT-M assess individuals’ perceived capacity to respond to change across multiple dimensions, including coping with uncertainty, learning new tasks, and managing stress [1], [2], [15]. While these instruments capture important dispositional and motivational aspects of adaptability, they rely on retrospective judgments and provide limited visibility into the mediating process through which adaptability unfolds during task engagement. Outcome-based approaches present a related limitation: successful performance may occur without substantial revision of strategy, making it difficult to disentangle adaptability from persistence, effort, or prior expertise, e.g., [2], [7], [13], [16].

In response to these concerns, scholars have called for clearer distinctions between adaptability and adjacent constructs, as well as more precise specification of what constitutes evidence of adaptation [2], [7], [17]. Although persistence, flexibility, and metacognition all involve forms of regulation or engagement, they differ in important ways. Persistence reflects sustained efforts despite difficulty [19]. Flexibility denotes openness to alternative approaches but does not necessarily imply responsiveness to feedback or disruption [19]. Metacognition encompasses monitoring and regulation more broadly [20]. Adaptability, by contrast, is specifically concerned with detecting meaningful change or misalignment and adjusting action in response [2]. In engineering design contexts, where constraints, requirements, and stakeholder expectations evolve over time, failure to maintain these distinctions risks conceptual overlap and complicates efforts to measure adaptability in a theoretically coherent way.

Building on this literature, a process-oriented perspective conceptualizes adaptability as unfolding through structured appraisal and regulation over time [1], [2], [13], [21]. This perspective makes explicit the mediating processes implied in I-ADAPT theory and shifts attention from whether individuals possess adaptability to how adaptive reasoning is enacted in context. For measurement purposes, this shift is consequential. If adaptability operates through perception, appraisal, and regulatory adjustment, then construct clarification must be grounded in empirical examination of how individuals articulate and enact these processes during ongoing work. Qualitative approaches are well suited to this aim, as they allow adaptation to be examined as it is expressed in situated reasoning rather than inferred from trait reports or end-state outcomes [6], [12], [22].

Context and Data Source

The data for this study were drawn from an undergraduate senior capstone design course in the engineering college of a large, public, research-intensive university in the southwestern United States. The two-semester capstone serves as a culminating experience in the undergraduate curriculum, requiring students to apply prior technical knowledge in extended, open-ended, industry-sponsored design projects completed in teams of three to six students [8], [23]. This study focuses on data collected during the first semester, during which teams engage in problem scoping, requirements development, concept generation, and preliminary evaluation, laying the groundwork for prototyping and refinement in the second semester. Consistent with prior research, this phase represents a critical transition between academic preparation and professional engineering practice, as students confront evolving requirements, incomplete information, and constraints related to feasibility, time, budget, and stakeholder expectations [10], [11]. Through interim deliverables such as design reviews and reports, students encounter recurring moments of misalignment and revision, creating sustained opportunities to engage in the mediating processes associated with adaptive performance [8], [9].

During the first semester, students complete three individual written reflections aligned with major phases of the design process. The first addresses problem definition and the development of project requirements and success criteria; the second focuses on concept development, including how ideas were generated and refined in response to constraints and feedback; and the third examines concept evaluation, asking students to assess design viability and explain how new evidence shaped subsequent decisions. Across these reflections, students are prompted to interpret challenges, justify tradeoffs, and explain changes in direction as projects evolve. Reflections are completed individually, graded for completion rather than evaluative quality, and designed to elicit students' honest sensemaking about uncertainty, disruption, and change during a bounded phase of the capstone experience [24], [25].

The dataset consists of three reflections per consenting student, each typically 750–1,000 words in length. These reflections are not treated as direct measures of adaptability, but as analytic artifacts that reveal how students articulate recognition of misalignment, interpret constraints, and describe regulatory adjustments during extended engineering work. As such, they provide a contextually grounded basis for clarifying the processes underlying adaptive reasoning and informing future measurement efforts [24], [25].

Researcher Positionality

The authors bring relevant experience teaching, designing, and studying undergraduate engineering capstone courses to this work. This familiarity informed decisions about data selection and interpretation, particularly in attending to how students describe uncertainty, constraint negotiation, and project revision. Analysis was guided by a process-oriented conceptual framework rather than assumptions about desired outcomes or student success, with sustained attention to students' own language and interpretations. Reflections were treated as situated accounts of sensemaking rather than objective representations of behavior [26], [27].

The second author served as the lead instructor for the capstone course during the semester in which the reflection data were generated. To mitigate potential power dynamics and influence on student responses, consent for research use of the reflections was obtained retroactively, after all assignments had been completed and graded [28], [29]. This timing reduced the likelihood that students tailored their reflections for research purposes or perceived participation as influencing course evaluation. Nonetheless, the instructor–researcher role may shape interpretation and remains a limitation, as discussed further in the Limitations and Future Work section.

Methods

This study employed a primarily inductive qualitative approach [12], [30] to examine how undergraduate engineering students articulated adaptive and non-adaptive reasoning in written capstone reflections. The analytic emphasis was on process-level interpretation and construct clarification rather than evaluation or instrument validation. Although informed by sensitizing concepts [31] drawn from adaptability literature, including the mediating processes articulated in I-ADAPT theory (situation appraisal, strategy selection, self-regulation), codes were developed from close engagement with the data rather than imposed deductively.

Participants

Participants included 47 undergraduate engineering students enrolled in the first semester of a two-semester senior capstone design course. Of 135 enrolled students, eight were excluded for failing to complete all three required reflections, and 80 did not provide or respond to research consent. The final dataset comprised all 141 reflection artifacts (three per participant) from the 47 consenting students.

Participants were students in a general engineering program and represented multiple concentrations: 15 in robotics systems, 14 in mechanical engineering systems, 10 in automotive systems, four in manufacturing engineering, and four in electrical engineering systems. These proportions reflected overall course enrollment. No additional demographic information was collected to minimize participant burden and reduce the risk of identification, particularly given the instructor–researcher role. All reflections were de-identified prior to analysis in accordance with Institutional Review Board approval.

Unit of Analysis

The unit of analysis in this study was a reflection segment, defined as a coherent portion of text in which students described a challenge, decision point, shift in understanding, or response to evolving project conditions. Reflections were treated as situated accounts of sensemaking rather than objective representations of behavior [24], [25].

Data Analysis

Coding was conducted by the second author and began with iterative reading and open coding of an initial subset of 72 reflection artifacts corresponding to complete reflection sets from 24 participants. Through first-cycle coding [30], recurring patterns were identified in how students described recognizing misalignment, interpreting constraints, revising strategies or goals, recalibrating success criteria, and persisting without substantive change. A provisional coding scheme was developed inductively from these patterns and refined across successive analytic cycles. No substantive new codes emerged in later rounds of analysis, indicating code saturation

[32]. Following stabilization of the coding framework, the remaining 69 artifacts were analyzed using the established framework. This subsequent analysis confirmed and elaborated existing themes but did not generate additional categories.

Second-cycle coding [30] was then conducted to collapse, differentiate, and organize first-cycle codes into higher-level patterns of adaptive and non-adaptive reasoning (Table 1). Codes were examined both within individual reflections and across reflections written at different points in the semester to trace how patterns unfolded over time. Consistent with the exploratory aims of the study, emphasis was placed on identifying patterns and sequences of reasoning rather than producing frequency counts. Interpretive claims are grounded in representative excerpts drawn from across the full dataset [12], [22].

Table 1: Codebook for analyzing adaptive reasoning in capstone reflections.

Code Name	**Definition**	**Example Excerpt**
Recognizing misalignment	Explicit articulation that current assumptions, plans, requirements, or expectations do not align with project realities, constraints, or feedback	In our initial design, we did not use o-rings and only used a single hole to pull the vacuum. However, after talking to our industry partners, we decided to incorporate an o-ring and use 2 holes to pull the vacuum.
Recognizing constraint pressure	Explicit acknowledgment that limits (e.g., time, resources, safety, industry partner direction) meaningfully shape what can be done.	Making the entire fixture in one setup would minimize runout, but it would require access to machines we do not have. We have to compromise and split the machining into stages.
Revising strategy	Description of a concrete change in approach, design, method, or plan in response to recognition or evidence	After reviewing the scores with our industry mentors, we decided to combine the two, therefore adopting Concept 1's approach with Concept 3's concept.
Reframing scope	Redefinition or narrowing of project goals, requirements, or focus to make the problem manageable or aligned with constraints	We have also tabled any major changes to the [design] due to time constraints.
Justifying tradeoffs	Explicit reasoning that weighs competing considerations and explains why one option was chosen over others	We prioritized manufacturability so we could actually build the final design. Another debate was regarding universality…We chose precision and safety over universality.
Recalibrating success criteria	Explicit adjustment of what counts as "success" in response to constraints, feedback, or evolving understanding	Meeting the plan of record for terrain classification will be sufficient for project success because of the time constraints. Getting any classification results would be a success for our team.
Persistence without revision *(non-adaptive pattern)*	Definition of continued effort on an approach without evidence of evaluation, revision, or reconsideration despite challenges	There is still uncertainty about whether the processor can meet expectations…Based on the feedback and evidence gathered this semester, our design concept appears to be viable and on track for continued development.

Deferral of action *(non-adaptive or ambiguous pattern)*	Acknowledgment of a problem or uncertainty without a clear plan or decision to act	There are still notable risks [that] we still haven't tested.

Trustworthiness

Several strategies supported trustworthiness of the analysis [28]. Analytic memoing was used to document code development, analytic decisions, emerging interpretations, and disconfirming cases, supporting transparency in how findings were constructed [22]. Analytic attention was also given to both adaptive and non-adaptive reasoning patterns to avoid overgeneralizing from apparent success. Together, these practices supported careful, transparent interpretation aligned with the study's construct-clarification aims.

Findings

The findings highlight recurring patterns in how undergraduate engineering students articulated adaptive and non-adaptive reasoning in their capstone design reflections. The analysis focused on how students described moments of disruption, misalignment, and response, rather than on evaluating the technical effectiveness of design outcomes. Across the dataset, adaptive reasoning involved recognizing misalignment or constraint, interpreting its implications, and enacting regulatory adjustments through strategy revision or goal recalibration. In contrast, non-adaptive reasoning involved recognition of uncertainty without articulated interpretive engagement or timely adjustment. The themes below illustrate these patterns with anonymized excerpts; all identifying details, including industry partner and project-specific information, have been removed to preserve confidentiality while maintaining the integrity of students' reasoning.

Theme 1: Strategic revision following recognition of misalignment.

A recurring theme was the articulation of adaptation as a deliberate strategy revision after recognizing that an initial approach no longer aligned with project constraints or requirements. These revisions were typically framed as responses to new information, feedback, or evaluation, rather than as adjustments made through trial and error. For example, one student reflected: "After evaluating Concept 2 against the original requirements, we realized it was not meeting the necessary durability, so we decided to pivot to Concept 1 for better performance" (Student 17, Concept Development). In this example, the student explicitly identified a misalignment between the design performance and stated requirements and described a concrete shift in strategy. The phrase "so we decided" signaled interpretative evaluation followed by regulatory adjustment, consistent with adaptive reasoning.

Another student described revising a manufacturing plan after receiving new input: "While this initial plan seemed good, when discussing options with the manufacturing manager, he informed the team that it would be best to begin with the other shape of the fixture…This was surprising to the team as our initial plan had begun very differently" (Student 08, Concept Evaluation). Here, the student contrasted the original plan with a revised approach and identified external expertise as the catalyst for change. The articulation of surprise marked appraisal of misalignment, and the subsequent revision reflected regulatory adjustment.

Across similar reflections, adaptation was expressed as deliberate, justified revision in response to perceived mismatch. In these cases, recognition of disruption was accompanied by interpretive evaluation and strategic change.

Theme 2: Regulation through scope redefinition and recalibration of success.
A second form of adaptive reasoning involved regulation at the level of goals and success criteria rather than strategy alone. Whereas Theme 1 reflected changes in how the project was executed, this theme reflected changes in what the project was trying to achieve. Students frequently described narrowing objectives, deferring features, or redefining success in response to time, resource, or feasibility limitations. These adjustments were typically framed as pragmatic choices that allowed progress to continue despite constraints. For example, one student described narrowing the project focus due to time limitations: "Given the limited time remaining, we decided to focus solely on optimizing the core function and leave additional features for future iterations" (Student 04, Concept Development). In this instance, adaptation involved recalibrating scope rather than redesigning the system. The student acknowledged constraint pressure and articulated a deliberate decision to reprioritize to preserve project viability.

Similarly, another student described shifting performance goals in response to resource limitations: "Initially, we aimed for a fully automated process, but after reviewing our resources, we decided a semi-automated solution would meet our needs and fit within our budget" (Student 10, Problem Definition). In this case, feasibility considerations prompted reinterpretation of what constituted acceptable success. Rather than abandoning the project, the team revised its performance expectations to align with contextual constraints.

Across reflections, this form of adaptation made visible the regulatory dimension of adaptive reasoning, i.e., deciding what to prioritize, what to postpone, and what level of performance was acceptable given current conditions. Students adjusted goals, timelines, and performance benchmarks in response to evolving conditions, demonstrating flexibility grounded in appraisal and deliberation.

Theme 3: Non-adaptive reasoning expressed through continuity or deferred decision-making.
A third theme captured non-adaptive reasoning patterns in which students acknowledged challenges but did not articulate substantive evaluation or regulatory change. In these cases, recognition of uncertainty was not followed by interpretive analysis or revision. As illustration, one student wrote: "The current design concept seems promising, and we will move forward with it, even though we still need to complete more testing" (Student 14, Concept Evaluation). Although uncertainty was acknowledged, the student did not describe reassessment of strategy or adjustment in response to that uncertainty. Instead, continuation was framed as confidence in the existing trajectory.

Similarly, another student discussed deferred resolution of emerging issues: "We plan to address the issues after the initial prototype testing in the coming weeks" (Student 21, Concept Evaluation). In this project, potential problems were postponed to a later phase without articulated plans for evaluation or modification. These segments were coded as non-adaptive not because students expressed uncertainty, but because recognition of disruption was not accompanied by interpretive engagement or timely adjustment.
Across accounts, non-adaptive reasoning was characterized by continuity or postponement despite acknowledged risk. While students often framed these decisions as reasonable within project constraints, the absence of articulated evaluation or revision distinguished these patterns

from adaptive regulation. Across the full dataset of 141 reflections, these patterns remained consistent: adaptive reasoning involved recognition of misalignment followed by evaluation and revision, whereas non-adaptive reasoning involved recognition without substantive adjustment. These patterns form the basis for the theoretical and measurement implications discussed below.

Discussion

This study examined how undergraduate engineering students articulated adaptive and non-adaptive reasoning in reflective accounts of capstone design work, with the aim of clarifying adaptability as enacted in context rather than as a stable trait [8], [9]. The findings suggest that adaptability involves recognizing disruption, interpreting its implications, and regulating strategies or goals over time. These patterns align with the mediating processes articulated in I-ADAPT theory (situation appraisal, strategy selection, self-regulation) while illustrating how those processes unfold in engineering practice [1], [2].

Across reflections, adaptive reasoning consistently involved three interrelated moves. First, students articulated misalignment between expectations and evolving project conditions. Second, they interpreted what that misalignment meant for feasibility, performance, or scope. Third, they enacted regulatory adjustments through strategy revision or goal recalibration. In contrast, non-adaptive reasoning occurred when recognition of uncertainty was not followed by interpretive engagement or timely modification of action. This distinction suggests that adaptability in engineering design depends not only on willingness to change, but on the capacity to interpret when and why change is warranted. In contexts characterized by ambiguity and evolving constraints, preparedness for practice may therefore hinge on meaning-making processes rather than on procedural flexibility alone [10], [11].

These findings also clarify the distinction between adaptability and related constructs [1]. Persistence and sustained effort were evident in both adaptive and non-adaptive reflections, underscoring that effort alone does not constitute adaptability. Likewise, flexibility, understood as openness to multiple approaches, proved insufficient without evidence of interpretive evaluation and deliberate revision. Although metacognitive monitoring appeared in adaptive accounts, adaptability was specifically tied to moments of disruption and subsequent regulation. Students who persisted without revision or deferred decisions often recognized uncertainty but did not articulate how that recognition informed immediate adjustment, reflecting incomplete enactment of adaptive processes rather than absence of effort or awareness [20].

Notably, adaptive regulation occurred at multiple levels. In some cases, students revised specific design strategies, and in others, they recalibrated goals, narrowed scope, or redefined success criteria. Highlighting goal regulation extends prior conceptualizations of adaptability by demonstrating that effective adaptation may involve redefining what constitutes success rather than altering how to achieve it. Such recalibration reflects regulatory sophistication that is unlikely to be captured through trait-based or outcome-only approaches.

These findings position adaptability in capstone design as a situational, interpretive process enacted through context-triggered appraisal and regulation. By grounding this characterization in students' reflective accounts, this study extends I-ADAPT theory into undergraduate engineering contexts and clarifies how adaptive reasoning differs from persistence, routine expertise, or generalized flexibility [7], [13].

Implications for Instrument Development

Building on the process structure identified above, measurement approaches may benefit from shifting attention from adaptive performance domains to the reasoning mechanisms that precede performance. Most existing adaptability instruments, including those derived from Pulakos et al.'s taxonomy, emphasize performance categories or perceived capability (e.g., handling uncertainty, learning new tasks, managing stress) [2]. While valuable, such approaches offer limited insight into how individuals interpret disruption and determine whether and how to revise their course of action.

A process-oriented instrument would instead be designed to elicit reasoning under evolving constraints. For example, a scenario-based assessment could present an engineering design disruption (e.g., Table 2) and require respondents to identify the main issue, explain its implications, and justify a course of action. This format evaluates whether individuals detect misalignment, engage in evaluative reasoning, and articulate a coherent regulatory response. Scoring would distinguish between responses that merely persist with the existing plan or defer action and those that demonstrate evaluative reasoning and strategic revision.

Table 2: Example process-oriented scenario for measuring adaptive reasoning.

Scenario: You are part of a capstone team designing an automated sorting device. Two weeks before your final review, your client informs you that the operating environment will involve significantly higher ambient dust levels than originally specified. Preliminary testing under dusty conditions reveals intermittent sensor failure. Consider the following: 1. What is the most significant issue raised by this new information? 2. How does this issue affect the feasibility or reliability of your current design approach? 3. What would you recommend your team do next, and why is this the most appropriate response given time and resource constraints?

This process-based approach offers several advantages over outcome-based formats, particularly in undergraduate engineering contexts. First, undergraduate students often operate with constrained timelines and incomplete knowledge, and design outcomes may reflect resource limitations or instructional scaffolding rather than adaptive reasoning capacity. Measuring final performance alone risks conflating adaptability with technical proficiency, past experience, or access to resources. A student may produce a viable design without having engaged in deliberate adaptive reasoning, just as another may engage in sophisticated evaluation but lack time to fully implement revision.

Process-based measurement can also identify where adaptive reasoning breaks down. Some individuals may recognize disruption but fail to reinterpret constraints, while others may propose changes without articulating the evaluative logic that justifies them. Disaggregating these components yields more informative profiles than a single adaptability score and reduces conflation with related constructs such as persistence or generalized flexibility. Embedding ambiguity, competing constraints, and evolving requirements into assessment tasks further approximates the adaptive demands of engineering design. Scenario-based or task-embedded formats can capture how individuals reason through change, not simply whether change occurs.

By grounding instrument design in empirically observed reasoning patterns, process-oriented measures can more accurately assess adaptability as enacted in context rather than inferred from static trait reports or end-state outcomes. Collectively, these implications point toward a shift from domain-based performance taxonomies toward structured assessment of adaptive reasoning processes, for which the present findings provide an empirical foundation.

Limitations and Future Work

This exploratory study focused on clarifying process-level indicators of adaptability rather than measuring individual differences or evaluating an instrument; therefore, the findings should not be interpreted as evidence of prevalence, reliability, or predictive validity. Participants were drawn from a single capstone course within a specific institutional context, limiting generalizability while remaining appropriate for early-stage qualitative work focused on construct clarification [33].

The methods used also shape what can be observed. One author served as the instructor for the capstone course during data collection. Although consent for research use of the reflections was obtained after all assignments were graded to reduce potential power dynamics, the instructor-researcher role may still have influenced interpretation. The reflections were designed as course assignments rather than prompts explicitly focused on adaptability. While this supports ecological validity by capturing students' natural sensemaking, adaptability was inferred from students' descriptions rather than directly elicited. Written reflections further limit access to cognitive processes that are difficult to articulate, and differences in writing fluency may have influenced the richness of the data. The specific task context and embedded constraints further shaped the forms of adaptability observed, and the indicators identified here should be understood as context-dependent rather than exhaustive.

Although students worked in teams of three to six members, the present analysis focused on individual reflections. Future research should examine how team-level factors, such as established norms or collective efficacy, influence adaptive and non-adaptive reasoning patterns, including whether certain team environments consistently support more sophisticated adaptive processes. Building on this foundation, subsequent work will translate the identified process indicators into candidate measurement elements, such as scenario-based prompts and aligned response formats [2], followed by pilot testing and early validation examining internal structure, reliability, and relationships with related constructs such as metacognition and persistence. Additional studies should incorporate complementary data sources beyond reflections, including behavioral or trace data, to capture adaptive processes that are difficult to verbalize and to examine how adaptability manifests across institutional contexts and student populations, particularly in relation to perceptions of constraint and agency.

Statement on Artificial Intelligence (AI) Usage

Generative artificial intelligence (AI) tools were used to assist with drafting and editing portions of this manuscript, including improving clarity, organization, and conciseness of written text. The authors made all study design, data analysis, and interpretation.

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