Mapping Moves, Modes and Methods: Designing Socratic Conversational Agents for AI-Enhanced Learning

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Abstract: Conversational agents powered by Large Language Models (LLMs) are increasingly proposed as scalable tools for personalised learning support. Yet much existing research focuses on algorithmic capability rather than the nuanced human learning dialogues that shape educational practice. This leaves a gap in empirically informed frameworks for translating rich instructional conversation into actionable design principles for Socratic AI partners. This paper addresses this need through a secondary analysis of live, online design critiques conducted at a South African university - an environment reflective of many Global South contexts marked by resource constraints, student diversity, and socio-economic pressure. Building on the author's doctoral research, the study synthesises previously collected empirical material, including surveys, a focus-group interview, and recorded critique sessions. A composite conceptual lens (Conversation Theory, Experiential Learning Theory, and Cognitive Apprenticeship) guided the interpretive analysis. The findings identify four recurring student–tutor relationship archetypes and four interaction dimensions that position critiques as formative, iterative, formal, and immersive. These insights are consolidated into a "moves–modes–methods" matrix that captures how knowledge is negotiated, feedback is scaffolded, and agency is fostered in the critique space. Mapping this matrix onto current scholarship on LLM-based tutors reveals both alignments, such as the value of probing questions, and tensions related to contextual sensitivity, including bandwidth limitations, student diversity, and socio-economic realities. By integrating detailed empirical insight with emerging work on AI-supported learning, the study offers an evidence-based framework to inform the design of conversational agents that augment human expertise while preserving the pedagogical integrity of the online critique in under-resourced, highly diverse settings.

Keywords: Conversational agents, Large language models (LLMs), Socratic AI tutors, Online design critique, Global south higher education, Human-AI bollaboration, Design education

1. Introduction

Large Language Model (LLM) driven conversational agents are increasingly promoted in higher education for their potential to deliver personalised, scalable learning facilitation to large and diverse student cohorts (Zawacki-Richter et al., 2019; Luckin & Cukurova, 2023). Yet, much of the existing research and development focuses predominantly on algorithmic optimisation (Kasneci et al., 2023), often overlooking the nuanced human learning dialogues that underpin meaningful educational experiences (Laurillard, 2013). This creates a notable gap in empirically grounded frameworks capable of translating the richness of human-to-human educational conversation (specifically those rooted in formative, dialogic traditions) into actionable design specifications for Socratic AI partners (Stokel-Walker & Van Noorden, 2023).

The live, online architectural design critique (or "crit") offers a productive context for addressing this gap. As the signature pedagogy of architectural education (Shulman, 2005; Cuff, 1992; Crowther, 2013), the crit is a structured formative encounter in which students present work-in-progress and engage in iterative dialogue with tutors. During a crit, students are required to articulate design intent, justify decisions, respond to probing questions, and demonstrate iterative refinement of their ideas, while tutors model expert reasoning, challenge assumptions, scaffold conceptual leaps, and provide multimodal feedback. This interaction integrates verbal explanation, visual artefacts (drawings, diagrams, models), real-time annotation, and reflective discussion; producing a dense conversational space where knowledge is co-constructed through moves, such as presenting, questioning, commenting, adapting, and reflecting (Kuhn, 2001; Laurillard, 2013). In this sense, the crit exemplifies a disciplined form of guided inquiry closely aligned with the principles of Socratic teaching.

In the South African and broader Global South context, where resource scarcity, linguistic diversity, and socio-economic inequalities intensify demand for scalable yet high-quality learning support (Morkel & Cronjé, 2022; Ng'ambi et al., 2013), the online crit takes on added significance. Conducted synchronously via webinar platforms, it enables geographically distributed and working students to participate (Wang & Hsu, 2008), while also highlighting challenges related to digital access, bandwidth limitations, reduced physical presence, and the need for explicit verbalisation of design reasoning. These conditions raise critical questions about how relational dynamics, interactional modes, and scaffolding strategies can be preserved or reimagined within AI-mediated learning environments.

This study builds on the author's doctoral research, which explored the student–tutor interaction in the live online critique in a blended architectural technology programme in South Africa (Morkel, 2022). That qualitative, exploratory investigation analysed surveys from current students, graduates, and tutors, alongside a focus-group interview and detailed protocols of three recorded critique sessions. Guided by an integrated conceptual lens combining Conversation Theory (moves: present, question, comment, adapt, reflect) (Laurillard, 2013), Experiential Learning Theory (modes: negotiation, exploration, reflection, application) (Kolb, 1984), and Cognitive Apprenticeship (methods: articulation, modelling, scaffolding, coaching) (Collins et al., 1989), the study identified four recurring student–tutor relationship archetypes—novice–expert, consultant–client, mentee–mentor, and parent–child—and four interactional dimensions—formative, iterative, formal, and immersive.

In the present paper, these empirically derived insights are mapped against emerging scholarship on LLM-powered tutors conceptualised as Socratic partners (Bazouche, 2025). This comparative analysis highlights convergences, such as the pedagogical value of probing questions, reflective prompts, and iterative feedback (Stokel-Walker & Van Noorden, 2023), as well as tensions, including the need for contextual sensitivity to bandwidth constraints, multilingual realities, and socio-economic pressures in Global South contexts (Olweny, 2017; Morkel et al., 2021). By bridging detailed empirical understanding of human critique interactions with current AI tutoring design literature, the paper proposes an evidence-based "moves–modes–methods" matrix as a framework for developing conversational agents that augment human expertise while safeguarding the pedagogical integrity of online critiques; specifically in under-resourced, highly diverse educational settings.

2. Literature Review

This literature review examines the intersection of architectural design critique pedagogy and emerging AI-driven tutoring, situating the live online critique as both a distinctive disciplinary practice and a suitable site for exploring how conversational agents can support complex, feedback-intensive learning.

2.1 Conversational Agents and Socratic AI Tutoring

Conversational agents powered by LLMs have gained significant attention for their capacity to simulate human-like dialogue and provide personalised support at scale (Zawacki-Richter et al., 2019; Luckin & Cukurova, 2023). Their affordances include adaptive questioning, feedback generation, and conversational scaffolding, making them promising tools for learner-centered, constructivist pedagogy (Woolf, 2010; Kasneci et al., 2023). Current research increasingly frames LLM-powered tutors as "Socratic" assistants who guide learning through probing questions, reflective prompts, and iterative dialogue rather than direct instruction (Stokel-Walker & Van Noorden, 2023; Bazouche, 2025). However, much of this scholarship remains conceptual or system-oriented, focusing on optimisation of models and prompt strategies rather than grounding design in empirically documented human learning interactions.

This gap is significant, as the effectiveness of AI conversational tutors depends on their ability to engage in pedagogically meaningful dialogue - dialogue that is responsive, relational, contextual, and aligned with disciplinary norms. Without empirical models of such dialogue, the design of AI tutors risks becoming detached from the nuanced conversational and pedagogical practices that underpin effective human teaching and learning. This study addresses this gap by bringing empirical evidence from architectural design critiques to bear on the design of LLM-based Socratic tutors.

2.2 Architectural Education and the Design Crit

Architectural education is shaped by the design studio, widely recognized as its signature pedagogy (Shulman, 2005; Cuff, 1992; Crowther, 2013). At the centre of this pedagogy lies the architectural design critique, or crit, a structured formative encounter in which students present developing design work to (design) tutors and receive feedback through dialogic exchange (Schön, 1984; Kuhn, 2001). The crit is inherently multimodal: tutors and students rely on drawings, diagrams, models, hybrid media, and real-time annotation to make design thinking visible, negotiate meaning, and iterate conceptual and spatial decisions.

During a crit, students are expected to communicate design intent clearly, justify decisions, respond to probing questions, and demonstrate iterative development. Tutors, in turn, model expert reasoning, identify conceptual gaps, articulate design principles, and scaffold students' movement from novice to more expert-like ways of thinking (Anthony, 1991; Percy, 2004). These interactions constitute a disciplined form of guided inquiry characterised by structured turn-taking, reflective engagement, negotiation of alternatives, and iterative problem-solving.

The crit therefore provides an exemplary site for analysing the interactional patterns of formative educational dialogue - exactly the kind of structured, probing conversational architecture that Socratic AI tutors must learn to emulate. Its emphasis on cycles of presenting, questioning, testing, modelling, reflecting, and applying makes the crit a rich environment for studying how learning unfolds through conversation and experience, and how expertise is scaffolded in real time.

In the South African and broader Global South context, the online crit has additional significance. Resource scarcity, cultural diversity, and socio-economic inequalities shape student participation and interaction patterns (Ng'ambi *et al*., 2013; Morkel & Cronjé, 2022). During the rapid transition to online and blended learning, the live online crit emerged as one of the few opportunities for synchronous, high-engagement interaction (Morkel *et al*., 2021). Conducted via webinar platforms, online crits enable remote participation (Wang & Hsu, 2008) but also amplify challenges such as bandwidth limitations and the need for explicit verbalisation of spatial reasoning. These contextual factors highlight the urgent need for pedagogical models and AI support tools that are responsive to diverse, under-resourced educational environments (Olweny, 2017).

2.3 Interactional Dynamics in the Live Online Crit

The author's doctoral research (Morkel, 2022) offers a detailed empirical account of student–tutor interactions in live online crits within a blended architectural technology programme. Using an integrated conceptual framework, the study identified four recurring student–tutor relationship archetypes, namely novice–expert, consultant–client, mentee–mentor, and parent–child; each influencing the tone, expectations, and pedagogical stance adopted during the crit. These relational patterns shaped the kinds of questions asked, the level of scaffolding offered, and the extent to which students were positioned as autonomous designers or as students needing guided support.

The study also identified four interactional dimensions (formative, iterative, formal, and immersive) that characterise how online crits unfold. The online crit functions primarily as a formative assessment space where feedback is central; it is iterative, involving cyclical development of ideas; it is formal and structured, often more so than physical studio interactions; and it is immersive, involving deep engagement with multimodal representations of student work.

Underlying these relational and interactional patterns is a consistent set of pedagogical moves, experiential modes, and cognitive apprenticeship methods that recur across the crits. These patterns provide an empirical foundation for understanding how disciplinary thinking is modelled, how problem-solving is scaffolded, and how students learn through guided dialogue and applied reasoning, offering a structured vocabulary for analysing and designing educational conversations.

2.4 Bridging Human Critique Practices with AI Tutoring Design

To systematically analyse the crit as a dialogic learning environment, this study draws on three complementary theoretical frameworks:

2.4.1 Conversatino theory (Laurillard, 2013)

Conversation Theory conceptualises learning as a structured dialogue involving iterative exchanges between student and tutor. The theory identifies key conversational "moves" (such as presenting ideas, questioning, commenting, adapting, and reflecting) that describe how knowledge is negotiated. These moves map directly onto the interaction patterns in crit dialogue and form the foundation for the coding of conversational strategies in this study.

2.4.2 Experiential learning theory (Kolb, 1984)

Kolb's model describes learning as a cycle of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. The crit embodies this cycle: students present experiential work, tutors prompt reflection, conceptual reasoning is articulated, and students test new strategies. These dynamics inform the experiential "modes" used in the coding framework - negotiation, exploration, reflection, and application.

2.4.3 Cognitive apprenticeship (Collins et al., 1989)

Cognitive Apprenticeship explains how expert thinking is made visible and learnable through strategies such as modelling, coaching, articulation, scaffolding, and reflection. These methods map closely onto the pedagogical

practices employed in crits, where tutors model disciplinary reasoning, scaffold design decisions, and support conceptual development. These "methods" form the third dimension of the analytical framework.

Together, these theories provide a robust conceptual foundation for analysing the design crit as a site of dialogic, experiential, and scaffolded learning, and for translating its structure into specifications for Socratic AI tutors.

2.5 Linking Literature to Methodological Approach

The literature reviewed above establishes the crit as a dialogic, multimodal, socially situated learning interaction that naturally aligns with the principles of Socratic tutoring. It also provides theoretical justification for the moves–modes–methods matrix used in this study. By integrating Conversation Theory, Experiential Learning Theory, and Cognitive Apprenticeship, the framework supports a combined inductive–deductive analytical approach, enabling both the identification of emergent patterns and the structured classification of interactional behaviours. This theoretical grounding directly informs the methodological decisions outlined in the next section.

3. Methodology

This section outlines the qualitative exploratory design, participant profile, data sources, analytical procedures, and ethical considerations guiding the investigation of interactional dynamics in live, online architectural design critiques and their relevance for designing LLM–powered Socratic conversational tutors.

3.1 Research Design

This qualitative exploratory study examined live, online architectural design critiques (crits) within a blended part-time Architectural Technology programme at a South African University of Technology. The purpose was to analyse the interactional patterns that characterise critique dialogue and to map these onto pedagogically meaningful design principles for LLM-powered Socratic tutors. The study builds on and extends the author's doctoral research on student–tutor interaction in the same programme (Morkel, 2022), using a two-phase inductive–deductive analytical approach.

3.2 Setting and Participants

The live online crits were synchronous webinar-based sessions in which students presented design work and engaged in structured dialogue with tutors. Participants included 23 current students (Years 1 and 2), 13 recent graduates, and 5 design tutors. This sample reflects the linguistic, socio-economic, and professional diversity typical of South African higher education and captures perspectives from multiple positionalities within the crit environment.

3.3 Data Sources

Three complementary data sources were used to support triangulation:

- **Online surveys** (with open-ended questions) from students, graduates, and tutors captured perceptions of interaction quality, critique value, and relational dynamics.
- **A graduate focus-group interview** enabled deeper reflection on critique experiences.
- **Three recorded Year-1 crit sessions** were purposively sampled to include high engagement, diverse design approaches, and rich multimodal interaction.

These data sources served distinct analytical purposes: surveys identified broad perceptual themes, the focus group provided interpretive depth, and the crit protocols supplied naturally occurring conversational data for detailed interaction analysis.

3.4 Conceptual Framework

Data analysis was informed by an integrated conceptual framework combining:

- Conversation Theory (Laurillard, 2013), which defines conversational moves such as presenting, questioning, commenting, adapting, and reflecting.
- Experiential Learning Theory (Kolb, 1984), which outlines modes of engagement including negotiation, exploration, reflection, and application.
- Cognitive Apprenticeship (Collins et al., 1989), which identifies pedagogical methods such as modelling, articulation, coaching, and scaffolding.

Together, these three perspectives formed the moves–modes–methods analytical lens used in deductive coding and interpretation. In this study, the term framework refers to the conceptual analytical lens derived from these theories, while the term matrix refers to the applied mapping of moves, modes, and methods generated through the analysis.

3.5 Data Analysis

Data analysis proceeded in two phases following Braun and Clarke's (2006) reflexive thematic analysis:

Phase 1: Inductive Analysis

Survey and focus-group data were coded inductively to identify emergent themes related to crit characteristics and student–tutor relationship archetypes. Patterns were refined through iterative comparison across datasets.

Phase 2: Deductive Analysis

All three datasets were then deductively coded using the moves–modes–methods framework. This allowed for systematic classification of conversational moves, experiential modes, and pedagogical methods across interactional turns.

For the crit recordings, the unit of analysis was the interaction turn: each discrete contribution by a student or tutor, segmented according to verbal utterances and associated screen-based actions (e.g., drawing, pointing, or switching views).

Credibility was strengthened through:

- Data triangulation (surveys + focus group + crit protocols)
- Method triangulation (inductive + deductive coding)
- Peer checking of a sample of coded extracts to enhance dependability
- Maintenance of an audit trail documenting coding decisions
- Reflexive memoing during theme development

This multi-layered approach allowed comparison of perceived interactional patterns with observed conversational behaviours.

3.6 Ethical Considerations

Ethical clearance for the original doctoral research on which this paper is based was obtained from the Cape Peninsula University of Technology (Reference: CPUT/HW-REC 2018/H15). Participation in the earlier surveys and focus groups was voluntary, with informed consent obtained from all participants. Crit recordings were collected with institutional approval and were anonymised prior to analysis. No identifiable information has been included in this paper.

The current study involves a desk-based mapping and secondary analysis of previously collected data. No new data were generated from human participants, and the work therefore falls under the general ethical provisions for research conducted for teaching and learning purposes at the author's current institution. The study adheres to established ethical guidelines relating to confidentiality, secure data storage, and responsible reporting.

4. Findings

Drawing on survey responses, focus-group insights, and detailed analysis of live online critique protocols, the findings reveal distinct interactional patterns and pedagogical dynamics that not only shape the student–tutor relationship in the crit but also offer transferable principles for designing context-sensitive, Socratic AI tutors.

4.1 Student–Tutor Relationship Archetypes

Analysis of the survey, focus-group, and crit protocol data revealed four recurring relationship archetypes:

- Novice–Expert: The tutor acted as the authoritative source of disciplinary knowledge, directing the student towards established norms (Schön, 1984; Morkel, 2022).
- Consultant–Client: The tutor responded as a design consultant, treating the student's work as a brief to be improved (Anthony, 1991).
- Mentee–Mentor: The interaction extended beyond the immediate project, emphasising professional growth (Collins et al., 1989).

- Parent–Child: The tutor adopted a protective, directive stance, especially when students showed uncertainty (Blair, 2006).

These archetypes reflect the fluid, situational nature of teaching in the crit, with tutors shifting roles depending on student needs, project stage, and interactional cues. For AI Socratic tutor design, this implies the need for adaptive persona-switching (Bazouche, 2025), where the AI can modulate tone, questioning style, and feedback depth dynamically. Unlike static rule-based agents, LLM-powered systems can be trained to recognise cues signalling when to shift from directive guidance to exploratory mentoring (Stokel-Walker and Van Noorden, 2023; Luckin & Cukurova, 2023). Holmes *et al*. (2019) further argue that effective AI tutors must be capable of adjusting their pedagogical stance in real time to support learner agency while maintaining scaffolding appropriate to the learner's developmental stage.

4.2 4.2 Interactional Dimensions of the Live Online Crit

The student–tutor interaction in the live online crit was characterised by four dimensions:

- Formative – Resembling a formative assessment rather than a collaborative design session (Milovanovic & Gero, 2018; Morkel, 2022).
- Iterative – Cyclical revisiting of ideas and feedback (Laurillard, 2013).
- Formal – Structured turn-taking and reduced spontaneity (Maher, Simoff & Cicognani, 2012).
- Immersive – Intensive engagement with multimodal inputs such as drawings, 3D models, and verbal commentary (Ceylan et al., 2021).

These dimensions show that the online crit supports depth and focus but at the cost of informal, serendipitous interaction (Lotz et al., 2015). For AI tutor design, balancing formality and informality is critical — too rigid, and engagement suffers; too loose and learning outcomes may dilute. AI conversational agents could intentionally embed prompts for social exchange or reflective pauses to counteract the transactional nature of online sessions, fostering rapport while maintaining academic rigour (Luckin & Cukurova, 2023; Holmes et al., 2019). Designing such AI-mediated dialogue flows requires sensitivity to the balance between instructional control and student autonomy (Woolf, 2010).

4.3 The Moves–Modes–Methods Matrix in Practice

Using the integrated framework, interaction patterns were coded as:

- Moves – Presenting dominated early phases, questioning and commenting mid-session, with reflection primarily in closing stages.
- Modes – Negotiation and application were most frequent; reflection was often tutor-led (Percy, 2004; Morkel, 2022).
- Methods – Modelling and scaffolding were common; coaching was less frequent, and articulation tended to be tutor-driven.

This structured mapping confirms that effective crits blend multiple pedagogical strategies in a temporal sequence, echoing Laurillard's (2012) conversational model. For AI tutors, the moves–modes–methods logic can serve as a dialogue architecture, ensuring sequences include problem presentation, exploratory questioning, reflective synthesis, and application (Stokel-Walker and Van Noorden, 2023). Holmes et al. (2019) note that AI tutors that explicitly embed such conversational scaffolding can better emulate the responsive, iterative nature of expert teaching. LLM-based systems, in particular, could be fine-tuned to maintain this sequence while adapting language, timing, and questioning depth to individual students' responses (Luckin & Cukurova, 2023).

4.4 Implications for AI Socratic Tutor Design

Mapping findings to AI tutoring literature suggests key design priorities:

- Adaptive Role-Shifting – Emulating fluid movement between archetypes.
- Dimension Balancing – Combining the depth of formal engagement with moments of informality (Maher, Simoff & Cicognani, 2012).
- Dialogue Structuring – Embedding moves–modes–methods sequencing in conversation flow.
- Contextual Sensitivity – Accounting for bandwidth constraints, multilingual communication, and socio-economic diversity (Olweny, 2017; Morkel et al., 2021).

These priorities underscore that while many aspects of crit pedagogy (such as probing, modelling, and iterative refinement) are transferable to AI tutoring systems, relational and socio-cultural elements are harder to

replicate. Designing for pedagogical integrity means ensuring that AI tutors function not only as information providers but as strategic partners in thinking (Luckin & Cukurova, 2023; Holmes et al., 2019). Such systems should be evaluated not just on algorithmic accuracy but on their capacity to sustain the depth, adaptability, and relational quality that underpin effective human-led critiques.

5. Discussion

5.1 Bridging Human Critique Practices with AI Tutoring Design

The findings of this study offer a grounded empirical basis for informing the design of LLM-powered Socratic tutors. The moves–modes–methods matrix derived from live online crits provides a structured vocabulary for describing the conversational strategies, experiential engagements, and pedagogical interventions that characterise effective formative dialogue. These patterns highlight not only how design knowledge is negotiated between students and tutors, but also what kinds of conversational behaviours an AI tutor would need to emulate to support deep, iterative learning. This aligns with Pratschke's (2024) argument that meaningful learning (especially in AI-rich environments)requires shifting assessment focus from final outputs to the scaffolded processes through which students reason, iterate, and construct knowledge.

First, the distribution of conversational moves across crit sessions (early-session presenting, mid-session questioning and commenting, and closing-stage reflection) suggests that effective tutoring requires dynamic modulation of stance over time. Rather than supplying generic prompts, a Socratic AI tutor would need to recognise the student's stage in the design cycle and adjust its questioning, feedback, and reflective cues accordingly. This has direct implications for conversational flow modelling in AI systems, particularly those relying on sequence-based or state-based dialogic scaffolds.

Second, the dominance of experiential modes such as negotiation, exploration, and application indicates that design learning is fundamentally iterative and problem-centered. An AI tutor designed for such environments should therefore prioritise prompts that promote student reasoning, test alternative interpretations, and foster exploratory iterations rather than provide prescriptive solutions. The crit demonstrates the value of iterative cycles of "explain-probe-revise," which align strongly with contemporary framings of AI tutors as partners in guided discovery learning (Stokel-Walker & Van Noorden, 2023; Bazouche, 2025).

Third, the presence of cognitive apprenticeship methods (modelling expert thinking, scaffolding complex decisions, coaching strategic moves, and encouraging articulation, exploration and reflection) highlights the relational and pedagogical depth required for effective AI support. These methods underscore the need for conversational agents that can not only prompt reflection but also demonstrate disciplinary ways of thinking, manage cognitive load, and gauge support to the student's emerging capability. Importantly, the shift between mentoring, consulting, and directive guidance observed in crit tutors suggests that an AI tutor may need to adopt flexible personas or scaffolding levels to align with student needs.

Contextual factors also play a crucial role. In Global South settings where bandwidth limitations, diverse cultural realities, and socio-economic pressures shape student participation, AI tutors must operate with heightened sensitivity to diverse communication styles and variable levels of prior knowledge (Olweny, 2017; Morkel et al., 2021). The online crit exposes how tutors compensate for these constraints through explicit verbalisation, multimodal redundancy, and affective support - features that AI systems must be designed to replicate if they are to function equitably in under-resourced environments.

Overall, the alignment between crit interaction patterns and the aspirations of Socratic AI tutoring suggests that human critique practices provide a valuable empirical template for designing pedagogically credible conversational agents. By grounding AI design in the moves, modes, and methods observed in real educational dialogue, it becomes possible to develop systems that augment rather than oversimplify the complex cognitive and relational work of teaching. The empirically derived framework presented in this paper offers a pathway towards AI tutors that not only emulate the structure of Socratic inquiry but also honour the contextual, experiential, and relational nuances that define effective design critique pedagogy.

5.2 Implications for the Design of Socratic AI Tutors

The findings of this study offer several implications for the design of LLM-powered Socratic tutors that aspire to support reflective, dialogic, and contextually responsive learning. The moves–modes–methods matrix provides a structured foundation for translating human critique practices into AI-mediated tutoring behaviours. These implications span pedagogical design, conversational architecture, and contextual adaptation, each of which is critical for developing AI tutors that are both educationally credible and socially responsive.

Pedagogically, the results highlight the need for AI tutors to facilitate learning through iterative cycles of explanation, probing, and refinement, rather than through directive content delivery. The crit demonstrates that learning is driven by structured questioning that promotes students' reasoning, challenges assumptions, and prompts the exploration of alternative strategies. AI tutors should therefore prioritise open-ended, generative questions that mirror the conversational moves observed in crit dialogue – specifically questioning, commenting, and reflective prompting. Pratschke (2024) similarly notes that the conversational affordances of generative AI make it well-suited to dialogue-driven pedagogies and assessments, reinforcing the value of modelling critique-based inquiry within AI tutor design.

Additionally, the prominence of cognitive apprenticeship methods in tutor behaviour suggests that AI tutors must be capable of modelling expert thinking in transparent ways, offering scaffolded hints, and guiding students through increasingly complex tasks while preserving student autonomy. These pedagogical patterns imply the need for LLMs to balance epistemic authority with strategic restraint, avoiding both over-direction and superficial encouragement.

From an interaction design perspective, the study underscores the importance of AI tutors adopting flexible conversational stances that shift according to the student's stage in the task and the nature of their responses. The moves–modes–methods matrix provides a usable model for structuring such adaptivity, enabling AI systems to modulate their prompts based on conversational state (e.g., presentation, exploration, or reflection). This may involve incorporating state-based dialogue models, persona switching, or hierarchical prompting structures to ensure that feedback is appropriately timed and pedagogically purposeful. Furthermore, the multimodal nature of the crit, where sketches, diagrams, and models play a critical role, points to the need for AI tutors capable of interpreting and responding to visual artefacts, or at least, prompting students to externalise visual reasoning through descriptive language. Such capabilities align with current developments in multimodal LLMs and interaction design for AI-supported creative disciplines.

Contextually, the Global South learning environment foregrounds additional design considerations. Bandwidth limitations, device constraints, and other resource challenges shape how students participate in online learning spaces. AI tutors must therefore be designed to function effectively in low-resource settings, leveraging lightweight interactions, text-first modes, or offline-compatible models where needed. The relational dynamics observed in the crit, especially the parent–child and mentee–mentor archetypes, highlight the importance of dialogic warmth, empathy, and affective support. AI tutors should therefore incorporate socio-emotional sensitivity, culturally aware phrasing, and adaptive encouragement to foster psychological safety and learner confidence, particularly for students experiencing socio-economic or epistemic marginalisation.

Finally, these implications suggest that the design of Socratic AI tutors cannot rely solely on prompt engineering or generic instructional strategies. Instead, AI tutors must be grounded in empirical evidence of how disciplinary learning unfolds through conversation, how expert reasoning is made visible, and how contextual constraints shape educational interaction. The moves–modes–methods matrix developed in this study provides a structured foundation for such design, enabling the development of conversational agents that are pedagogically rigorous, interactionally adaptive, and contextually inclusive.

5.3 Contextual Considerations for global South Learning Environments

The contextual realities of Global South higher education exert a significant influence on how online critique practices unfold and, by extension, on how AI tutors should be designed to support such environments. The live online crit analysed in this study illustrates the ways in which students and tutors navigate structural constraints shaped by limited digital infrastructure, cultural diversity, and socio-economic inequalities. These contextual factors do not simply form the backdrop to learning; they actively shape interactional patterns, influence pedagogical decisions, and determine the accessibility and meaningfulness of learning experiences.

Digital infrastructure constraints represent a key consideration. Bandwidth instability, device limitations, and uneven access to reliable internet directly affect students' participation in online crits, often requiring tutors to compensate through heightened verbalisation, redundancy in explanation, and careful pacing of dialogue. As a result, AI tutors intended for these contexts must be designed to operate effectively under low-bandwidth or intermittent connectivity conditions, with a prioritisation of text-based or compressed interactions over high-volume multimodal exchanges. This includes the ability to maintain conversational coherence across connectivity disruptions and provide adaptive responses when students re-engage after losing access; capabilities not commonly prioritised in AI tutoring research conducted in well-resourced environments.

Socio-economic diversity adds an additional layer of complexity. Students may balance work and study responsibilities, face unpredictable living or environmental conditions, or experience varying levels of exposure to digital tools. These conditions influence confidence, willingness to participate, and ability to sustain engagement in synchronous online learning environments. The online crit reveals how tutors frequently adopt mentoring, coaching, or even protective relational stances to support students' persistence and emotional wellbeing. This underscores the need for AI tutors that integrate affective support; providing encouragement, normalising uncertainty, and offering validation that aligns with principles of care and inclusion. Such sensitivity is essential to avoid unintended reproduction of inequities of students.

Cultural and relational norms also play a pivotal role. In many Global South contexts, hierarchical educational cultures and respect for authority influence student participation, often leading to hesitation in questioning tutors or expressing uncertainty. Human tutors adjust their relational stance accordingly, using humour, reassurance, or strategic self-disclosure to reduce power distances and foster dialogue. AI tutors must similarly be capable of modulating tone and relational posture to ensure that interactions are experienced as supportive rather than evaluative or punitive.

Overall, the contextual considerations emerging from this study demonstrate that the design of AI tutors cannot rely on generalised assumptions derived from Global North learning environments. Instead, they must explicitly incorporate responsiveness to infrastructural, linguistic, socio-economic, and cultural conditions that shape learning in the Global South. By doing so, AI-supported critique practices can contribute to widening access, enhancing epistemic justice, and supporting meaningful participation for diverse student cohorts.

6. Conclusion

This paper set out to explore how interactional dynamics in live online architectural design critiques can inform the design of LLM-powered Socratic conversational tutors. Drawing on data from surveys, a graduate focus group, and three recorded critique sessions, and guided by an integrated framework of Conversation Theory, Experiential Learning Theory, and Cognitive Apprenticeship, the study identified the relational, pedagogical, and conversational structures that underpin critique dialogue. These include four student–tutor relationship archetypes, four interactional dimensions, and a moves–modes–methods matrix that captures how design knowledge is articulated, negotiated, scaffolded, and iteratively refined in practice.

By mapping these empirically grounded patterns against current scholarship on Socratic AI tutors, the study demonstrates that the crit provides a rich and structurally coherent model of pedagogically meaningful dialogue; one characterised by probing questions, reflective prompts, modelling of expert reasoning, and iterative cycles of reflection and exploration. The moves–modes–methods matrix offers a theoretically robust and practically usable framework for translating these human critique practices into AI-mediated tutoring behaviours. In doing so, the study contributes to the emerging field of AI-based conversational pedagogy by providing concrete, evidence-based specifications for how LLM-powered tutors might emulate, support, or extend expert human facilitation.

Importantly, the findings highlight that effective AI tutoring design must be sensitive to the contextual realities of Global South learning environments. Bandwidth constraints, socio-economic pressures, and hierarchical educational cultures shape the nature of online interaction and the forms of support students require. The crit illustrates how human tutors compensate for these conditions through explicit verbalisation, multimodal scaffolding, and affective support. AI systems intended for these contexts must therefore embed lightweight interaction modes, and culturally responsive feedback strategies to ensure equitable and meaningful learning experiences.

Overall, this study positions architectural design critique pedagogy as a productive empirical lens for designing Socratic AI tutors that are pedagogically rigorous, interactionally adaptive, and contextually inclusive. The moves–modes–methods matrix provides a foundation for AI systems that can participate in structured, reflective, and exploratory dialogue while preserving the relational integrity and epistemic complexity of human–human critique. Future research should explore multimodal extensions to support visual reasoning, evaluate learner experiences with AI-augmented critique environments, and investigate how hybrid human–AI facilitation models might enhance learning in design and other feedback-intensive disciplines. By grounding AI design in authentic educational practice, this work contributes to developing conversational agents that augment (rather than replace) the expert pedagogical judgement at the heart of meaningful learning facilitation.

AI declaration: Artificial intelligence (AI) tools were not used to generate data, conduct analysis, or produce any part of the study's findings. All coding, interpretation, and synthesis were carried out by the author using

established qualitative research methods. AI assistance was used only for editorial support (such as grammar refinement and text clarity), and all AI-assisted text was critically reviewed, verified, and edited by the author. Responsibility for all content, arguments, and interpretations presented in this paper remains with the author.

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