Metacognitive Conversational AI: A Design Framework for Reflective Well-Being

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Conversational artificial intelligence systems are increasingly embedded in everyday cognitive and relational tasks, while their optimisation for immediacy and solution delivery raises questions about how they shape users' reflective capacities. Drawing on metacognitive theory, this paper proposes a conceptual framework for Metacognitive Conversational AI, which structures interaction design around three mechanisms: Reflection Activation, Structured Scaffolding, and Transfer and Retention. This framework translates metacognitive processes into interface-level design principles intended to preserve users' evaluative participation rather than fully externalise it.

Using design fiction methodology, two illustrative scenarios, grammar correction and interpersonal conflict resolution, demonstrate how modest adjustments to conversational sequencing can shift interaction from direct answer substitution toward structured reflective engagement. The paper argues that such design choices may have implications for regulatory flexibility and sustained well-being. It further examines structural, economic, and ethical tensions, including usability trade-offs, user agency, and cultural variation in conceptions of reflection.

By reframing conversational AI as a cognitive environment rather than merely a problem-solving tool, this work contributes a theoretically grounded design framework for integrating metacognitive support into human–AI interaction.

Keywords: Conversational AI, Human Well-Being, Chatbot, Design Fiction, Human–AI Interaction

Introduction

Conversational artificial intelligence systems are increasingly embedded in everyday cognitive and relational tasks. From drafting essays to offering guidance during interpersonal conflict, large language models function as general-purpose cognitive assistants (Biancofiore et al, 2025). Their appeal lies in immediacy: users receive fluent, contextually relevant responses within seconds (Callister et al, 2025). While this optimisation for speed and helpfulness represents a significant technological achievement, it raises an important question: how does interaction with systems that perform cognitive work on users' behalf shape the reflective capacities associated with sustained psychological well-being?

Psychological well-being has been consistently linked to adaptive coping, effective problem-solving, and emotional regulation (Hernandez et al, 2018; Tan et al, 2019). These capacities require more than correct outcomes; they depend on individuals' ability to monitor their thinking, evaluate alternatives, and adjust strategies across contexts. Such higher-order monitoring and control processes are collectively described as metacognition (Flavell, 1979; APA Dictionary of Psychology). Importantly, metacognitive skills are strengthened through active engagement rather than passive reception (Santangelo, Cadieux, and Zapata, 2021).

Contemporary conversational AI systems, however, are typically designed to minimise cognitive effort (Tezer, 2025; Gerlich, 2025). In educational contexts, they rewrite text directly; in relational scenarios, they provide ready-made advice. Although these features improve usability and short-term performance, they may reduce opportunities for users to articulate reasoning, examine uncertainty, or engage in strategic self-monitoring. Interaction design, therefore, becomes psychologically consequential: it shapes the extent to which users participate in their own reflective processes.

Specifically, this paper proposes a conceptual framework for Metacognitive Conversational

AI, drawing on Flavell's (1979) tripartite model to translate metacognitive theory into interface-level design principles. It then examines how such an approach intersects with structural and economic incentives that prioritise frictionless interaction and illustrates its implications through two design-fiction scenarios involving learning and interpersonal conflict.

By articulating a theoretically grounded model of reflective AI design, this paper aims to contribute to interdisciplinary discussions in digital well-being, human–AI interaction, and cognitive augmentation. As conversational systems increasingly mediate reasoning and emotional appraisal, designing for metacognition offers a pathway toward AI systems that strengthen, rather than replace, human regulatory agency.

1. Conversational AI and Wellbeing

Conversational AI has increasingly been positioned as a tool for supporting psychological well-being, especially since the onset of COVID-19 (Amazu, 2020). Research suggests that AI-based conversational agents can provide mental health support and promote behavioural change (Li et al, 2023; Musikanski et al, 2020). Framed as scalable interventions, such systems aim to address gaps in traditional services by offering immediate responses, emotional validation, and structured guidance.

Within human–computer interaction research, technology-mediated nudging has been identified as one mechanism through which AI systems can influence well-being. Rather than merely providing information, nudges restructure the decision environment so that certain actions become more salient, emotionally compelling, or easier to execute (Hansen and Jespersen, 2013; Caraban et al, 2019). Caraban et al. (2019) identified mechanisms, including reinforcement, emotional framing, and social influence, through which interface design can steer behaviour toward predefined outcomes. Empirical applications, such as conversational programmes encouraging physical activity (Chater et al, 2022) and chatbot-based screening tools for eating disorders (Mejova and Suarez-Lledó, 2020), illustrate how dialogue-based systems can lower barriers to action and guide users toward specific behavioural steps. Despite these advances, important limitations remain (Gupta et al, 2023; Jiang et al, 2023). Many conversational systems prioritise fluent and immediately actionable output, requiring limited cognitive engagement from users. Recommendations can be accepted without articulating reasoning or evaluating alternatives, potentially reducing opportunities for reflective learning and limiting the durability of behavioural change. Moreover, responses generated from broad training data may reflect generalised patterns rather than deeply contextualised reasoning. While such systems can improve efficiency and short-term outcomes, their contribution to sustained regulatory development remains uncertain.

These limitations reveal a design asymmetry. Existing research often evaluates conversational AI in terms of symptom reduction, behavioural compliance, or user satisfaction, yet comparatively little attention has been given to how interaction structures shape users' cognitive participation. This conceptual gap motivates a shift in emphasis: from optimising solution delivery to structuring metacognitive engagement in AI.

2. Theoretical Foundation: What Is Metacognition?

To structure metacognitive engagement in AI, it is important to first clarify what metacognition is. Metacognition refers to the processes through which individuals monitor and regulate their own cognition. In his model of cognitive monitoring, Flavell (1979) proposed that monitoring emerges from the interaction of four elements: metacognitive knowledge, metacognitive experiences, goals (or tasks), and actions (or strategies).

Metacognitive knowledge denotes stored knowledge about oneself as a cognitive agent (e.g., strengths or habitual tendencies), about task demands, and about the conditions under which particular strategies are effective. This knowledge is relatively stable and generalisable across contexts. Metacognitive experiences, by contrast, are conscious cognitive or affective experiences that arise during task engagement. Feelings of uncertainty, confidence, difficulty, or fluency provide situational feedback about ongoing processing. Goals organise cognitive activity by defining what the individual seeks to achieve, while actions are the cognitive or behavioural operations undertaken in pursuit of those goals.

Although Flavell (1979) did not formally designate "metacognitive regulation" as a separate structural component, subsequent scholarship has used the term to describe the evaluative coordination through which metacognitive knowledge and experience guide strategic adjustment (Wongdaeng, 2022). In this paper, metacognitive regulation refers to this functional process: assessing the alignment between goals, current strategies, and ongoing cognitive states, and modifying behaviour accordingly.

This dynamic coordination is central to psychological functioning. Empirical research indicates that the ability to monitor and recalibrate cognitive and emotional processes is associated with adaptive coping and sustained well-being. Awareness of cognitive and affective states facilitates effective stress regulation (Solem et al, 2015; Drigas and Mitsea, 2021), while evaluative monitoring and goal-directed planning are linked to resilience and subjective well-being (MacLeod et al, 2008; Yazar and Tolan, 2020). The relevance of metacognition to well-being, therefore, lies in regulatory flexibility — the capacity to detect misalignment between goals and strategies and adjust accordingly.

If regulatory flexibility contributes to well-being, then the design of systems that participate in users' cognitive processes becomes consequential. In conversational AI contexts, users typically approach systems with defined goals, while strategic actions may be generated internally (by the user) or externally (by the system). When AI generates solutions without requiring evaluative engagement, aspects of the monitoring cycle may become partially externalised. Although such substitution can enhance efficiency, it may reduce opportunities for strengthening internal reflective capacities over time (Ahmad et al, 2023). Conversely, interaction designs that prompt awareness, encourage evaluation, and invite strategic reconsideration may support — rather than replace — users' regulatory involvement.

Accordingly, the present framework identifies three interrelated processes as primary sites of design intervention in conversational AI: activation of metacognitive knowledge, elicitation of metacognitive experience, and support for metacognitive regulation. While Flavell's original model also distinguishes goals and actions, these elements typically define the task structure itself. In conversational AI contexts, goals are often articulated by users, and actions may be generated either internally or suggested by the system. By contrast, knowledge, experience, and regulation constitute the reflective layer through which goals and actions are evaluated and adjusted (Merkebu et al, 2024). Focusing on these three processes, therefore, clarifies how conversational systems may influence the extent to which users remain active participants in their own cognitive control.

3. Conceptual Framework: A Three-Layer Model of Metacognitive Conversational AI

Building on the identification of metacognitive knowledge, metacognitive experience, and metacognitive regulation as primary sites of design intervention, the following task is to specify how conversational AI can engage these processes in practice.

This framework distinguishes three interrelated mechanisms of intervention: *Reflection Activation, Structured Scaffolding, and Transfer and Retention*. These mechanisms do not introduce new theoretical constructs; rather, they translate the previously outlined metacognitive architecture into interaction-level design principles. Their sequence reflects functional dependency rather than arbitrary categorisation. Specifically, metacognitive knowledge and experience must first become explicit before regulatory evaluation can occur, and regulatory engagement must be sustained before reflective insight can consolidate into durable, transferable knowledge. Each mechanism, therefore, builds upon the conditions established by the previous one.

Reflection Activation operates at the outset of engagement (Ribeiro et al, 2019) and primarily targets metacognitive knowledge and metacognitive experience. Conventional conversational systems typically deliver immediate, fully formed responses, leaving limited opportunity for users to articulate assumptions, clarify intentions, or recognise uncertainty. Reflection Activation reintroduces evaluative space by prompting users to define their goals, identify points of difficulty, or examine their current understanding before or alongside solution provision. By making these elements explicit, the system activates stored knowledge about the task and surfaces subjective cognitive or affective states that inform subsequent evaluation. Awareness here refers specifically to the conscious articulation of one's understanding, uncertainty, or strategic orientation.

Structured Scaffolding operates during task processing (Xun and Land, 2004) and primarily supports metacognitive regulation. Once knowledge and experience are brought into awareness, users must evaluate whether their current strategies align with their goals. Rather than completing this evaluative work on the user's behalf, the system organises reasoning into guided steps. Explanations of underlying principles, presentation of alternative interpretations, and prompts for comparison structure planning, monitoring, and adjustment. In this configuration, strategic modification remains participatory: the user continues to assess alignment between goals, strategies, and cognitive states instead of relying solely on externally generated conclusions.

Transfer and Retention operate beyond immediate task resolution (Farr, 2012) and reinforce metacognitive knowledge while strengthening future regulation. Many AI interactions conclude once a solution is delivered, limiting opportunities for abstraction. This mechanism introduces prompts that encourage users to extract generalisable principles from the exchange, such as articulating a rule, identifying a recurring pattern, or anticipating application in similar contexts. Such abstraction supports the consolidation of knowledge and increases the likelihood that regulatory flexibility extends across situations rather than remaining confined to a single instance.

Taken together, these mechanisms structure intervention across the progression of reflective engagement: awareness activation, regulatory support, and consolidation. By distributing metacognitive support across these stages, conversational AI can maintain user involvement in cognitive regulation while remaining compatible with efficiency demands. It should be noted that real-world interactions may not follow clean sequential phases, and reflective engagement may unfold iteratively rather than linearly. The three mechanisms, therefore, describe functional dependencies rather than rigid temporal stages.

4. Methodology

4.1. Design Fiction

This study uses design fiction to explore how conversational AI interaction could be redesigned by integrating metacognitive prompts to support and maintain human well-being, using the framework. Design fiction is well-suited to conceptual and design-oriented contributions because it enables speculative but plausible scenarios that extend existing technological practices and make design mechanisms visible for analysis (Dunne and Raby, 2024).

4.2. Case Study

Two cases were selected to illustrate metacognitive prompting across distinct task types. The first case focuses on grammar and spelling correction. It draws on Tabib and Alrabeei (2024) and reflects the increasing use of AI systems as writing assistants, particularly for checking and revising academic work (Tossell et al, 2024). This domain is useful for examining whether conversational AI can do more than provide corrected output. Specifically, whether it can prompt learners to notice errors, reflect on rules, and retain strategies for future writing.

The second case extends beyond rule-governed correction into social–relational reasoning. Conversational AI is less frequently used to address social dynamics because interpersonal conflict is highly context-dependent and requires personalised interpretation rather than fixed rules (Subramonyam et al, 2023). This case, therefore, tests whether metacognitive prompting can support reflection and planning in situations where "correct answers" are not well-defined.

4.3. Scenarios

Two scenarios were created to illustrate how conversational AI responses could be redesigned in line with the framework proposed above. Both scenarios were inspired by everyday situations that can be challenging for metacognitive regulation and were drafted using a conversational AI system (OpenAI, 2023), which can quickly simulate plausible interaction patterns in natural language (Nazi and Wang, 2023). It should be noted that although the illustrative scenarios were primarily created using ChatGPT 3.5 (OpenAI, 2023), the analysis does not depend on the specific capabilities of that model. The proposed framework concerns interaction structure rather than underlying model architecture. As newer conversational models continue to improve in fluency and contextual reasoning, the question of how interaction design shapes users' metacognitive engagement remains equally relevant. The principles outlined here therefore generalise to contemporary and future large language models that function as conversational cognitive assistants.

Each scenario is presented in two versions. Version 1 represents a baseline interaction pattern in which the system responds in a conventional direct-answer style. Version 2 represents a framework-guided interaction in which prompts are introduced to instantiate the three mechanisms: Reflection Activation (prompting users to articulate assumptions, goals, uncertainty, or feelings before or alongside advice), Structured Scaffolding (organising evaluation through stepwise reasoning, comparison, and guided self-evaluation), and Transfer and Retention (encouraging generalisation by prompting users to summarise principles or anticipate future application).

Scenario 1: Grammar and Spelling Correction

This scenario illustrates how conversational AI can be used to correct grammar and spelling errors in academic writing. A short paragraph of approximately 40 words was constructed, containing three spelling mistakes and two grammatical errors. The paragraph was submitted to conversational AI for correction.

As shown in Figure 1, in the baseline interaction, the system provides a fully corrected version of the paragraph immediately. While this format efficiently improves the text, it may reduce opportunities for the user to identify error locations or understand the grammatical principles involved. Users may focus on copying the corrected text rather than reflecting on the underlying rule. Without engaging in error diagnosis, the same mistakes may recur in subsequent writing (Covey, 1992).

To operationalise the proposed metacognitive framework, the interaction was restructured (Figure 2). Rather than presenting the corrected paragraph directly, the system first highlights specific areas of concern and prompts the user to reconsider them. For example, the user may be asked to double-check the spelling of a particular word or reflect on whether the verb tense is consistent. This step corresponds to Reflection Activation, as it brings relevant grammatical knowledge and uncertainty into awareness.

Following this, the system provides brief explanations of the grammatical principles involved before presenting the corrected form. This constitutes Structured Scaffolding, as the reasoning process is organised in a way that supports monitoring and evaluation rather than replacing them. The user is guided to understand why the correction is necessary.

Finally, the system may prompt the user to summarise the rule or identify similar errors elsewhere in the text. This stage supports Transfer and Retention, encouraging abstraction beyond the immediate instance and strengthening the likelihood that the user will apply the principle independently in future writing.

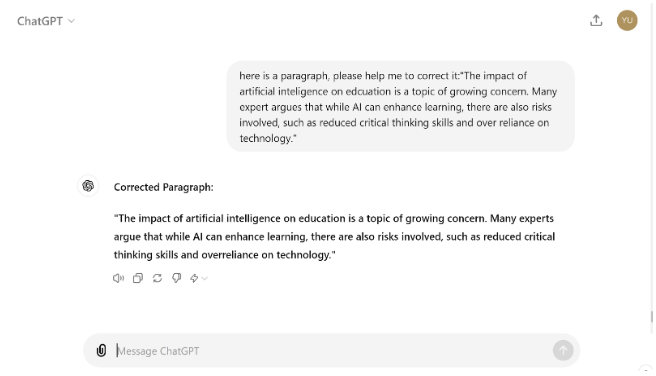


Figure 1: The screenshot of how conversational AI helps to correct the sentence.

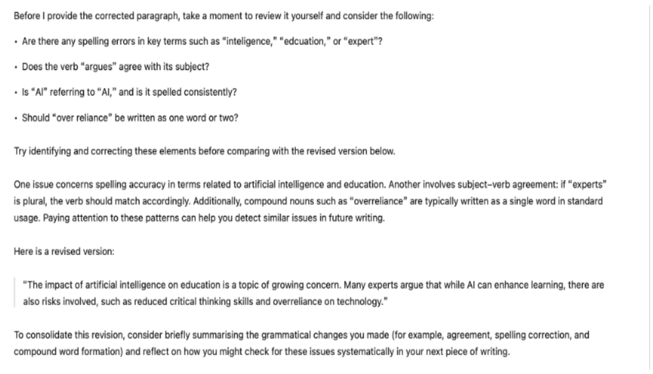


Figure 2: The screenshot of how conversational AI with metacognition prompts helps to correct the sentence.

Scenario 2: Interpersonal Conflict Resolution

The second scenario examines how conversational AI may be used to address interpersonal conflict. A fictional situation was constructed in which a user feels frustrated because a friend repeatedly arrives late to planned meetings. Although the user's friend promised to send a message in advance if she were late next time, the user still felt the problem was unsolved, and there was tension between them. The user submits this scenario to conversational AI and requests advice.

In the baseline interaction (Figure 3), the system provides general recommendations, such as communicating expectations clearly and planning in advance. Although these suggestions are reasonable, they remain broad and may not address the user's specific emotional experience or relational context. Because the advice is generated without eliciting deeper reflection, it may not prevent the recurrence of the same issue.

In the revised interaction (Figure 4), the response structure is modified in line with the framework. Before offering advice, the system asks a series of clarifying questions about the relationship, the emotional significance of punctuality, and prior communication attempts. These prompts activate metacognitive knowledge and experience, corresponding to Reflection Activation. By encouraging articulation of feelings and assumptions, the system creates evaluative space before solution delivery.

The questions also guide the user through structured reflection on patterns of behaviour and possible misalignment in expectations. For instance, asking how frequently lateness occurs or whether punctuality has been discussed previously supports self-evaluation and regulatory monitoring, aligning with Structured Scaffolding. Asking how the user typically handles unexpected changes introduces an element of planning, further engaging regulatory processes.

After this reflective stage, more tailored suggestions are provided. The user is also encouraged to consider how similar conflicts might be handled in the future, which corresponds to Transfer and Retention. By prompting forward-looking strategy formation, the system supports regulatory flexibility beyond the current incident.

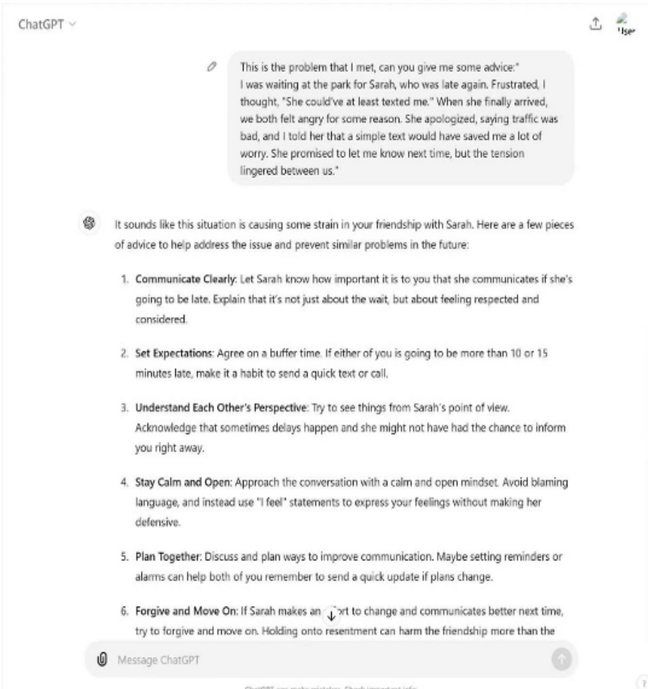
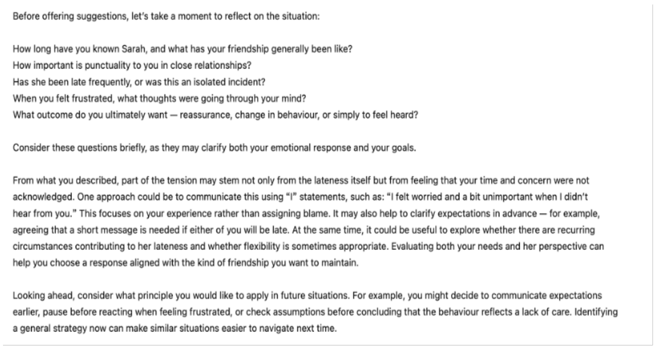


Figure 3: The screenshot of how conversational AI with metacognition prompts answers the

requirements of giving a recommended solution to an argument between friends initially.


Before offering suggestions, let's take a moment to reflect on the situation:

How long have you known Sarah, and what has your friendship generally been like?
How important is punctuality to you in close relationships?
Has she been late frequently, or was this an isolated incident?
When you felt frustrated, what thoughts were going through your mind?
What outcome do you ultimately want — reassurance, change in behaviour, or simply to feel heard?

Consider these questions briefly, as they may clarify both your emotional response and your goals.

From what you described, part of the tension may stem not only from the lateness itself but from feeling that your time and concern were not acknowledged. One approach could be to communicate this using “I” statements, such as: “I felt worried and a bit unimportant when I didn’t hear from you.” This focuses on your experience rather than assigning blame. It may also help to clarify expectations in advance — for example, agreeing that a short message is needed if either of you will be late. At the same time, it could be useful to explore whether there are recurring circumstances contributing to her lateness and whether flexibility is sometimes appropriate. Evaluating both your needs and her perspective can help you choose a response aligned with the kind of friendship you want to maintain.

Looking ahead, consider what principle you would like to apply in future situations. For example, you might decide to communicate expectations earlier, pause before reacting when feeling frustrated, or check assumptions before concluding that the behaviour reflects a lack of care. Identifying a general strategy now can make similar situations easier to navigate next time.

Figure 4: The screenshot of how conversational AI answers the requirements of giving a recommended solution to an argument between friends after training.

5. Discussion

Across both scenarios, restructuring conversational responses shifted the interaction from answer substitution toward reflective engagement in ways that may support well-being. In the writing context, prompting reconsideration before correction preserved users' involvement in monitoring and evaluation. Such engagement aligns with research showing that retrieval and self-explanation processes are associated with stronger consolidation and reduced repetition of error (Selmeczy, Kazemi and Ghetti, 2024), and that self-monitoring supports problem-solving development (Hewitt, Chreim and Forster, 2016). The scenario, therefore, illustrates how conversational design can scaffold regulatory participation rather than externalise it.

In the interpersonal context, introducing reflective questioning before advice provision similarly altered the sequencing of cognition. By foregrounding appraisal prior to prescription, the interaction theoretically reduces the likelihood of affect-driven distortion, consistent with evidence that strong emotions can bias judgment (Clore and Huntsinger, 2007). Encouraging users to examine relational patterns and anticipate future strategy supports evaluative monitoring and forward planning.
Together, the scenarios suggest that modest changes in interaction architecture can redistribute cognitive work to further maintain well-being, without fully displacing efficiency. Metacognitively structured conversational AI does not eliminate immediacy; rather, it introduces calibrated reflection alongside it. If regulatory flexibility contributes to sustained well-being (Tan et al, 2019; Yazar and Tolan, 2020), then preserving evaluative participation within AI-mediated interaction may have implications for long-term problem-solving capacity (Hartman, 2001).

However, this rebalancing introduces a structural trade-off. Additional reflective steps may increase cognitive load and reduce perceived efficiency. Users seeking rapid answers may experience frustration when confronted with extended questioning (Jeong, 2012). Conversational systems operate within markets that have converged on immediacy for a reason: speed is valued. A design that deliberately slows interaction to promote reflection may therefore conflict with prevailing engagement metrics.
These economic realities raise broader structural questions. Under what governance or institutional conditions would reflective scaffolding be incentivised? Educational technologies, subscription-based learning platforms, and public-sector mental health applications may prioritise long-term skill development over immediate engagement (Chumdoem, Boonlue and Narmluk, 2024; Damij and Bhattacharya, 2022). In contrast, in competitive consumer markets, design incentives typically reward immediacy and frictionless interaction, making reflective friction commercially unattractive (Gnewuch et al, 2018). Therefore, the adoption of metacognitive conversational AI is not solely a cognitive or technical issue but also an institutional one. This also further demonstrates that it is hard to find a balance between enhancing metacognition and the usability of the chatbot.

Relatedly, user agency warrants careful consideration. While metacognitive prompting may support adaptive outcomes, it cannot be assumed that users universally desire deeper engagement. Introducing reflective friction for users' “benefit” risks paternalism if imposed without transparency or choice. Adaptive or optional modes of interaction may provide a more ethically defensible pathway, allowing users to select scaffolded engagement in contexts involving learning or emotional complexity while retaining rapid-response functionality elsewhere.

Cultural context further complicates the assumption that metacognition is uniformly beneficial across populations. Much of the metacognitive literature underpinning this framework is grounded in Western psychological traditions. In collectivist or relationally oriented contexts, regulatory processes may be more distributed across social networks rather than centred on individual introspection (Wang and Liu, 2010). Conversational systems deployed globally should therefore remain sensitive to variation in communication norms, authority structures, and conceptions of well-being.

Moreover, several other limitations merit consideration. One potential limitation is that adding metacognition prompts might disrupt the natural flow of the conversation. This can be explained by the fact that the conversational AI is not that familiar with human natural language processing and human cognitive processes (Theophilou et al, 2023). This might cause the users to feel the interaction is unnatural and forced, which thus affects the usability of the chatbot.

In addition, effective metacognitive prompting requires personalisation based on the user's background, preferences and cognitive styles (Odilinye, 2019). This means that the conversational AI might need extensive data collection and analysis to provide personalised and useful suggestions for the users. However, this might raise the user's concerns about data security and privacy (Zhu et al, 2014).

As a result of the limitations, some future directions are provided. First of all, future research should empirically evaluate the cognitive and behavioural consequences of metacognitive conversational design. Experimental comparisons between direct-answer interfaces and scaffolded interfaces could assess differences in retention, transfer, and independent problem-solving. Longitudinal designs would be particularly valuable in determining whether repeated exposure to structured reflection enhances regulatory flexibility over time.

At the same time, identifying boundary conditions is essential. Excessive prompting may increase cognitive load or reduce engagement, and individual differences in motivation, prior knowledge, or cultural orientation may moderate effectiveness. Determining optimal levels and timing of reflective scaffolding will therefore be critical.

Implementation challenges also require attention. Effective calibration depends on conversational systems' ability to detect when reflective prompting is appropriate and what language should be used. This necessitates advances in contextual sensitivity rather than merely increasing prompt frequency. In addition, greater emphasis on data protection and privacy safeguards will be necessary if personalisation is used to support metacognitive engagement.

Conclusion

Enhancing and sustaining human well-being remains an important interdisciplinary concern, particularly as conversational AI becomes increasingly embedded in learning and relational contexts. Although conversational systems are often positioned as tools for supporting well-being, they are typically optimised for immediacy and solution delivery. As a result, users may receive efficient answers without engaging in the reflective processes that support long-term regulatory flexibility.

This paper proposed a conceptual framework for Metacognitive Conversational AI, suggesting that interaction design can be structured to activate awareness, support evaluative regulation, and encourage transfer beyond immediate tasks. Through two illustrative scenarios, writing correction and interpersonal conflict, the analysis demonstrated how modest adjustments to conversational sequencing can preserve users' participation in monitoring and strategy formation, rather than fully externalising these processes, which may have implications for sustained well-being.

The contribution of this work is conceptual rather than empirical. It argues that conversational AI should be understood not only as a problem-solving tool but as a cognitive environment that shapes reflective engagement. Future work should examine how metacognitive prompting can be calibrated to balance usability and reflective depth, while also addressing issues of privacy, contextual sensitivity, and cultural variation. By integrating metacognitive principles into conversational design, AI systems may better support sustained well-being rather than merely providing immediate solutions.

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