

Supporting Self-Regulated Learning with Generative AI via the Diamond Chain Method

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Abstract

The rapid adoption of Generative Artificial Intelligence (GenAI) tools in higher education has fundamentally altered how students approach learning, problem solving, and knowledge construction. Although GenAI systems can generate explanations, code, and design alternatives with unprecedented speed, their integration into formal learning processes raises critical pedagogical questions. Among these are the risks of superficial understanding, over-reliance on automated outputs, and the erosion of metacognitive control in learners.

Recent research in AI-supported education emphasizes the importance of human-in-the-loop approaches, where learners remain actively responsible for interpretation, decision-making, and validation of AI-generated content [1]. However, many existing models focus either on tool adoption or learning outcomes, offering limited guidance on how to structure the learning process itself when GenAI is used as a cognitive partner.

This extended abstract builds on a previously introduced communication framework between humans and GenAI systems, referred to as the Diamond Chain Method (DCM) [2], which extends the well-known Double Diamond design model [4]. In its original form, the method assigns divergent thinking tasks (idea generation, exploration of alternatives) to GenAI, while convergent thinking tasks (evaluation, selection, decision-making) remain explicitly human responsibilities. The present work extends this framework to an iterative learning-oriented model, focus-

ing on how GenAI-supported problem solving can be transformed into a structured, transparent and reflective knowledge construction, as Figure 1 shows.

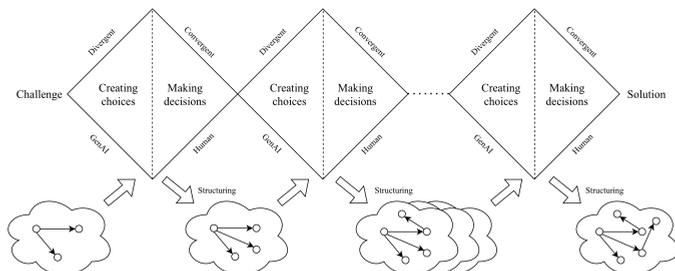


Figure 1. Diamond Chain Method with Second Brain extension

Using a student-centered case study that involves the first use of MATLAB in an AI-assisted fashion-oriented data analysis project, we demonstrate how iterative interaction with GenAI, combined with systematic documentation in a personal knowledge management system, can support self-regulated learning (SRL), metacognition, and scaffolded knowledge development.

The classical Double Diamond model describes design processes through alternating divergent and convergent phases. In the DCM, this structure is adapted for human–GenAI collaboration by assigning distinct cognitive responsibilities:

- *GenAI in a divergent space:* Generation of alternatives, exploration of possible solutions, code drafts, workflows, and conceptual explanations.
- *Human Learner in convergent space:* Interpretation, critical evaluation, decision-making, validation, contextualization.

In the present work, this structure is further extended into an iterative chain, where each cycle produces not only a solution attempt but also structured knowledge artifacts.

The iterative process follows this pattern: *Communication* → *AI response* → *Structured knowledge representation* → *Knowledge expansion* → *Emergence of new questions* → *Next iteration*

This transformation reframes the GenAI interaction from a question–answer paradigm into a learning loop, where each iteration deepens conceptual understanding rather than merely advancing task completion.

The method was explored as a university assignment project that involved students working on an AI-supported fashion analysis task. The technical goal was to explore whether MATLAB could be used to perform an initial clustering of fashion styles based on image datasets [3].

The learning process began with high-level questions directed to GenAI on the feasibility and suitability of the tool. Following AI-generated suggestions, a

concrete workflow was proposed, including dataset selection, feature extraction, and clustering.

A critical component of the method is the use of an Obsidian vault as a structured knowledge repository. Rather than treating AI-generated code as a final artifact, the learner systematically processed the output:

- Each line of MATLAB code was examined.
- Explanations for unfamiliar functions and syntax were requested.
- The concepts were linked to broader themes (e.g., clustering, data preprocessing, feature extraction).

This process transformed AI responses into interconnected knowledge nodes that effectively function as an external memory and metacognitive support system. The vault enabled:

- Transparent documentation of the learning process
- Traceability of conceptual development
- Identification of knowledge gaps that informed subsequent prompts

A key conclusion of this study is that by assigning divergence to AI and convergence to the learner, the method mitigates the risk of passive consumption of AI output. This aligns with Bloom's taxonomy, where higher-order cognitive processes, such as analysis, evaluation, and creation, remain human responsibilities.

The iterative Diamond Chain structure transforms learning into a process of progressive knowledge refinement. This supports theories of knowledge scaffolding, where temporary supports (GenAI suggestions) are internalized through active processing and documentation.

As an outcome, this work proposes the Second Brain extension of the Diamond Chain Method as a transferable, learning-oriented framework for human-GenAI collaboration that educators and students can adapt to technical and interdisciplinary learning contexts.

References

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