How Human-AI Interactions Shape Collaborative Learning

An Activity Theory Perspective

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Introduction

- Collaboration and reflection are important components to support Generative artificial intelligence (GenAI) usage (Chiu et al., 2024). Interaction with GenAI stimulates the dynamic co-creation of thoughts (Obrenovic et al., 2024). Exploring the roles GenAI takes in collaborative learning would facilitate the understanding of the ecological context of integrating GenAI into authentic courses.

- Targeting negotiated knotworking among multiple activity systems (Engeström & Sannino, 2021), the third generation of Activity Theory (AT) provides an ecological lens to analyse the interaction in GenAI-assisted collaborative learning.

- In pre-service teach students education, lesson plan is time consuming. With the advance of GenAI, some articles have explored the potential of GenAI in lesson plan automatical generation (Choi et al., 2024; Okulu & Muslu, 2024). Though the automated lesson plan generation reduce the labour and time invested in lesson plan design, some shortcomings are identified like vagueness of instruction and inability to provide external materials (Choi et al., 2024; Okulu & Muslu, 2024).

Research questions

Lesson plan assessment task is an ill-defined problem-solving task, encompassing diverse challenges such as prior pedagogical knowledge and domain knowledge activation, problem representation, a variety of revision solutions exploring, and converge on the applicable revision suggestions.

This process requires private information that commercial GenAI does not include, such as student profiles, prior teaching materials used, and the preparation of operational experimental materials. Integrating GenAI into human-led lesson plan evaluation tasks could combine the advantages of both, the massive information stored by GenAI and the customized private data stored by humans in specific scenarios.

This study utilize GenAI as an assistant to support lesson plan assessment first in individual and then in collaborative set. The findings from this study also contribute to the understanding of how human-GenAI interactions evolve between individual and collaborative tasks.

- How do tools and division of labour elements fluctuate from GenAI-assisted individual learning to collaborative learning?

Research questions

This study aims to reveal the characteristics of students' collaboration with GenAI and human partners in cognitive and regulative dimensions at two levels: individual and collaborative.

In the context of Gen-AI assisted assessment, learners conceptualize a mediated activity system where students are subjects prosecuting their assessment tasks. Although the subject, object, and tool exist in the same community, students have different rules, and each activity system has its own division of labour.

A simplified relationships among these elements can be seen in figure 1.

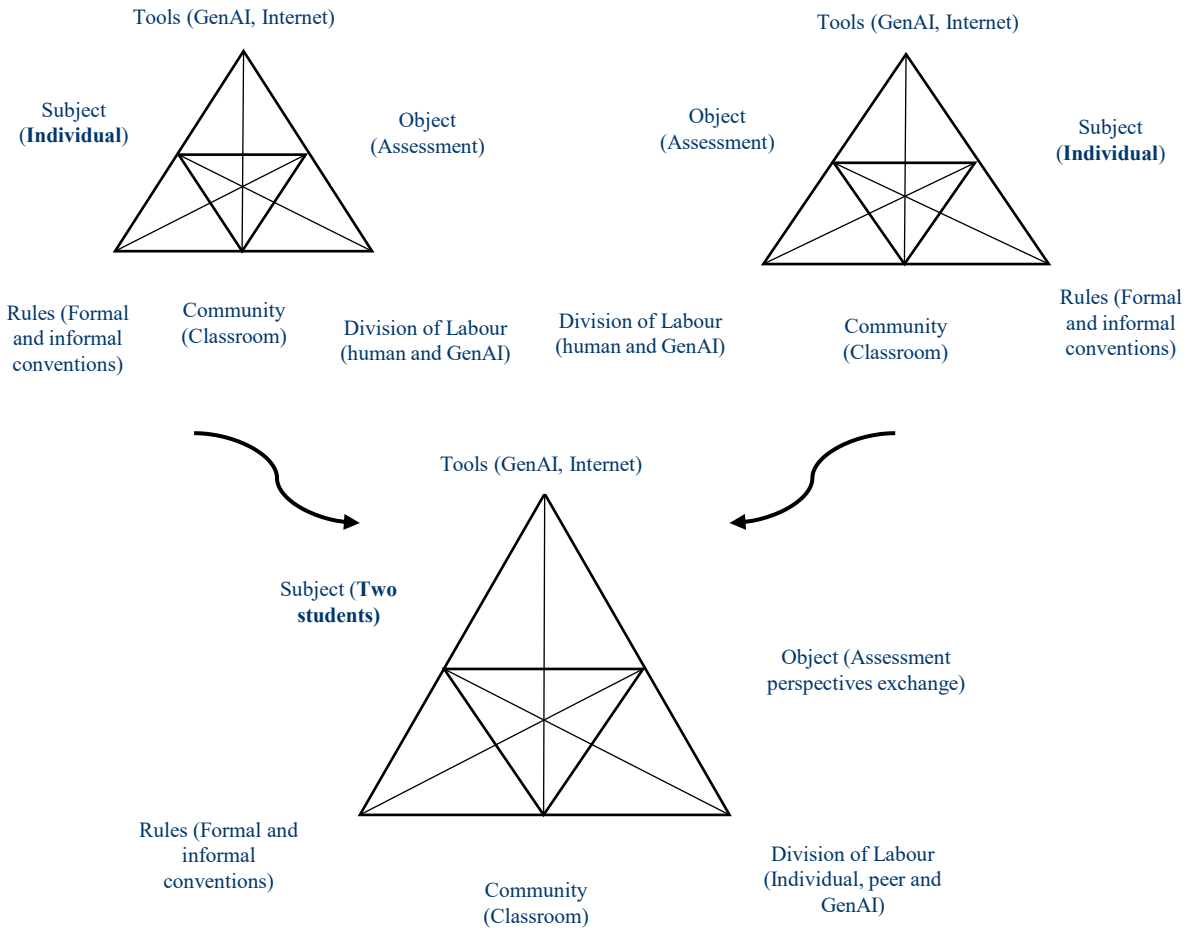

Figure. 1. GenAI-assisted assessment tasks based on Engeström's AT-

Methods

The study was conducted in two phases: GenAI-assisted lesson plan assessment by individual students and then by groups. The detailed of the assessment activities design from a AT framework can be found in table 1. Participants were randomly assigned two-person groups to finish the assessment task.

AT elements	Individual assessment task	Collaborative assessment task
Tools	WORD document (lesson plan), GenAI tool	WORD document (lesson plan), GenAI tool
Subject	individual student	students and their peers
Object	assess and revise the self-designed lesson plan	GenAI-assisted lesson plan peer assessment task to facilitate the integration of GenAI in classroom and to stimulate pre-service teacher students critically thinking how to use GenAI in lesson plan design.
Rules	individual students need to decide whether, and how to use and evaluate generated outputs from GenAI; GenAI act as an assistant in lesson plan assessment.	Students need to decide to take turns as the feedback provider and receiver GenAI act as an assistant in lesson plan assessment.
Division of labor	individual students' inquiry GenAI to evaluate and revise lesson plan; GenAI generates feedback to the inquiry; individual students either accept or reject the generated feedback.	As feedback provider, students need to provide give their comments and reasoning; As feedback receivers, students need to response to the comments received and express their willingness and reasoning; GenAI can be used to assist students with giving and response the feedback.
Community	authentic classroom setting, instructor, GenAI, individual students	authentic classroom setting, instructor, GenAI, individual students and their peers
Outcome	Revised lesson plans, screen recordings	revised lesson plans, screen recordings, peer dialogue recordings

Methods

- **Data collection:** Data sources included screen recordings of individual ChatGPT sessions, audio recordings of group discussions, and students' written lesson plan revisions. Audio recordings were manually transcription and segmented for further analysis.

- **Data analysis**: We conducted thematic analysis (Braun & Clarke, 2006) to identify patterns in interaction. Considering the research question proposed in this study, attention was mainly paid to the division of labour of the 3rd generation of AT because this element refers to horizontal division of tasks and vertical division of power and status (Engeström Y., Sannino, 2021).

Results

During individual tasks, besides the assigned tools, other related tools were utilized to enrich or verify the lesson plan during assessment such as search engine and self-developed courseware.
As shown in figure 2, 6 main themes, 10 subthemes were identified to describe the human-AI interaction in individual tasks. Most of them demonstrated the preference to generate text from text.

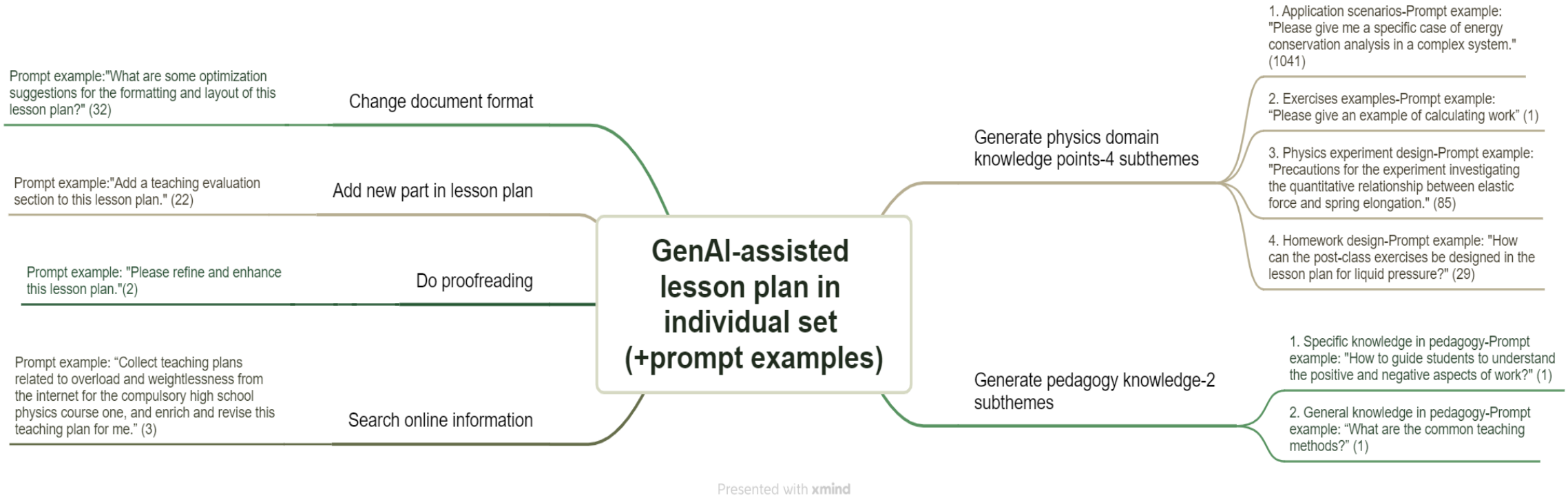

Figure 2. Division of labours themes in GenAI-assisted lesson plan assessment individual tasks.

Results

Regarding GenAI-assisted collaborative tasks, 5 main themes, 26 subthemes were found, including Human group conversation, combination of Human group+GenAI, combination of Human group+other group, combination of Human group+instructor, Search engines as other data sources (details in Figure 3). Compared to individual tasks above, more interaction activities happened.

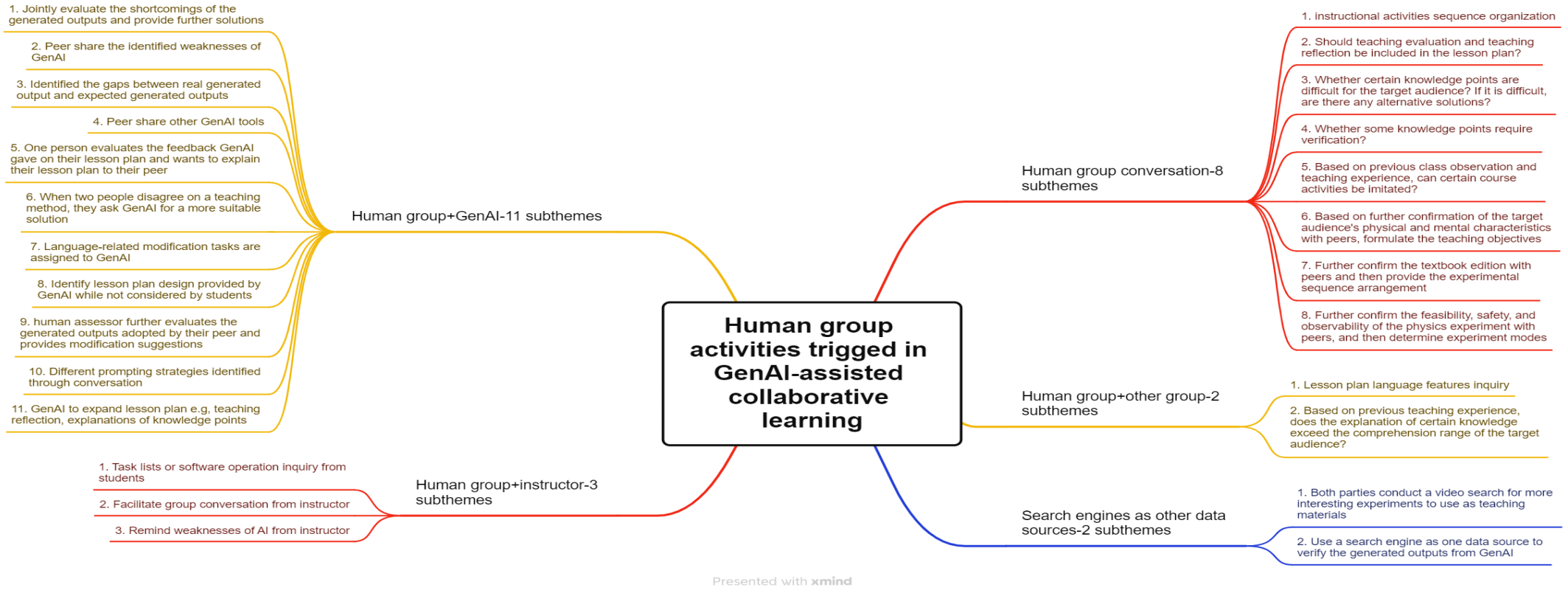

Figure 3. Division of labours themes in GenAI-assisted lesson plan collaborative tasks.

Discussions

- Compared to other empirical studies about GenAI-assisted tasks using AT as analysis framework

Similar to the tensions identified from Otto et al. (2025), our study also found these tensions. Furthermore, our study provides additional empirical evidence to exemplify this tension. For tension in the object mediation, based on the prior individual usage experience and the GenAI usage in collaborative learning, more epistemic and pragmatic events were triggered. For example, generated feedback as shared targeted artifact, student groups share their usage experiences of the identified weakness of GenAI in lesson plan design. The generated feedback as a evaluation reference, students actively evaluate the generated feedback from GenAI and critically explain their lesson plan to their peer.

- Compare to other studies in GenAI-assisted problem solving tasks

Like the affordances provided by GenAI in the study by Urban et al. (2024), we also found the involvement of GenAI facilitate the deep exploring of the problem space and develop more elaborated solutions. Furthermore, this phenomenon not only emerged in human-AI individual task but also in human-AI collaborative task.

Conclusion and Impications

For future studies, educators, curriculum designers, or educational technology developers need to pay attention to:

- Metacognition and task decomposition support in GenAI-assisted problem solving.

Integrating AI outputs into human knowledge systems requires human's technical and conceptual skills to assess the outputs of AI systems for which knowledge practice like sense making and meaning making is becoming important (Markauskaite et al., 2022). During the working with GenAI, metacognitive flexibility and task decomposition play significant roles. Metacognitive flexibility refers to adaptively shift cognitive strategies when realizing a current strategies not effective while task decomposition invloves breaking down a task into actional subtasks (Tankelevitch et al., 2024).

- Teacher AI literacy development.

For pre-service teacher students education, the proliferation of AI in many aspects of human life require teacher to develop AI literacy. This necessitates equipping teachers with fundamental AI knowledge. By integrating this understanding with their pedagogical expertise, educators can effectively design curricula that incorporate AI-driven learning and instruction (Ding et al., 2024). The mode in this study combing individual tasks and collaborative tasks would be suggested to stimulate pre-service teacher students critically thinking about what and how AI can do in classroom.

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