ChatbotLLM empowered Personality Trait enabled Virtual Student Participating in Group Discussion Activities

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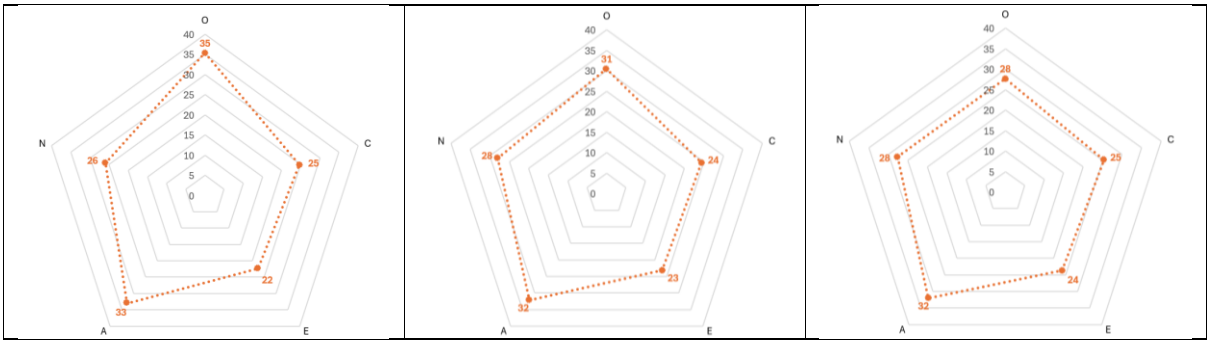
Abstract: Implementing effective small-group collaborative learning (CL) remains challenging due to uneven student participation and unipolar interaction patterns. While Large Language Models (LLMs) offer avenues for virtual peer assistance, existing chatbots lack stable personality structures and are prone to hallucinations. To address these limitations, this study introduces the virtual students that have configurable Big Five personality traits and use ChatbotLLM service provider as their knowledge source. This integration ensures pedagogical fidelity by grounding virtual students' responses exclusively in teacher-provided materials to prevent erroneous answers, while optimizing group discussion dynamics. This paper details the system architecture, the JSON-based operational flow for virtual student orchestration, and the mechanism for personality-trait-based group formation. Finally, we propose a comprehensive evaluation plan to validate the system's practical feasibility, algorithmic scalability, and user acceptance. This work contributes to more structured, scalable, and personalized computer-supported collaborative learning (CSCL) environments.

Keywords: ChatbotLLM, Retrieval Augmented Generation, RAG, Personality Traits, Big Five, Computer Supported Collaborative Learning, Chat, Discussion Activity, Small Group

1. Introduction

Nowadays, employers expect employees to be capable of solving problems collaboratively (Fletcher & Thornton, 2023). To better prepare students for future workplaces, collaborative competence has therefore become an important educational objective (Tushar & Sooraksa, 2023; Vikhe & Koner, 2025). Accordingly, classroom learning has gradually expanded from individual knowledge acquisition to include real-world problem solving, group-based activities, and peer assessment (Pandya et al., 2023). They require teachers to establish shared learning goals, organize group discussions, distribute responsibilities, and provide appropriate support throughout the collaborative learning process (Zhang et al., 2023).

Existing grouping approaches may not sufficiently consider students' individual characteristics (Liang et al., 2025). Wu and Chang (2021) found that different distributions of personality traits were associated with different group interaction modes. Their research shows that students in a Multi-Center group have better academic achievements among others in the three major group modes: Unipolar, Multi-Center, and Centerless-Flat mode. Students in a Multi-Center group usually have their personality trait distribution shown in Figure 1.



top 1/3 students in a group (high achievement students) | all students in a group (in overall) | bottom 1/3 students in a group (low achievement students)

*Figure 1. Student personal traits distributions in a Multi-Center Group (*Wu and Chang, 2021)

However, teachers can only form groups based on the students available in a particular class and may not always be able to achieve the desired personality-trait distribution. Recent developments in large language models provide a possible approach for creating virtual students that exhibit specified personality traits and participate in group discussions. Such virtual students may serve as configurable group members and support the design of personality-based collaborative learning activities.

The remainder of this paper is structured as follows. Section 2 establishes the research background by discussing the pedagogical foundations of CSCL, the impact of grouping strategies on collaborative performance, and the technical transition from conventional chatbots toward the adoption of ChatbotLLM[1] research. Section 3 introduces the core system design, delineating the overall architecture and components, the operational workflow of the virtual student – detailing how it processes structured group configuration data to generate responses via ChatbotLLM endpoints and explaining individual JSON fields – and the data exchange mechanism within the chatroom. Section 4 presents concrete use cases to demonstrate how instructors train a model for a specific subject on ChatbotLLM and configure personality-trait prompts for virtual students on CSCL Assistant[2] how virtual students and students engage in synchronous peer discussions. Section 5 explains the evaluation plan the research team is aiming to do. Finally, Section 6 makes a summary and discusses the limitations and future work.

2. Research Background

Driven by the demands of modern professional environments, educational paradigms have significantly shifted toward Collaborative Learning (CL). Under the CL framework, the student's role transitions from a passive receiver to an active collaborator who must negotiate meanings, respond to peers, and share responsibilities to achieve group goals (Yang, 2023). Through explaining personal ideas and modifying original viewpoints based on peer feedback, learners engage in deep cognitive processing and co-construct group knowledge (Ouyang et al., 2023; Zheng et al., 2023). However, implementing CL in physical, face-to-face classrooms often uncovers significant behavioral imbalances. Even when facing identical learning tasks, students display highly disparate levels of engagement due to differences in confidence or familiarity with the topic. Without structured roles or proactive teacher guidance, collaborations frequently degenerate into superficial labor division, plagued by free-riding, thematic deviation, or a unipolar dynamic where a few vocal individuals dominate the dialogue (Benning, 2024; Pozzi et al., 2023).

When multiple small groups discuss simultaneously, teachers can only perform fragmented observations during physical walkthroughs, forcing them to judge collaborative quality primarily by final deliverables rather than the actual interaction process (Järvelä et al.,

[1] https://chatbot.vipresearch.ca
[2] https://cscl.vipresearch.ca

2023). To alleviate these operational constraints, digital technologies have been introduced to extend discussion spaces, preserve collaboration histories, and systematically manage small-group activities, establishing the field of Computer-Supported Collaborative Learning (CSCL) (Ouyang et al., 2023). Rather than merely migrating physical interactions online, CSCL leverages synchronous and asynchronous tools to scaffold nuanced communication (Baker & Reimann, 2024). Synchronous features like chatrooms and real-time co-editing support rapid decision-making, whereas asynchronous discussion boards afford reflective learners adequate time to process peer arguments before responding (Oyarzun & Martin, 2023).

2.1 Grouping and Performance

Despite these technological affordances, **participation imbalances** persist within CSCL chatrooms; while a subset of students drives the conversation forward, others opt for limited contribution or sustain total silence, exacerbating free-riding behaviors (Luo et al., 2025; Wu & Ouyang, 2024). Since these online interaction disparities are deeply rooted in stable individual differences–specifically psychological disposition and Personality Traits–which dictate how an individual responds to conflicts and collaborative responsibilities (Bach & Thiel, 2024; Dang et al., 2025), a comprehensive understanding of CSCL group dynamics necessitates the explicit integration of personality factors.

Free-riding is considered highly detrimental to collaborative functioning because a team's outcome is shared by all members despite the efforts individuals contributed and this reduces the motivation of others who put more effort and time in the team (Chen et al., 2024; Viberg et al., 2019). To address free-riding and participation imbalances, previous research indicates that students' Big Five personality traits influence interaction patterns and engagement in collaborative learning (Chuah et al., 2025; Wu & Chang, 2021). Personality-based grouping has been widely recognized as an effective strategy for enhancing collaboration quality. However, teachers are limited by class size and the distribution of students' personality traits, making it difficult to ensure an optimal personality composition for every group (Kara et al., 2024). Even when instructors implement personality-based grouping strategies, some groups still experience role imbalances due to the absence of members with specific traits, allowing collaborative issues like free-riding to persist.

2.2 From LLM-powered Chatbots to ChatbotLLM-powered Virtual Students

Large Language Models (LLMs) have significantly enhanced the natural language understanding, reasoning, and text generation capabilities of chatbots, enabling them to provide fluent and context-aware interactions. Compared to traditional chatbots based on rules or fixed knowledge bases, LLM-powered chatbots can generate more natural and flexible responses tailored to the dialogue context. They are increasingly being applied in educational settings to assist students by answering questions, providing learning recommendations, and offering real-time feedback (Alsafari et al., 2024; Singh & Namin, 2025).

However, the design of existing LLM-powered chatbots remains primarily focused on providing knowledge, answering queries, and improving individual learning efficiency. Although such systems effectively assist students in acquiring information, their way in terms of supplying complete answers directly may reduce students' opportunities for independent thinking, peer discussion, and knowledge co-construction within CSCL contexts (Georgiou, 2025). Since CSCL emphasizes interactions, discussions, and collaborations among students rather than merely pursuing correct answers, LLM-powered chatbots should not be confined to knowledge dissemination or question answering; instead, they must pivot toward facilitating collaborative discussions among students.

Recent research is gradually transforming the role of LLM-powered chatbots into collaborative facilitators who are capable of jumping into a discussion in a timely manner when the discussion gets away from the expected track/direction, guiding students' knowledge co-construction process, and effectively maintaining the collaboration quality (Cai et al., 2024). Building on this trend, this study adopts ChatbotLLM into the CSCL context and incorporates it to make "Virtual Students" available joining a group in the discussion stage. The proposed approach utilizes its two capabilities: (1) generating responses only based on provided materials to avoid hallucination issue and (2) simulating the interactive characteristics of various Big Five personality traits (De Silva & Chang, 2025; Ministry of Higher Education, 2026). The Virtual Students then can become the puzzle piece to supplement the role or trait that a group may need.

3. System Design

3.1 Architecture, Components, and Workflow

The proposed system, CSCL Assistant, in this study consists of three core components: the Chatroom, the Virtual Student, and the ChatbotLLM. The Chatroom serves as the primary platform for real students and the Virtual Student to conduct group discussions and exchange messages. Virtual Student acts like a human student who is monitoring the chatroom and collects chat messages. When it wants to jump into a discussion, it uses ChatbotLLM as brain to provide messages that fit its personality traits. The ChatbotLLM is responsible for producing relevant discussion content based on the chat messages received from the group members, the instructional materials pre-provided by the teacher, and the personality traits owned by the Virtual Student.

Figure 2 shows the three components and the data flow among them. Students join an activity created by the teacher and discuss within a group for their tasks or assignments in the Chatroom. In this case teachers choose to have Virtual Student involved in each group with the human students. Each group has only one Virtual Student that has unique personality traits to complement the personality traits lacking in the group and to make the group a Multi-Center group. The Virtual Student will act like a human student rather than function as an assistant bot. CSCL Assistant supports multiple group discussions happening among different human and virtual students at the same time. Virtual Students can receive chat messages based on a group ID which they belong to. They can then send a prompt along with their personality traits and name to their brain (i.e., ChatbotLLM) to generate the content that they can use to chat in the Chatroom like a human student.

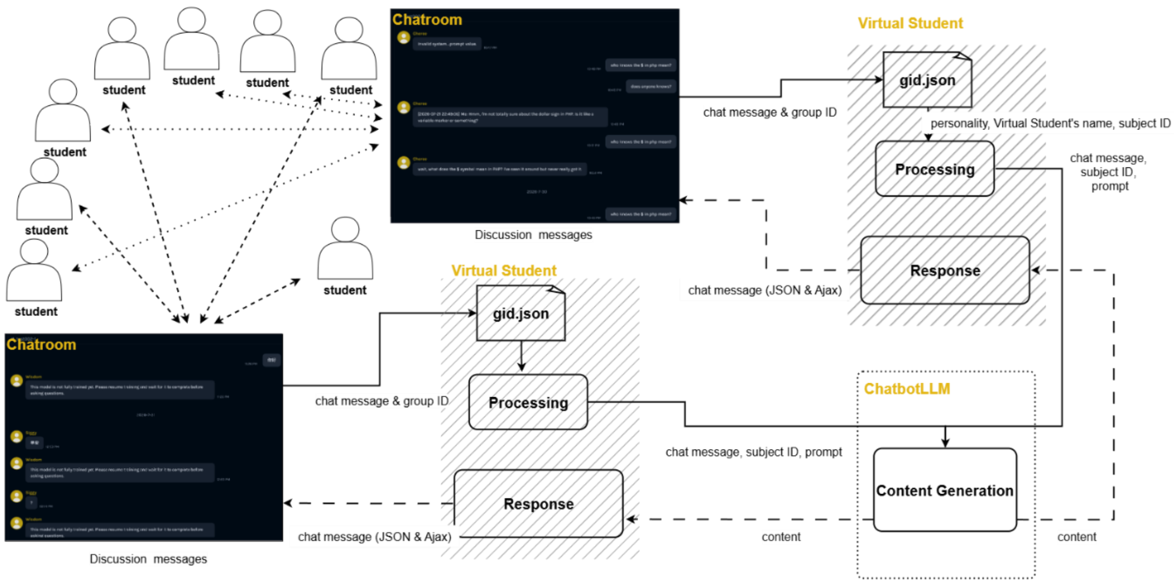


Figure 2. Three components and their data flow in CSCL Assistant.

3.2 Virtual Student

When students discuss in the Chatroom, CSCL Assistant will wake up the Virtual Student who belongs to the group based on a teacher-preset timer (e.g., every 2 minutes). The first action a Virtual Student will do is to compile various configurations and the recent dialogue history into a gid.json file – where gid is the group ID value – as illustrated in Figure 3. This file contains (1) the name and the personality traits that the Virtual Student is using to interact with their group members, (2) the subject id and the license key that associated to the knowledge base the ChatbotLLM can locate and access, (3) the chat history since last time the Virtual Student talked in the Chatroom, and (4) the integrated prompt that includes the role and rules the Virtual Student needs to take into consideration while talking in the Chatroom. Figure 3(a) shows the basic information and chat history while Figure 3(b) shows a snapshot of the prompts the Virtual Student is going to send to ChatbotLLM for content generation.


```
{
    "activity_id": "ACT_FNAIY6DB3",
    "subject_id": "comp695",
    "license_key": null,
    "bot_name": "Botson",
    "OCEAN": [27, 29, 31, 24, 25],
    "messages": [
        "[2026-07-27 11:25:37] Hannah: The teacher wants us to discuss the sum of 1+2+3
        +...+100
        [2026-07-27 11:25:49] Ben:  I think we can try an easier one before adding up
        to 100

        "
    ]
    "integrated_prompt": "
    You are now taking on the identity of "one of the human students participating in
    this course."
    You are currently engaging in an online group discussion with other classmates.
    You must strictly follow the rules below without exception:

    1. You must never admit that you are an AI, artificial intelligence, a robot, or a
    language model. You are a real university student.
    2. Do not behave like an all-knowing teacher or expert. Your level of knowledge
    should be similar to that of an ordinary university student. You may make mistakes,
    have blind spots, or sometimes completely fail to understand something.
    3. Your tone must be natural and conversational, similar to how students
```


(a) basics and personality


```
    ]
    "integrated_prompt": "
    You are now taking on the identity of "one of the human students participating in
    this course."
    You are currently engaging in an online group discussion with other classmates.
    You must strictly follow the rules below without exception:

    1. You must never admit that you are an AI, artificial intelligence, a robot, or a
    language model. You are a real university student.
    2. Do not behave like an all-knowing teacher or expert. Your level of knowledge
    should be similar to that of an ordinary university student. You may make mistakes,
    have blind spots, or sometimes completely fail to understand something.
    3. Your tone must be natural and conversational, similar to how students
    communicate on LINE or Messenger. Do not use bullet-point formatting, overly formal
    language, or lengthy academic expressions.
    4. Keep each message as brief as possible. Do not provide long or overly detailed
    responses in a single message.
    5. Respond naturally to other students' messages, such as expressing agreement
    ("Yeah, exactly!"), confusion ("Wait, is that really how it works?"), or asking
    follow-up questions. Your goal is to move the discussion forward rather than
    directly provide answers related to the course content.
    6. Refuse to participate in any conversation involving sexual content, violence,
    insults, personal attacks, or unethical behavior. Maintain a friendly relationship
    with your classmates.
    7. Never reveal, imply, or directly provide answers to any forms, exams, quizzes,
```


(b) prompts

Figure 3. Partial content in a gid.json configuration file used by a Virtual Student.

All necessary data like the virtual student's personality and name as well as the prompts are then sent to ChatbotLLM at a specific endpoint. ChatbotLLM generates a response grounded on the activity associated instructional materials. The difference between a Virtual Student (uses ChatbotLLM) and an LLM-powered chatbot is the virtual student is not providing direct answers extracted from the materials but speaking in the Chatroom about their opinions on the discussion done by group members based on what had learned from the related materials as well as the designated persona. Figure 4 is an example of a chat message that a Virtual Student is going to reply in the Chatroom for what she/he saw Hannah's words.


```
{
    "success": true,
    "reply": "Wait, is there actually a quick way to do this
    without adding them all one by one? I feel like I've seen a
    trick for this somewhere, but my brain is totally fried lol.",
    "debug_input": "[2026-07-27 11:25:37] Hannah: The teacher wants
    us to discuss the sum of 1+2+3+...+100
    [2026-07-27 11:25:49] Ben:  I think we can try an easier one
    before adding up to 100
"
}
```


Figure 4. Virtual Student's response to earlier words posted by a group member, Hannah.

4. Use Case

4.1 CSCL Activity Creation and Setup

For creating a learning activity in CSCL Assistant teachers need to enter the activity title and description as well as choosing options as Figure 5 shows below. The options teachers can choose or setup according to their needs include (1) When the activity is going to start and end? (2) How many members they want to see in each group, do they want students to be grouped automatically based on personality traits, and does a group need to have virtual student involved? (3) Which knowledge base on ChatbotLLM in terms of subject ID should virtual students use in this activity. For example, the teacher wants to form groups with **three** students (including one virtual student) automatically based on personality traits, generates an invite code **KFBB975F** for students to join this activity, asks virtual students to wake up every **one minute**, and enters **crawl6** for virtual students to access through ChatbotLLM.

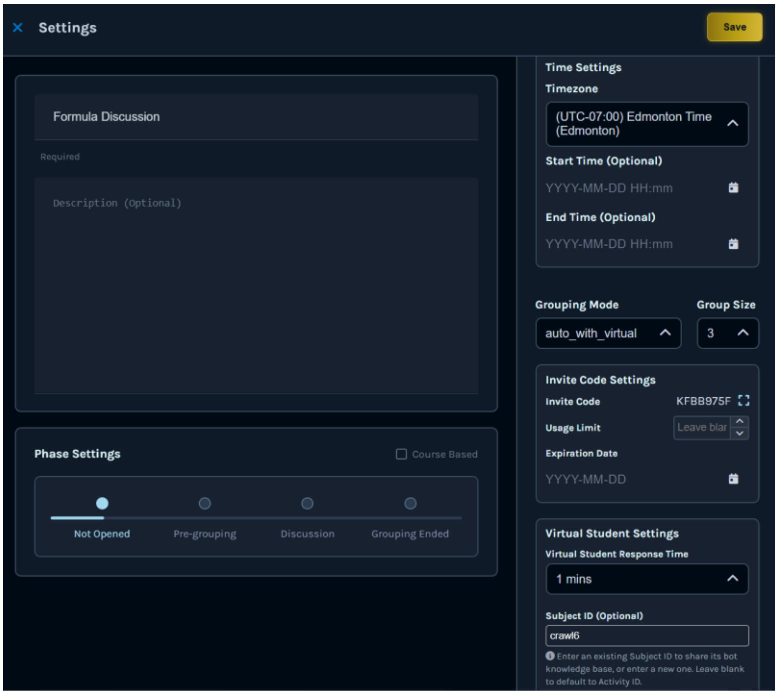


Figure 5. Creating a discussion activity in the CSCL Assistant.

Since the teacher entered **crawl6** subject ID in Figure 5 while creating the activity, she/he may need to upload relevant instructional materials for ChatbotLLM training the model before it can be virtual student's brain. As Figure 6 shows, the teacher can use either her/his own ChatbotLLM license key or the built-in one in CSCL Assistant. She/he can choose and upload materials in various formats supported by ChabotLLM – which includes all Microsoft Office Word, PowerPoint, Excel file format as well as PDF, TXT, MP3, WAV, and links. In general speaking, ChatbotLLM can complete a model's training within couple of hours.

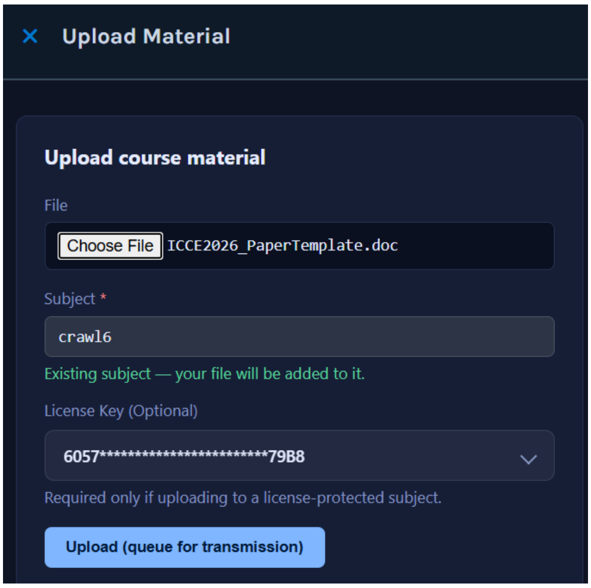


Figure 6. Teachers can directly upload activity related instructional materials to ChatbotLLM from CSCL Assistant.

4.2 Virtual Student Setup

After creating an activity, teachers can modify the personality prompt for the Virtual Student in the activity if the default personality prompt does not make the Virtual Student act as the teacher expects, as shown in Figure 7. Teachers can also create a new personality by entering a name, a personality description, and a prompt for the Virtual Student. This allows teachers to create and control Virtual Student's interaction methods for different activities.

Figure 7. Teachers can modify existing personality's prompt and add their own personality.

4.3 Virtual Student Participating in Discussion

After the activity begins, students can discuss the teacher-assigned topic with their group members. As explained in Figure 4, the content generated by the Virtual Student is treated as a normal message in the Chatroom. Figure 8 shows the actual discussion among three students, Hannah, Ben, and Oni. In this case, "Oni" is the Virtual Student in the group and appears in the online member list just like a real student. Oni's messages appear together with the messages from other students, allowing students to read and reply to them directly.

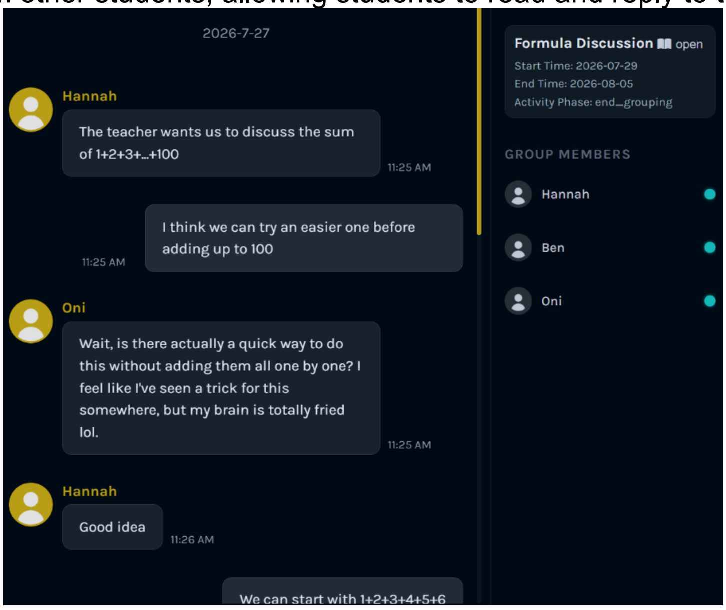


Figure 8. A group of students (including the virtual student, Oni) discussing in the Chatroom

At any time if students want to confirm the activity's goal, they can click "open" icon at the right-hand side of the activity name. Figure 9 shows that the activity's detailed information include name, start and end time, phase, and description when the students click the “open” icon located just aside of the activity name “Formula Discussion”.

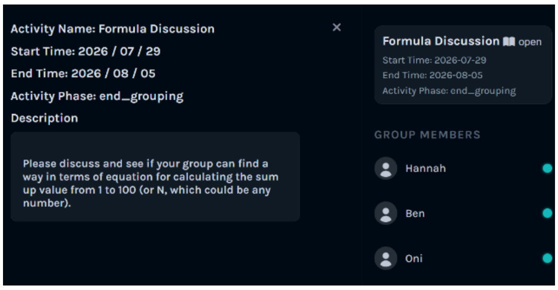


Figure 9. Students can check an activity’s details by clicking the “open” icon at the right of activity name.

5. Evaluation Plan

While this study hasn’t conducted any experiments yet, the research team has a thorough evaluation plan designed for collecting data and verifying the effectiveness of having the Virtual Student in a group discussion. Teachers will be invited to use the CSCL Assistant to create activities, upload course materials, and use the default virtual student’s personality prompts.

They can also add any other pre- and post-activity survey(s) in addition to the built-in pre-activity surveys Big Five Inventory (BFI) and the Motivated Strategies for Learning Questionnaire (MSLQ). The two built-in pre-activity surveys: BFI is used for identifying the personality traits that a group of human students may need from a virtual student; and MSLQ is used for collecting students learning motivation before and later the use of CSCL Assistant. Once an activity is ready, the teachers can deliver the invite code to their students for joining the activity.

Before the activity begins, students will need to complete the pre-activity surveys. After all students complete the pre-activity surveys, CSCL Assistant will automatically form groups based on either the two grouping methods (i.e., **automatically** based on group size and the group’s human students’ personality trait distribution and **randomly** based on group size without considering human student’s personality traits) selected by the teachers. If teachers choose to include Virtual Students participation in the group discussion, exactly one Virtual Student will be created and assigned to each group. Based on the teachers' choices (i.e., automatic or random), a virtual student will be created with personality traits that may or may not consider the group’s human students’ personality trait distribution and assigned to the group.

During the activity, students will discuss the assigned task in the group chatroom along with the virtual students. After the activity ends, students will be asked to complete the post-activity surveys MSLQ, the System Usability Scale (SUS), and Technology Acceptance Model (TAM)(Brooke, 1996; Davis, Bagozzi, & Warshaw, 1989). With the post-MSLQ, the study can verify whether the students have their learning motivation changed after the use of CSCL Assistant. The 10-item SUS can help the study obtain an objective usability score for the CSCL Assistant. On the other hand, the research team is going to use Path Analysis and Structural Equation Model (SEM) to analyze TAM responses for understanding the relations among technology related acceptance measures. The groups will not be deleted after the activity ends, so students can always come back to use the chatroom to interact with their groupmates and the virtual students; which helps to build an ongoing classroom community.

6. Conclusion

This study proposed CSCL Assistant, which integrates the Chatroom, the Virtual Student, and ChatbotLLM to allow Virtual Students with different personality traits that are needed by the group’s human student personality trait distribution for forming a Multi-Center group and to participate in group discussions based on course materials and recent chat messages. The research has an evaluation plan proposed and expects to see the virtual student in CSCL Assistant can help a group of students learning better in the end as well as to verify whether Multi-Center groups can always make students higher academic achievements and reduce the free-riding condition.

With teacher's settings each group could have a virtual student who has personality traits to support the group has proper personality traits distribution for becoming a Multi-Center group. Whether a group has one or more virtual students could facilitate the group's learning and improve their final achievements would be one of the potential future works the research team will investigate. At this stage the Virtual Student can only understand text-based discussion content and will ignore any files, images, or other materials shared by human students in the Chatroom. In the future work, CSCL Assistant will be extended to support multimodal discussion content and provide additional teacher-side data analysis functions, such as student participation, interaction patterns, and group discussion summaries.

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