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Development and Application of Facilitating-chatbot based on Six Thinking Hats*

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ABSTRACT

This study aimed to create and implement a Facilitating-chatbot to enhance synchronous online discussions using the Six Thinking Hats method. Slack, a popular collaboration tool, served as the messenger platform. Leveraging Slack's plug-ins, the researchers developed a chatbot utilizing the RTMClient (Real-Time Messaging) API, specifically version 2.9.3 of the Python slackclient module. The system database utilized Excel, managed through the Python openpyxl module version 3.0.7, with each chat group allocated its own Excel sheet. The usability of the Facilitating-chatbot was evaluated with 58 college students, yielding an average score of 4.52. Qualitative analysis of user experiences revealed that features such as guided learning using Six Thinking Hats, task tracking, and participation monitoring facilitated effective discussions and enhanced user engagement. Future improvements include enhancing command input and providing intelligent feedback to users.

1. Introduction

Due to the pervasive impact of COVID-19 and the ongoing digital transformation, non-face-to-face education has become increasingly commonplace. What was once seen as a temporary response to crises or a supplementary aid to traditional offline education has now evolved into a pivotal component of future education. However, current non-face-to-face educational practices have their limitations when viewed through the lens of future-oriented education. Merely delivering digital content, such as lecture videos, is no longer sufficient. Instead, there is a pressing need to shift

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towards learner-centered education that actively fosters higher-order thinking skills like problem-solving, discussion-based learning, and cooperative learning. Real-time discussion-based learning, as advocated by Wediyantoro, Lailiyah, and Yustisia (2020), serves as a prime example. Through sharing diverse perspectives and expertise, learners engage in critical thinking while coordinating mutual understanding and arguments. Furthermore, it's crucial to preserve the advantages of face-to-face discussions, including immediate reactions and feedback from peers, active communication, and effective conflict resolution. Smooth communication channels are essential for activities such as brainstorming, idea generation, decision-making, and collaborative task completion, as highlighted by Phillips (2005).

Chatbot-based discussions offer a unique opportunity for learners to engage in deep reflection on learning topics. By automatically recording discussion content as it unfolds and facilitating regular review, these discussions allow for in-depth examination of the subject matter (Johnson, 2006). However, active participation in such discussions requires proficient typing skills, and sustained engagement over extended periods can lead to cognitive strain and fatigue. Moreover, simultaneous input from multiple participants may result in distraction or a loss of immersion in the discussion process. These challenges have the potential to impede the smooth progression of non-face-to-face discussion-based learning and undermine learning outcomes. To address these issues, it is essential to implement strategies for organizing real-time discussions effectively and enhancing their impact. In this study, we seek to systematize and streamline the process of real-time discussion-based learning by employing a Facilitating-chatbot developed using the Six Thinking Hats technique. Through this approach, we aim to evaluate the effectiveness and potential value of the Facilitating-chatbot by examining learner responses.

The Six Thinking Hats technique, conceptualized by British psychologist Edward de Bono (2017), offers a structured approach to thinking wherein participants metaphorically don different colored hats, each representing a different thinking style or perspective. By adopting these roles, participants can break away from their habitual thinking patterns and explore various viewpoints suggested by the hats. Primarily used in educational settings for fostering creative thinking and facilitating discussion-based learning to encourage diverse perspectives, the Six Thinking Hats technique has also found application as a problem-solving and decision-making tool in business contexts. Previous research, such as that by Schwier and Balbar (2002), as well as Zollinger (2021), highlights its efficacy in educational contexts. Similarly, Singh and Jankovitz (2018) illustrate its utility as a management tool in business settings. Several prior studies have demonstrated the application of the Six Thinking Hats technique in the realm of online discussion-based learning, showcasing its effectiveness in promoting critical thinking and collaborative problem-solving (Karami, 2024).

Tamura and Furukawa (2007) introduced a chatbot-based collaborative learning system grounded in the principles of the Six Thinking Hats technique. Within this system, discussions follow a structured sequence: 'Red-White-Green-Yellow-Black-Blue-Question'. Following each colored hat phase, students engage in group reviews where they critique one another's statements. The study revealed that students were able to conduct discussions smoothly with minimal instructor intervention. Moreover, students participating in these structured discussions presented ideas that were both quantitatively

and qualitatively superior to those in regular online discussion groups. This suggests that the systematic application of the Six Thinking Hats technique in a chatbot-based learning environment can enhance the quality and depth of discussions.

Schellens et al. (2007) conducted a comparative analysis of online discussions utilizing the Six Thinking Hats technique and Weinberger's argument model. Their findings revealed that discussions employing the Six Thinking Hats elicited deeper levels of argumentation from students. Particularly noteworthy was the observation that students remained fully engaged in each step of problem-solving facilitated by the Six Thinking Hats, underscoring the technique's efficacy in fostering meaningful online discussions. However, existing research has tended to overlook strategies for mitigating cognitive overload during real-time discussions and has paid limited attention to psychological and emotional factors that influence discussion dynamics. In our study, we aim to capitalize on the educational benefits of the Six Thinking Hats technique while also devising strategies to support discussion-based learning from social and managerial perspectives using chatbots. The specific research questions guiding our investigation are outlined below.

Research Question 1: How can a Facilitating-chatbot based on the Six Thinking Hats be developed?
Research Question 2: What is the experience of using a Facilitating-chatbot based on the Six Thinking Hats in real-time online discussion learning?

2. Development of a Facilitating-chatbot using Six Thinking Hats

Chapter 2 provides an in-depth examination of the overarching structure and detailed functionalities of the Facilitating-chatbot developed as part of this study.

2.1 System structure

[Figure 1] illustrates the comprehensive flow of the chatbot system developed in this study. Unlike traditional one-on-one interactions, this chatbot engages with multiple users within a group chat environment. Moreover, instead of allowing users unrestricted questioning capabilities, the chatbot assumes roles such as outlining performance objectives and tasks for users, along with furnishing essential guidance throughout task execution. Consequently, the chatbot incorporates predefined guidelines for specific objectives intended to be imparted to users.

Upon receiving a signal indicating readiness from the group's users, the chatbot initiates by introducing its features and delivering a concise tutorial on their usage. Following the tutorial phase, the chatbot presents collaborative goals for group members to accomplish together, along with detailed tasks and relevant resources to facilitate team activities. These tools encompass functionalities such as 'What to do now', 'References for ongoing tasks', 'Overall progress', and 'Summary of progress and content of team activities conducted thus far', which the chatbot employs during the tutorial. Activation of these tools is contingent upon specific keywords provided.

To enhance user awareness, all resources provided by the chatbot are presented in text form,

distinct from general chat interactions, utilizing platform-provided functions. The primary conversational flow between the chatbot and the learner group involves the presentation of detailed tasks and the submission of answers to these tasks. In addition to supporting cognitive elements through resources and guidance, the chatbot integrates motivational components, including encouragement messages triggered by user activities and acknowledgment of individual user participation.

Upon completion of all tasks outlined in the database according to the provided guidelines, the program concludes by informing the learner group that all activities have been successfully accomplished.

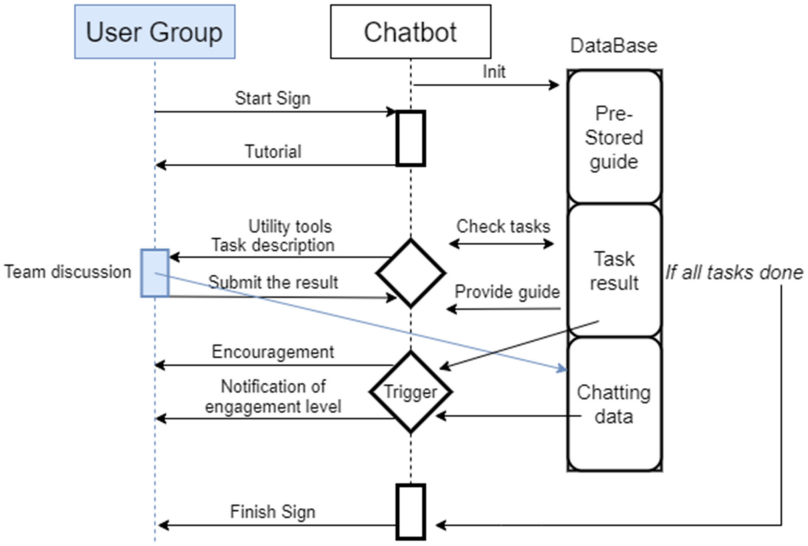

Fig. 1. System workflow

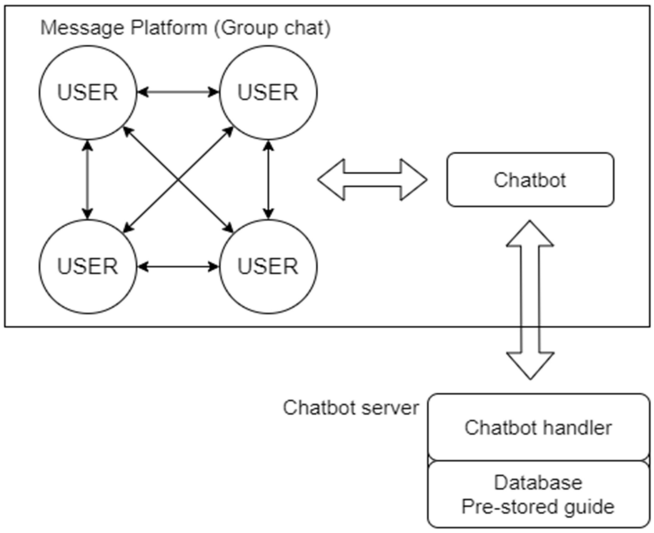

Fig. 2. System structure

[Figure 2] depicts the structure of the developed chatbot system. The chatbots function within the framework of a messenger account situated in a messenger platform environment that supports cross-device compatibility and group chat functionality. To engage with the chatbot, all users must utilize the corresponding messenger account and be members of a group chat that includes the chatbot.

Although conversations among learners may commence autonomously, the chatbot remains inactive until a specific keyword is entered or an event occurs. The sequence of processes is managed through a Chatbot handler situated on a separately constructed server via the API module of the messenger platform. This server, linked to the database, gathers all raw conversation data occurring within the group chat, from the initiation of cooperative learning participation to the program's conclusion. It furnishes pre-established guidelines and compiles summaries of team activities. Organized group activity results are accessible, reviewable, and modifiable by users within the group.

2.2 Details

The chosen messenger platform for this project is 'Slack', renowned as a versatile collaboration tool. Within Slack's extensive array of plug-ins, a chatbot was developed utilizing the RTM (Real-Time Messaging) API, leveraging web sockets. The chatbot was created using the 3.6 (64-bit) version of the Python slackclient module and the 2.9.3 version of RTMClient. For database management, the Python openpyxl module version 3.0.7 was employed, utilizing the Microsoft Excel program as the system's database. Each chat group was allocated a dedicated Excel spreadsheet seat, facilitating organized data storage and retrieval.

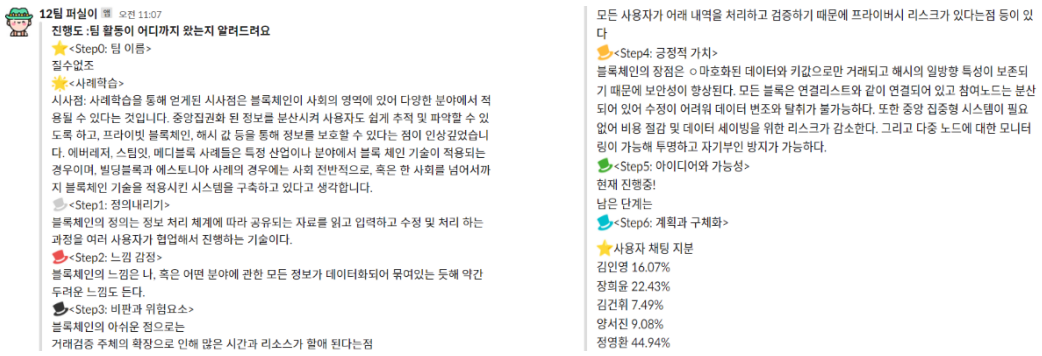

Fig. 3. Example of 'task progress' and 'participation' information messages

Each chatbot within the system is responsible for gathering raw data from its associated chat group, including team activity results. This data is then stored within the database and utilized to furnish pertinent information regarding team activities, such as guidelines and progress status updates. Additionally, when presenting task progress to users, the chatbot calculates the user participation rate based on the number of characters entered from the initiation of the task to the time of progress confirmation. This metric offers insights into user engagement and involvement throughout the task completion process.

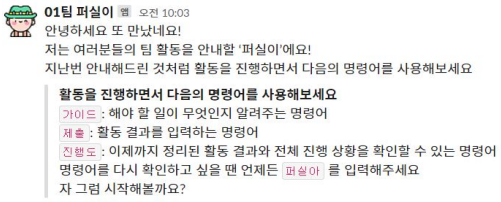

Fig. 4. Chat using Markdown

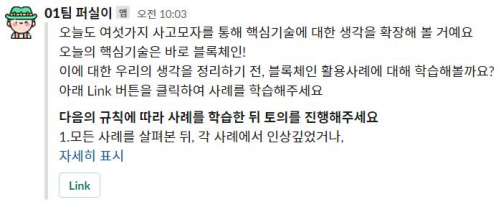

Fig. 5. Example of 'link button' application

As depicted in [Figure 4], the chatbot enhances the visibility of various data and resources provided to users by segregating them from general chat interactions, utilizing the 'Markdown' feature offered by the platform. To accommodate information that exceeds the limitations of chatbot conversations, such as case studies, a pre-designed web page was employed. This web page was made accessible to users via the button action function provided by RTMClient, offering a user-friendly alternative to conventional hyperlinks.

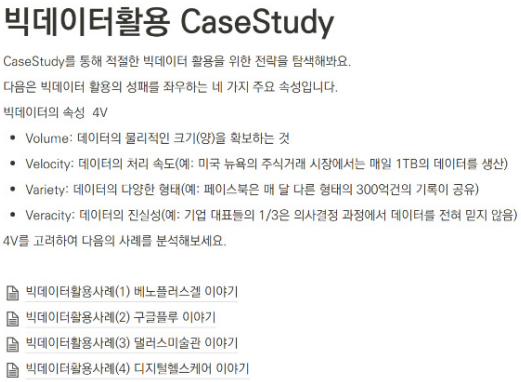

Fig. 6. Example web page for case study

Fig. 7. Example of 'synchronous feedback' application

A chatbot event occurs when specific conditions are met, prompting the chatbot to deliver a message to the user. Two primary conditions for generating events within the implemented chatbot are ‘Emotional feedback’ and ‘Submission of opinion’. The first condition involves tracking the occurrence of specific keywords and chat activity within a designated time frame. When the count of keywords such as ‘like’ or ‘joa’ surpasses a predefined threshold within a specified time interval, a trigger is activated. For instance, if the number of positive keywords exceeds K counts per N minutes, an event trigger is activated. To facilitate continuous condition monitoring, the Python asyncio module was utilized to create asynchronous native coroutines for each count. This approach enables the provision of functional and motivational feedback tailored to the context of the ongoing chat channel discussions.

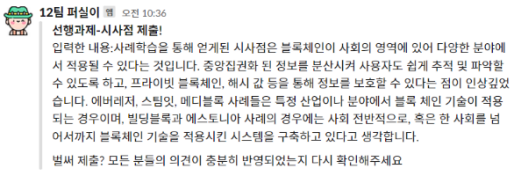

Fig. 8. Example of ‘Suggestion Message’ application (1)

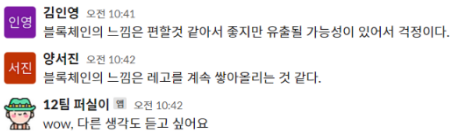

Fig. 9. Example of ‘Suggestion Message’ application (2)

The second condition pertains to an event triggered by a ‘suggestion message’ upon the completion of a task. Starting from the initiation of a new task by the group, the chatbot monitors various factors such as the number and frequency of chats, task progress duration, etc. Based on this monitoring, feedback is provided regarding actions such as submitting the first opinion, prematurely drawing conclusions, or progressing through the task too slowly. This feedback aims to guide users towards more effective and efficient collaboration during task completion.

3. Application of Facilitating-chatbot using Six Thinking Hats

This chapter delves into the analysis of the application process of the Facilitating-chatbot and presents the usability evaluation results garnered from user survey.

3.1 Research subject

To assess the effectiveness of the Facilitating-chatbot, real-time online discussion learning employing the bot was implemented within a liberal arts elective course titled ‘Technology of Innovation’

at D University in Gyeonggi-do. This course was operational from March to June 2021. The study participants comprised students enrolled in the course, totaling 58 individuals. The table below provides an overview of the demographics of study participants. Students were organized into teams consisting of 3-4 members from diverse majors, and the course proceeded without alterations until its conclusion.

Table 1. Participant demographics

Category		Number	Percentage
Gender	Male	24	41.3%
	Female	34	58.6%
Academic Year	1st Year	4	6.8%
	2nd Year	19	32.8%
	3rd Year	25	43.1%
	4th Year	10	17.2%
College	College of Arts	6	10.3%
	College of Engineering	13	22.4%
	College of Commerce	19	32.7%
	College of Social Sciences	18	31.0%
	Humanities Department	2	3.4%
Total		58	100%

3.2 Application procedures and contents

The real-time online discussion learning aimed to facilitate discussions on 'the characteristics and ways to utilize the core technologies of the 4th Industrial Revolution.' This learning initiative spanned 4 weeks, with the first week dedicated to providing advance information and conducting team-building activities. The objective was to acquaint students with the discussion learning environment and alleviate any potential novelty effects associated with learning alongside a Facilitating-chatbot. Additionally, the aim was to foster team cohesion by facilitating mutual introductions among team members.

Subsequent weeks focused on specific core technologies of the 4th Industrial Revolution, with real-time discussion learning based on the Six Thinking Hats technique. The second week centered on AI technology, the third week on big data, and the fourth week on blockchain technology. Each week's discussions were tailored to delve into the characteristics and potential applications of the respective technology.

Throughout the discussion learning process, all conversations exclusively took place within the Slack online discussion learning environment. At the commencement of each discussion learning session, students invoked the Facilitating-chatbot by typing '퍼실아' and proceeded with the discussion under the bot's guidance. They systematically completed guided tasks, progressing through each step of the Six Thinking Hats methodology. Specific details of the tasks assigned by the Facilitating-chatbot at each stage are outlined in Table 3.

Moreover, the Facilitating-chatbot incorporated features aimed at managing cognitive load, such

as progress guidance, in addition to the previously mentioned social and emotional support, including the delivery of motivational messages.

Table 2. Context of class

Lecture Topic	- Core Technologies of the 4th Industrial Revolution	
Lecture Goal	- Understanding the core technologies of the 4th Industrial Revolution - Exploring the influence of core technologies of the 4th Industrial Revolution - Deriving ideas for utilizing core technologies of the 4th Industrial Revolution	
Pre-class activities	- individual study of core technologies of the 4th Industrial Revolution	
Activities in class (60 minutes)	**Guide (10 minutes)**	- Introduction to class agenda - Information on collaboration activities
	collaborative activities (50 minutes)	- Discussion on core technologies of the 4th industrial revolution using bots
After class activities (20 minutes)	- Summary of team activities and personal reflection	

Table 3. Weekly discussion topics

Step	Details
Pre-stage	Guide to learning environment, Facilitating-chatbot, and discussion agenda
1st discussion	Discussion on the value and utilization of AI technology
2nd discussion	Discussion on the value and utilization of big data technology
3rd discussion	Discussion on the value and utilization of blockchain technology

Table 4. Message from Facilitating-chatbot

Step	Chatbot Message Example
Opening mission guide	**12팀 퍼실이** 앱 오전 10:04 **Step0: 팀 이름 적기** 지난 시간 정했던 팀 이름이 뭐였더라... 우리 팀의 이름을 적어보세요 예시: 제출0 우리팀이름 p.s. 제출0과 우리팀이름 사이에 한칸 띄어쓰는 것 잊지마세요!
Case study guide	**12팀 퍼실이** 앱 오전 10:05 오늘도 여섯가지 사고모자를 통해 핵심기술에 대한 생각을 확장해 볼 거예요 오늘의 핵심기술은 바로 블록체인! 이에 대한 우리의 생각을 정리하기 전, 블록체인 활용사례에 대해 학습해볼까요? 아래 Link 버튼을 클릭하여 사례를 학습해주세요 **다음의 규칙에 따라 사례를 학습한 뒤 토의를 진행해주세요** 1.모든 사례를 살펴본 뒤, 각 사례에서 인상깊었거나, 흥미로웠던 부분에 대해 생각해보세요 2.다른 사례와 대비되는 각 사례의 특징은 무엇이었는지 말씀해주세요 (모든 팀원이 자신의 생각을 말씀해주셔야해요) 3.발표를 진행하면서 잘 이해가 안되거나,서로의 생각이 다른 부분에 대해 깊게 논의해주세요 4.모든 활동을 마친 후 사례학습을 통해 얻게 된 시사점을 정리하여 다음과 같이 제출해주세요 제출0-1 사례학습을 통해 얻게 된 시사점은 ...이다 간략히 보기 Link

Table 4. Cont.

Step	Chatbot Message Example
White hat prompt	 **12팀 퍼실이** 앱 오전 10:36 자 그럼 이제 본격적으로 블록체인에 대한 생각을 확장해볼까요? **Step1: 하얀 모자** 자 먼저 하얀 모자를 쓰고 이야기를 나눠볼까요? 우리가 수집한 정보를 토대로 객관적인 정의를 내리는 데 집중하도록 해요. 오늘의 핵심기술을 `한문장으로` 어떻게 `정의`할 수 있을까요? 토론 후 `제출1 ...의 정의는 ... 이다` 를 입력해서 결과를 등록해요
Red hat prompt	 **12팀 퍼실이** 앱 오전 10:41 **Step2: 빨간 모자** 빨간 모자를 쓰면 감정, 직관, 본능에 관한 생각을 나눠요 여러분은 오늘의 기술에 대하여 어떠한 정서적 감정을 갖게 되나요? 어떤 느낌이 드는지, 자신 혹은 주변 사람들의 경험을 토대로 자유롭게 말씀해주세요. 토론 후 `제출2 ...의 느낌은 ...하다`를 입력해서 결과를 등록해요
Black hat prompt	 **12팀 퍼실이** 앱 오전 10:54 **Step3: 검정 모자** 검정 모자는 경각심을 일깨워요 주의해야 할 것, 위험한 것, 약점 혹은 잠재적인 문제는 무엇인지 떠올려보고 기술에 대해 비판적인 판단과 위험요소는 무엇인지 정리해주세요. 토론 후 `제출3 (...의 위험요소, 비판점으로는) ...이 있다` 를 입력해서 결과를 등록해요
Yellow hat prompt	 **12팀 퍼실이** 앱 오전 10:59 **Step4: 노란 모자** 노란 모자를쓰고 긍정적인 관점에서 이점과 가치를 찾아봐요 여러분은 오늘의 기술이 어떠한 가치를 갖고 있다고 생각하나요? 자유롭게 생각해봐요! 토론 후 `제출4 ...의(긍정적 가치는) ...이다` 를 입력해서 결과를 등록해요
Green hat prompt	 **12팀 퍼실이** 앱 오전 11:05 **Step5: 녹색 모자** 녹색모자는 창의적인 아이디어와 대안, 가능성을 떠올리게 해요 오늘은 앞서 학습한 빅데이터 활용 사례를 참조하여, 다음의 주제에 대해 아이디어를 떠올려보도록 할게요 [동네 서점 활성화하기] 당신은 용인시 수지구에 위치한 작은 서점의 사장, 운영진이다 최근 여러가지로 경기에 어려움을 겪고 있는 당신, 파리날리는 지금의 상황을 해결하기 위하여 `빅데이터`라는 걸 한번 활용해보면 어떨까 하는데... 자유롭게 토론을 진행한 후 `제출5 기술활용방안과 아이디어` 를 입력해서 결과를 등록해주세요 간략히 보기
Blue hat prompt	 **12팀 퍼실이** 앱 오전 11:14 **Step6: 파란 모자** 마지막 모자는 초점을 맞추고 순서와 계획을 수립하는 데 도움을 주는 파란 모자에요 앞서 여러분이 제안한 아이디어 중 실현가능성과 기대성과가 높은 아이디어는 무엇인가요? 그 아이디어를 구체화하기 위해 지금부터 무엇을 시작하면 좋을까요? 토론 후 `제출6 지금부터 시작해야할 일`을 입력해서 결과를 등록해요
Exit message	 **12팀 퍼실이** 앱 오전 11:22 **모든 과제 완료!** 오늘 수업은 여기까지! 열띤 토론을 진행해줘서 고마워요, 수고 많았습니다! 수행 결과는 `진행도` 명령어를 통해 확인할 수 있어요 수업 진행에 문제가 있다면 교수님에게 알려주세요

3.3 Facilitating-chatbot usability evaluation

Following the completion of four real-time online discussion learning sessions utilizing the Six Thinking Hats methodology facilitated by the Facilitating-chatbot, learners were requested to submit individual reflection diaries regarding their experiences. Subsequently, a survey was administered to gather learners' opinions and feedback specifically on the Facilitating-chatbot.

Table 5. Survey contents for usability evaluation

Category	Survey contents	
Class Satisfaction	1. The class conducted with the Facilitating-chatbot was satisfactory.	Not at all (1) - Strongly Agree (5)
cooperation satisfaction	2. Collaborative learning using the Facilitating-chatbot was satisfactory.	
Chatbot Usability	3. The Facilitating-chatbot was useful.	
Chatbot Efficiency	4. Facilitating-chatbot helped make collaborative learning meaningful.	
Ease of use of chatbots	5. The process of conducting cooperative learning under the guidance of the chatbot was not difficult.	
Chatbot attractiveness	6. Collaborative learning using the Facilitating-chatbot was enjoyable.	

To assess usability, a reflection journal designed as a web survey was administered. Participants were asked to rate their responses on a 5-point Likert scale across six areas: class satisfaction, cooperation satisfaction, chatbot usefulness, chatbot effectiveness, chatbot ease of use, and chatbot attractiveness. The questions posed in the survey align with those outlined in Table 4.

The response outcomes from the usability evaluation questions are as follows: Class satisfaction was 4.32, cooperation satisfaction was 4.70, bot usefulness perception was 4.62, bot effectiveness perception was 4.49, bot ease of use was 4.39, bot attractiveness was 4.62, and the average was 4.52 or higher.

Table 6. Facilitating-chatbot usability evaluation results

Types	N	M	SD
Class Satisfaction	58	4.32	0.71
cooperation satisfaction	58	4.70	0.46
Chatbot Usability	58	4.62	0.55
Chatbot Efficiency	58	4.49	0.65
Ease of use of chatbots	58	4.39	0.72
Chatbot attractiveness	58	4.62	0.55
M		4.52	0.62

3.4 Analysis of Facilitating-chatbot usage experience

In the survey concerning the Facilitating-chatbot, user experiences were analyzed through the inclusion of open-ended questions, allowing participants to freely describe their ‘chatbot usage experience.’ Responses to the open-ended questionnaire were categorized utilizing the Inductive Content Analysis method. This method involves classifying responses into areas based on predefined standards and commonality of meaning. Common or higher-level concepts were grouped together and integrated into ‘1st small areas,’ followed by further division of topics with similar or common contexts into ‘2nd medium areas,’ and finally into ‘3rd large areas.’

After classifying the content based on major keywords, the frequency of classified keywords was calculated. To ensure reliability, researchers collaboratively classified keywords and calculated inter-rater agreement. The Intraclass Correlation Coefficient (ICC) value calculated through analysis of variance was found to be .954, indicating a high level of reliability that was statistically significant (p=.000).

To comprehend the positive and negative factors encountered during the collaborative learning process facilitated by the Facilitating-chatbot, the results of analyzing responses to the open-ended questionnaire are presented in Tables 6 and 7. The analysis primarily focused on content pertaining to negative and positive perceptions. Given that this study primarily aims to evaluate the usability of the Facilitating-chatbot, other opinions such as those concerning class content, instructors, team members, etc., were excluded from the analysis.

Table 7. Positive perception of the functions of the Facilitating-chatbot

Keywords	Frequency (ratio)
Effect of promoting cooperation and discussion process	6 (16.2)
Function to guide efficient progress	15 (40.5)
Function that summarizes the discussion process	4 (10.8)
Automatic participation rate check function	7 (18.9)
Ability to provide emotional feedback	5 (13.5)
Sum	37(100.0)

Initially, to ascertain positive perceptions of the Facilitating-chatbot, participants were asked an open-ended question: “Please feel free to write about what you liked about the group discussion with the ‘Facilitating-chatbot.’” Out of all study participants, 37 responses were analyzed, excluding non-responsive or ‘none’ answers. Five categories corresponding to positive perceptions were identified, including ‘effectiveness in promoting cooperation and discussion processes’, ‘automatic participation rate check function’, ‘efficient progress’ and ‘organization of cooperation process’, opinions on usefulness, and satisfaction with ‘emotional feedback’. The frequency (ratio) of responses for each classification item is presented in Table 6.

To begin with, the contents related to the ‘effect of promoting cooperation and discussion processes’ are summarized as follows: Participants expressed that structuring the entire discussion process based on the Six Thinking Hats facilitated step-by-step discussions, leading to systematic and substantial learning.

"I liked that the steps were divided in detail and helped me think about a topic in many ways!" (SW Convergence College, female, 4th year)

"The process of going through the steps for each hat color was interesting. This time, Little Red Riding Hood asks 퍼실이 the questions that can be a bit boring! Blue hat! By explaining things this way and presenting a witty problem, it makes people think that they want to solve the problem quickly." (College of Social Sciences, female, second year).

Furthermore, participants noted that the Facilitating-chatbot facilitated the discussion process using the Six Thinking Hats method in a step-by-step manner. It efficiently separated tasks, enabling each mission to be completed sequentially while supporting the collection and submission of results at each step. This approach was perceived as efficient, reducing cognitive burden during discussions by promoting divergent thinking and concurrently supporting convergent activities for collecting and organizing opinions.

"It seems that the team members' participation was more active when 퍼실이 intermittently encouraged them to submit their opinions. Also, I think it was good to know exactly the problem that needs to be solved through 퍼실이's words" (College of Engineering, female, second year).

"When working as a group, it is easy to get sidetracked, but 퍼실이 gave me details along with the topic, so I liked that whenever I went in a different direction, I was able to go back to the original position." (College of Social Sciences, Female, Grade 4).

"It was good that they explained the steps step by step so that I didn't get confused at first with people I didn't know" (SW Convergence College, male, 2nd year).

"Even though it is a group task, it feels like a progress roadmap is presented rather than just a topic and all team members have to work on it... I was satisfied that there was a task for each step! "I thought 퍼실이 was the group leader" (College of Social Sciences, female, 4th year)

It was confirmed that the Facilitating-chatbot promoted team member participation by automatically checking and providing guidance on progress and participation rates. Additionally, its role in facilitating efficient progress and its usefulness in managing the discussion process were acknowledged.

"Even if the professor did not manage each group separately, the 퍼실이 guided the activities to be done, which saved time and was very convenient." (SW Convergence College, female, third year)

"After sufficient discussion with team members, it was easy and interesting to submit a conclusion with a shortcut key and 퍼실이 responded immediately" (College of Education, female, 4th year).

"It was nice that when I entered the command, I got an immediate response and clearly told me

what to do." (College of Business and Economics, female, second year).

Satisfaction with emotional feedback that delivered positive messages such as praise in a friendly manner also appeared to be high. Related opinions are as follows:

"I am very satisfied with 퍼실이's quick response. And I think it's an advantage to feel good when you receive an answer mixed with appropriate praise." (College of Social Sciences, female, 4th year).

"퍼실이 looked at our discussion from time to time and gave feedback such as 'That's a good idea' and 'Are there any other opinions?', which made us feel more familiar and cute and made us laugh." (Business Economics University, female, third year).

"It was nice to be able to be guided through the group assignments through 퍼실이 without needing a separate guide, and it was nice that the discussion was not boring because they provided reactions in between." (College of Music and Arts, female, 3rd year).

"It was good that 퍼실이 encouraged answers from time to time, and I think being able to call 퍼실이 whenever necessary and move on to the next step without being restricted by time creates an environment where discussions can be held freely." (Associate Director College of Science, female, 3rd year).

"I was impressed by the fact that '퍼실이' did not sit still but responded positively to the answer after raising a problem. Due to this positive response from '퍼실이,' I think I was able to lessen the awkwardness with students I had never met in non-face-to-face classes." (College of Social Sciences, female, second year).

"I supplemented the interrupted flow with motivational comments from time to time." (College of Business and Economics, male, third year).

To identify negative perceptions about the Facilitating-chatbot, participants were asked an open-ended question: "Please feel free to write down anything you regretted during the group discussion with 'Facilitating.'" Responses that were non-responsive or indicated 'none' were excluded from the analysis. A total of 22 responses were analyzed. Three classification items related to negative perceptions emerged: 'error in submission of discussion results', 'inappropriate response', and 'limited level of response'. The frequency (ratio) of responses for each classification item is presented in Table 7.

Table 8. Negative perception of Facilitating-chatbot

Keywords	Frequency (ratio)
Requirements for submitting discussion results	5 (22.7)
inappropriate response	5 (22.7)
limited level of response	12 (54.6)
Sum	22 (100.0)

In examining the responses by classified category, opinions regarding 'errors in submission of discussion results' are as follows: During the process of entering the 'Submit' command to submit the discussion results, participants encountered input errors due to entering incorrect commands. They reported feeling unfamiliar with inputting commands or making frequent mistakes, leading to discomfort.

> "It is unfortunate that when 퍼실이 submits his form, if there is even a slight difference in the form, it is not recognized as an answer. For example, I put a space in 'submit + number' and they told me to submit it again." (College of Social Sciences, female, 4th year).

> "It was a little inconvenient that whenever the word 'submission' was mentioned during discussions with team members, a guide on submission would pop up. I think it would be okay if I just let it float once!" (College of Business and Economics, female, 3rd year).

Opinions regarding the 'inappropriate response' are as follows: Events (encouragement messages, etc.) that were inserted with the intention of encouraging team members' participation and generating positive emotions were met with a strange response as they occurred at inappropriate times. Most learners found such reactions unexpected and responded that they were fun and interesting, but suggested it as a feature that needs improvement.

> "When I was talking with my team members, 퍼실이 would give reactions in between, and while it was fun, there were also times when the reactions came out unrelated, so it was a little disappointing." (SW Convergence College, female, third year).

> "There are times when 퍼실이 speaks without looking at the answer properly. For example, when a student posts an answer saying, 'Wow, that's a difficult question,' 퍼실이 immediately responds with something like, 'Oh, you gave a good opinion for the first time, thank you!' I was disappointed in the fact that I wish 퍼실이 had understood and responded in more detail about the answer." (College of Social Sciences, Female, 2nd year).

The opinion regarding the 'limited level of response' was that it was disappointing that the Facilitating-chatbot remained in the role of facilitator of the discussion and could not play a role in mediating the discussion or leading the direction of the discussion in a more constructive manner.

> "퍼실이 only raises questions about a given problem and provides no additional feedback, making it difficult to lead discussions with classmates. I think that if opinions are exchanged and developed in depth, mutual understanding of a given topic can increase and positive results can be shared." (International University, Male, 4th year).

4. Discussion

In this study, we developed a Facilitating-chatbot and evaluated its effectiveness in promoting learners' participation in real-time online discussion learning and providing social and cognitive support. While various tools and environments have been studied to enhance cooperation in online discussion learning, chatbots play a unique role in supporting cooperation by replacing or assisting fellow learners or instructors in the collaborative learning process, necessitating new design strategies. Therefore, we developed a Facilitating-chatbot based on the Six Thinking Hats technique and applied it to the curriculum to evaluate usability and analyze learners' experiences. The main results of this study are summarized as follows:

Firstly, the usability evaluation results indicated high satisfaction across various aspects of the Facilitating-chatbot, with scores averaging 4.52 or higher. Learners expressed satisfaction with the structured approach of discussing topics based on the Six Thinking Hats technique, which contributed to efficient collaboration by guiding discussions and organizing results comprehensively. This immersion in the learning process highlights the positive impact of chatbots in encouraging participation and motivating learners in real-time online discussions.

Secondly, the ease of use for the Facilitating-chatbot scored slightly lower at 4.39, primarily due to challenges encountered during command input and submission processes. Addressing this issue requires exploring alternative input methods for learners unfamiliar with command-based interactions, ensuring smoother user experiences from the outset.

Thirdly, as the Facilitating-chatbot was rule-based, learners increasingly expect more intelligent responses over time, beyond simple guidance and responses. This aligns with the CASA model, where users attribute social and relational meanings to computers in human-computer interactions. To meet these expectations, future iterations may explore hybrid chatbot development, integrating machine learning technologies to provide advanced conversational support and feedback based on discussion analysis.

Fourthly, while technically feasible to enhance the chatbot's capabilities by integrating GPT (Generative Pre-trained Transformer) functions, limitations exist due to GPT's lack of specialized learning data and focus on generating general responses. However, leveraging GPT's synchronous feedback function can address issues such as irrelevant or fixed responses, enhancing the chatbot's adaptability and responsiveness to user inputs. Furthermore, employing emotional classification and generative functions can improve response quality and relevance, offering tailored answers based on user emotion and keywords.

5. Conclusion

In this study, we developed a Facilitating-chatbot based on the Six Thinking Hats method and conducted a pilot study to evaluate its effectiveness in enhancing online discussion-based learning among students. The findings confirmed that the chatbot was successful in structuring conversations and simplifying the learning process. It systematically guided students through various modes of

thinking, which increased participation and reduced cognitive overload.

However, the study also revealed several issues with the chatbot, including inappropriate timing of responses and limitations in managing complex conversations or providing depth in interactions. These challenges, along with technical difficulties related to command input, highlight areas that need further development.

In conclusion, while the chatbot shows significant potential in promoting systematic and efficient learning, continuous improvements are crucial to meet the increasing expectations for dynamic and context-sensitive educational tools. Enhancing the chatbot's response capabilities and resolving technical issues are expected to significantly boost its efficiency and user satisfaction in future applications. Additional research is needed to further refine and optimize its functionality.

Follow-up research can build upon the improvements identified in this study by developing an enhanced version of the Facilitating-chatbot and applying it across diverse learner groups, topics, and learning contexts (including face-to-face or hybrid environments). Additionally, exploring innovative ways to utilize various types of Facilitating-chatbots and designing new strategies for their integration is crucial.

It's essential to investigate the evolving roles of Facilitating-chatbots, particularly through analyzing group dynamics influenced by team composition factors such as expertise and personality types. Understanding these dynamics can inform the development of adaptive chatbot features tailored to different group contexts.

Furthermore, to enhance adaptive feedback mechanisms, future research should consider providing Emotion Classification judgments as probabilities and devising strategies for delivering feedback based on these probabilities. Evaluating the performance of such feedback mechanisms will be integral to refining the effectiveness of the Facilitating-chatbot in supporting collaborative learning experiences.

Conflicts of Interest

No author has any other conflict of interest to declare.

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