Enhancing Student Learning Through Mobile Learning Groups

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***Abstract*—With the advent of mobile phones, particularly smartphones, there has been consideration interest in mobile e-learning. In particular, mobile phones provide an effective channel to complement existing channels to enhance the student learning experience. Coupled with artificial intelligence (e.g., chatbot), more innovative learning functions can be provided. In this paper, we make two contributions to the aforementioned development. First, we present an innovative AI[5] model with five important learning elements: Inception, Interest, Instruction, Information and Inspiration, to facilitate mobile collaborative learning. Second, we present a mobile app prototype for students to form mobile learning groups. In each learning group, students can interact with one another and with a chatbot. Furthermore, the mobile app can facilitate the sharing of open educational resources.**

Keywords—mobile learning, e-learning, AI, chatbot, OER

I. INTRODUCTION

University education is undergoing fundamental changes, as shown in Table I. In summary, supported by advanced technologies as well as methodologies, university education is becoming more student-centered and learning focused. E-learning will play an important role in this transformation process.

TABLE I. CHANGES IN UNIVERSITY EDUCATION

Past	Present and Future
Classroom	Learning space/community
Physical	Hybrid/blended
Teacher-centered	Student-centered
Teach	Learn and develop
Local	Global
Knowledge	Thinking and learning capability
Textbooks	Multimedia resources and learning objects
Standard grading	Holistic assessment and learning analytics
Understand, Apply	Analyze, Design, Create

Indeed, many studies confirm the advantages of e-learning (e.g., [1]) to complement traditional learning. In particular, based on the study in [2], e-learning exerts a significant influence on student motivation, a key factor in learning. With the advent of smartphones and other mobile devices, a new era of e-learning or mobile learning is emerging (see a critical review in [3]). This not only provides a new way of learning, but also opens a new and unique channel for student interaction and communications [4]. For example, the study in [5] indicates that WhatsApp can enhance student learning in a variety of areas, such as facilitating discussion and collaboration, sharing information and knowledge, and integrating different learning resources. The emergence of Artificial Intelligence (AI) can bring mobile learning to a new dimension [6]. In particular, the study in [6] indicates that AI use can provide better student feedback, facilitate personalized learning and monitor student performance more effectively. Furthermore, chatbots can be used to complement mobile instant communications and mobile learning [7]. The survey in [8] indicates that chatbots can enhance the student learning experience, in particular, for finding quick answers and obtaining learning feedback. [9] evaluates the use of chatbots based on Chickering and Gamson's Seven Principles for Good Teaching, and finds that five of the principles can be fulfilled. However, [10] finds that chatbot effectiveness depends on their training (i.e., students may lose interest if the answers are not satisfactory). The study in [11] also indicates that the effective implementation of a chatbot for educational purposes depends on a good dataset (i.e., training data). Based on the unified theory of acceptance and use of technology, [12] finds that performance expectancy, effort expectancy and habit are the three key factors required for students to use chatbots.

On the other hand, there are now many good e-learning materials or Open Educational Resources (OERs) available over the Internet [13][14]. For example, various studies have shown that using YouTube videos can enhance student learning [15]. Based on the comprehensive study in [15], there are various benefits to using YouTube videos in lectures (e.g., 98.6% of students indicated that videos could help them understand the lectures, and 94.3% indicated that the overall lecture could be enhanced through the videos).

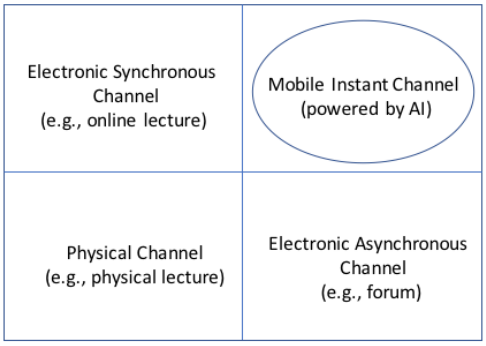

Fig. 1. Different channels to interact with students

Inspired by the above related work and development, this paper presents a new learning channel to complement the existing ones (see Fig. 1). To enable the formation of smart learning groups, a mobile app is presented. Through the mobile app and supported by an innovative AI^5 education model (to be explained later), students can interact with one another and with a smart agent or Virtual Intelligent Teaching Assistant/Agent (VITA). By using a VITA, student communications can be made more personalized and interesting. For example, each student can even be assigned a VITA to stay in touch with the student around-the-clock and communicate with him/her in a friendly manner (e.g., to motivate his/her learning based on the student profile and performance). This can complement existing student interaction channels. In addition, peer learning can be enhanced through the mobile learning groups facilitated by mobile instant communications and the sharing of OERs. The remaining sections of this paper are organized as follows. Section II discusses the conceptual model. Section III presents a mobile app prototype and initial evaluations. Section IV gives the conclusion.

II. CONCEPTUAL MODEL

In this section, we first present the conceptual model. With the aim of enhancing student independent learning, the following AI^5 Model (see Fig. 2) is proposed:

App for

- Inception – Help students start their "learning engine"
- Interest – Motivate students to learn by enriching their interest
- Instruction – Guide students to learn
- Information – Provide students with information/OERs for learning
- Inspiration – Inspire students to learn further and deeper

The model seeks to cover the major learning phases in the student learning process. Basically, students should be motivated to start learning, be provided with instructions and information for learning, and be inspired to continue learning.

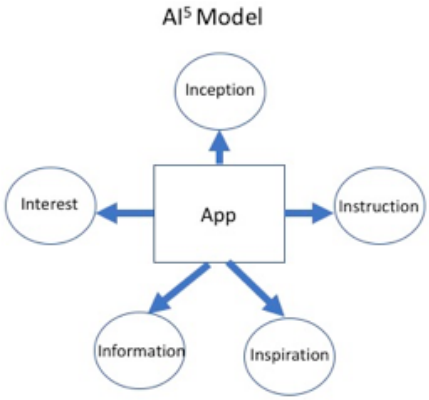

Fig. 2. AI^5 Model

Based on AI^5 Model and with the aim of enhancing the student learning experience, this project seeks to develop a mobile app with a Virtual Intelligent Teaching Assistant/Agent (VITA) to support smart learning groups with the following key features.

Students can create learning groups on various topics or for different purposes, and invite other interested students to join. Teachers can also create learning groups for a class of students (i.e., to complement classroom teaching and to support student projects).

Each learning group can be managed by a smart agent (i.e., VITA or chatbot). For subject-based use, the smart agents can function as virtual teaching assistants under the management of the corresponding teacher. The smart agents can interact with students (e.g., using chatbot functions) and recommend OERs to students for both common and personalized needs (e.g., Agent: "I just found the following OERs for the last lecture. Take a look, quite useful."; Agent: "It seems that you cannot solve the first tutorial problem. Read and try this …"). In addition to existing OERs, useful OERs can also be created with the help of student assistants. For example, when it is found that students have difficulties in understanding certain concepts (e.g., from the chat messages), new OERs can be created to enhance teaching/learning. The new OERs can also be used in future classes.

In each learning group, people can also share related OERs (e.g., useful YouTube videos found), and give likes, ratings and/or comments. Note that some OERs can also be created by students (e.g., for inquiry-based learning). Students can sort the OERs by "likes" and other means to facilitate learning and discussion. Apart from subject-based learning, learning groups can also be set up for project-based learning and student advising purposes.

There is a chat function for group members to communicate, discuss projects and interact with one another. Additionally, people can chat with a smart agent, which can also initiate discussion (e.g., Agent: "The concept in the last lecture is a bit complex. Let's find some related videos. Here is one of them …"). There can also be personalized communication or encouragement (e.g., Agent: "Don't be too disappointed with your assignment result. Watch this …") and interaction for project learning/management purposes (e.g., Agent: "This may be useful for our subject project …").

The app can also provide data analytic functions for data analysis (e.g., e-learning analytic) and student assessment purposes. For example, the following useful information can be available from the app, such as number of messages sent, number of OERs suggested, number of "likes" provided, number of comments posted etc. The information can reflect student participation (e.g., with the introduction of a participation grade). Note that the app can also evaluate comments and messages based on the content. The information can also be used for further analysis. For example, it is of interest to evaluate the correlation of student participation and the grades. Machine learning and/or data mining techniques can be used to conduct in-depth analysis.

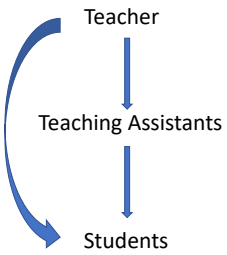

Fig. 3. Traditional management structure

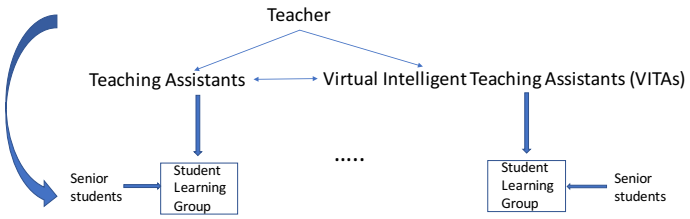

Fig. 4. New management structure

Fig. 3 shows that traditionally, a teacher typically manages the students of a subject/class with the assistance of teaching assistants while he/she can also interact directly with students. As shown in Fig. 4, this project seeks to introduce a new teaching/learning management structure to complement traditional teaching/learning management. As mentioned above, students can be assigned to student learning groups (e.g., based on their project groups) to facilitate peer learning and effective management. The student learning groups can be managed with the assistance of the teaching assistants as well as VITAs under the teacher's overall management. Indeed, teaching assistants and VITAs can work in a complementary manner to enhance student learning. Also, the teaching assistants can assist the teacher in managing VITAs. Note that in each student learning group, senior students (e.g., students who have taken the subject before) can optionally be assigned to help students as well. This will further strengthen student learning, as senior students can share their learning experience in the subject. The proposed mobile app can facilitate the aforementioned teaching/learning management structure with the aim of enhancing student learning.

Note that the mobile app can also support the use of OERs. In essence, each student learning group should search for OERs. Whenever an OER is found in a chat message, the corresponding OER (i.e., link) will be filed in the OER collection page to facilitate viewing (e.g., YouTube videos). Furthermore, "likes" and comments can be made by students. The OERs can be sorted and easily searched to facilitate student learning. To further enhance student learning, competition/game-based learning can be used (e.g., by organizing student competitions based on OERs searched/created, and by student participation in learning groups).

In summary, to illustrate how VITA (chatbot) can be used to facilitate teaching/learning, we present the following example. Suppose that a teacher would like to teach a computing algorithm in a subject. Based on the AI^5 Model, he/she can use the mobile app and instruct VITA (chatbot) to send the following messages (see Table II):

TABLE II. MESSAGES

	VITA (chatbot) chat message	Desired student action
Inception	"Tomorrow's lecture will be about a computing algorithm. Here is a short video to explain a related problem."	Students watch the video and try to find further information.
Interest	"Recently, an interesting computing algorithm has been developed … Watch this news."	Students discuss the news through the learning group.
Instruction	"After the lecture, please do assignment 1. Here is a related website."	Students read the website and discuss among themselves.
Information	"It seems that you need more help with Q1 of Assignment 1, read this …"	The student reads the OER and seeks help from other students as well.
Inspiration	"Well done on Assignment 1! Now, this is an advanced, challenging topic for you to explore further …"	The student reads the topic and studies more materials.

III. MOBILE APP PROTOTYPE

In this section, we present a mobile app prototype and initial evaluations. Fig. 5 shows the basic system architecture. In terms of the technological aspect, the aim is to develop AI-based chatbots (smart agents or VITAs) to interact with students (i.e., to support the AI^5 Model) based on Google's Dialogflow (https://dialogflow.com). In general, VITAs or smart agents can be developed based on two basic approaches. First, a knowledge-based approach can be used, in which question/answer templates can be defined. In addition, we shall explore personalized answers (e.g., based on student profile or performance). In the second cognitive-based approach, student questions can be analyzed using AI to determine the meaning or intent so that suitable answers can be provided. This will involve data training, with student help. For Google's Dialogflow, there are three general steps: identifying intent, extracting entity and controlling dialogue (see https://dialogflow.com for details). Again, with student assistance, better intelligent responses can be provided through training. For the mobile app development, Flutter was used (https://flutter.dev/), so that a cross-platform app could be developed more

effectively. The app was developed using Firebase, and hence should be protected by Firebase's security functions. For authentication purposes, there is a basic login function using student email addresses. The aim of this paper is to discuss the app's basic functions. Security/privacy issues will be handled in the future.

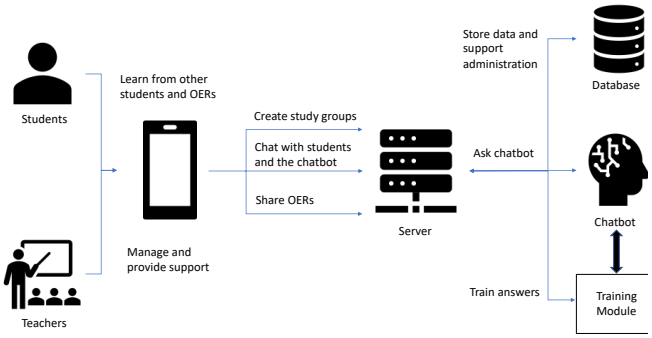

Fig. 5. Basic system architecture

In the following subsections, we present the basic functions of the mobile app prototype, including forming study/learning groups, interacting with the chatbot/agent (e.g., asking academic questions), discussing with other students, sharing and commenting on OERs, viewing OERs in a group library, searching for videos by the chatbot (e.g., through YouTube), adding playlists and managing schedules (i.e., task lists). The functions are inspired by the aforementioned conceptual model (i.e., AI^5 Model). Note that the chatbot functions as VITA or smart agent, as discussed above.

With the aim of facilitating collaborative learning, Fig. 6 shows that students can easily form study/learning groups based on their interests. In each study group, students can chat with a chatbot, asking questions related to the study topic. This seeks to enhance their interest in the study topic. For example, as shown in Fig. 6, students can ask questions related to C programming, with instant answers provided by the chatbot.

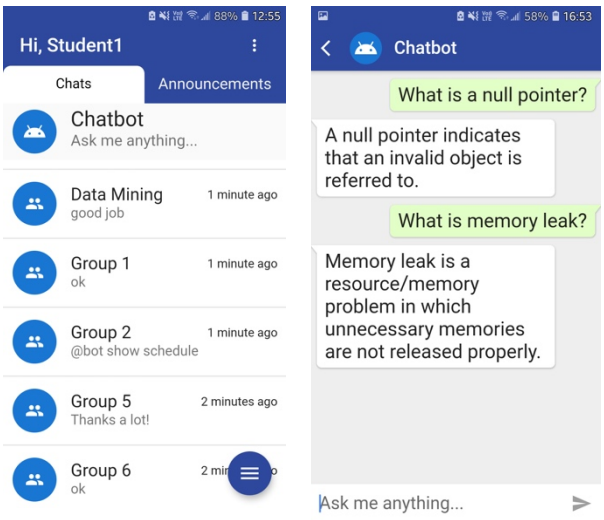

Fig. 6. Study group and chatbot

In addition to asking questions, students can also ask the chatbot to do something. As shown in Fig. 7 and Fig. 8, a student can ask the chatbot to add to and show the study schedule, respectively. In this case, the chatbot can function as a student's teaching assistant. This function seeks to facilitate student study management.

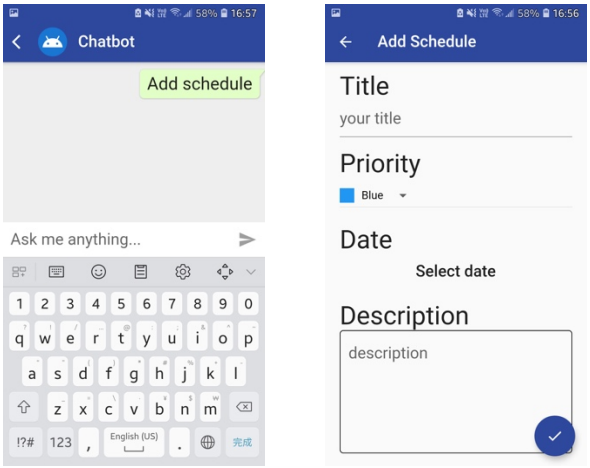

Fig. 7. Chatbot and adding a schedule

To facilitate students in finding the learning materials, as shown in Fig. 9, a student can ask the chatbot to perform a search. For example, as shown in Fig. 9, the chatbot can help students search for learning materials (i.e., OERs) related to online lectures.

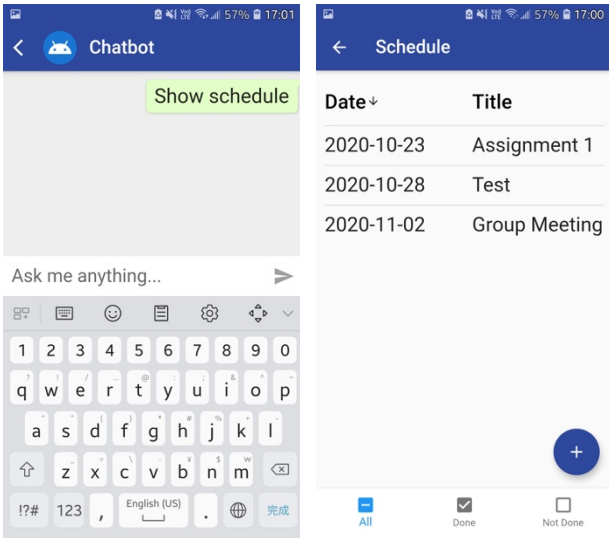

Fig. 8. Chatbot and showing a schedule

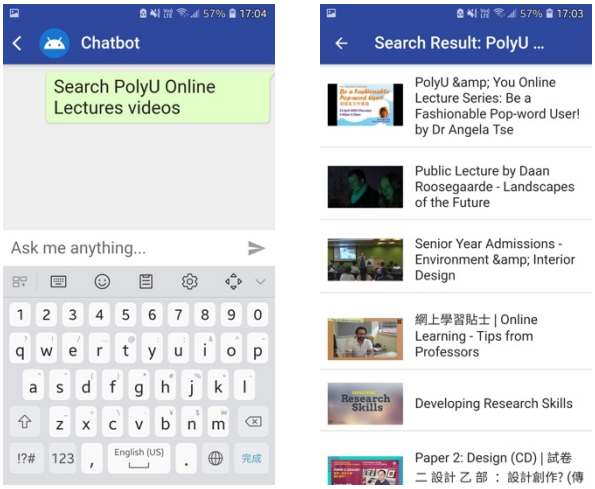

Fig. 9. Chatbot and search results

As communication is a key element in learning, the chatting function plays an important role. Fig. 10 shows that a student can chat with other students in a study group as well as with the chatbot (e.g., similar to chatting with a teaching assistant). To communicate with the chatbot (i.e., to indicate that a message is for the chatbot), "@bot" should be included in the message. The chatbot can also suggest OERs for students.

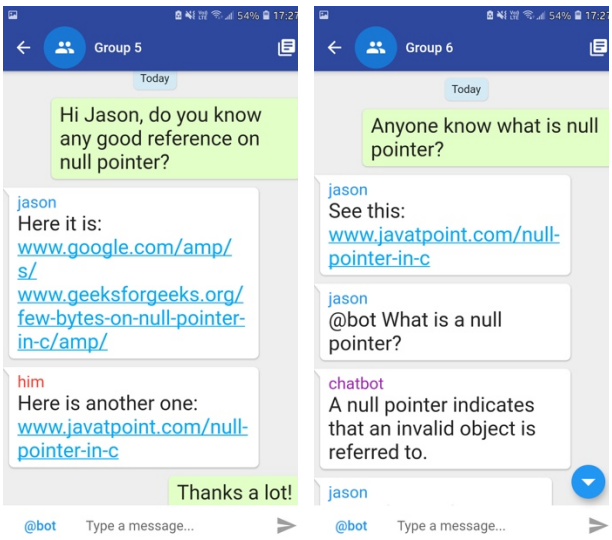

Fig. 10. Group chatting

To enhance student learning, students are encouraged to share OERs. As shown in Fig. 11, OERs (corresponding Uniform Resource Locators (URLs) can be included in chat messages. Each URL (link) is automatically saved in the group library, so that students can access the OERs through the group library. In other words, the group library can facilitate student access to the OERs or learning materials through a single interface.

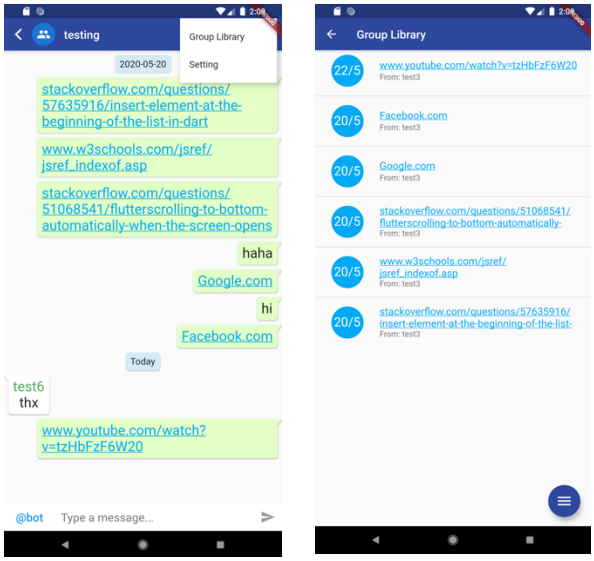

Fig. 11. Chat messages and group library

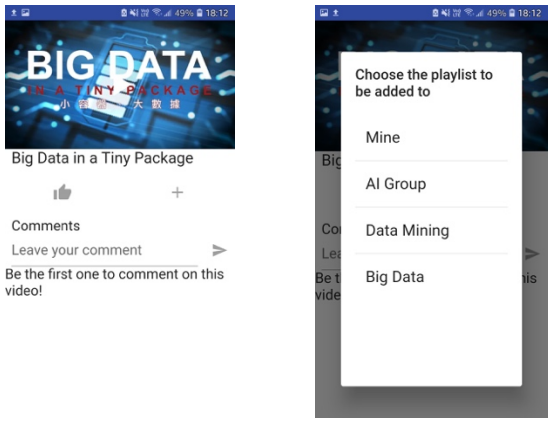

Fig. 12. OER/video and playlist

As shown in Fig. 12, a student can see an OER (e.g., YouTube video) and provide "likes" and comments. An OER can be added to the student playlist as well. Note that students can watch the videos anytime through their mobile phones.

We conducted an initial/pilot survey to evaluate the mobile app prototype. There were 10 students (i.e., volunteers) who tried out the app. They were asked to complete a survey through a web form with nine major questions. The results are positive and promising. More comprehensive surveys will be conducted later. Fig. 13 shows student chatbot usage. The answers were provided using a six-point scale (from 0 (never use) to 5 (always use)). Basically, 0-2 and 3-5 correspond to low and high usage, respectively, with different usage sublevels. It can be seen that most students used it to ask academic questions. Students did not use the chatbot to search for videos, probably because they preferred to search for OERs/videos directly, rather than indirectly through the chatbot. Fig. 14 presents further evaluation. Students were asked whether they found the chatbot functions useful. Note that multiple answers or no answer could be provided. It shows that most

students liked the "add schedule" and "show schedule" features, followed by the "ask academic questions" feature

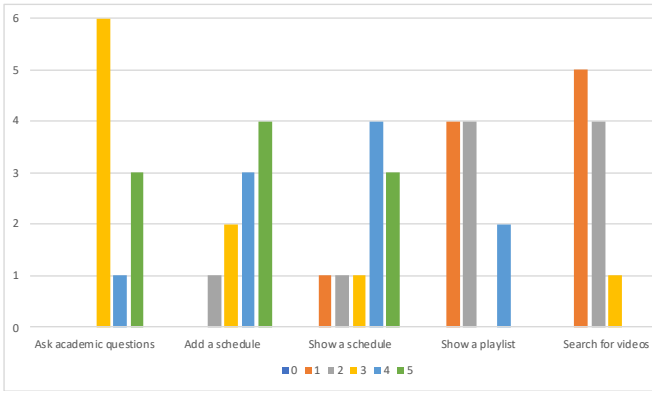

Fig. 13. Chatbot usage

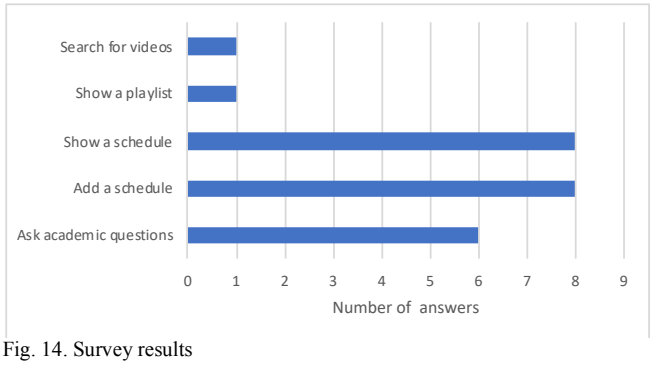

Fig. 14. Survey results

Students were also asked to evaluate the chat (i.e., instant messaging) and group library (i.e., sharing OERs) functions. A five-point scale is used with the meaning of the lowest/highest points defined in Table III. Fig. 15 shows that in general, students found the instant messaging function easy to use. They were also satisfied with the overall functionality. Additionally, Fig. 16 shows that students were satisfied with the group library function, which helped them with their studies.

TABLE III. MEANING OF THE LOWEST/HIGHEST POINTS

Questions	Meaning	
	1	5
Is the chatbot function useful?	Not useful	Useful
Is the instant messaging easy to use?	Not easy	Easy
How good is the overall function?	Not good	Good
Is the group library easy to use?	Not Easy	Easy
Is the group library useful/helpful for your studies?	Not useful	Useful

IV. Conclusion

In this paper, we have presented an innovative AI[5] model with five important learning elements, namely: Inception, Interest, Instruction, Information and Inspiration, to facilitate mobile collaborative learning. Furthermore, we have presented a mobile app prototype to facilitate the formation of mobile learning groups. The mobile app allows students to interact with each other and with a chatbot (i.e., AI agent) for learning purposes. Furthermore, students can effectively share OERs through a library function. Initial/pilot evaluations show positive student feedback. For future work, we shall conduct more comprehensive surveys, further enhance the app/system and handle security/privacy issues.

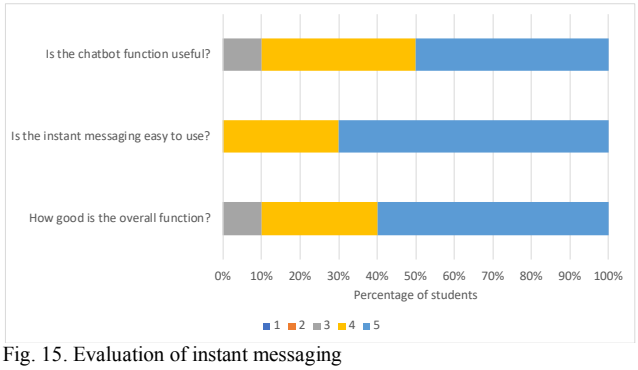

Fig. 15. Evaluation of instant messaging

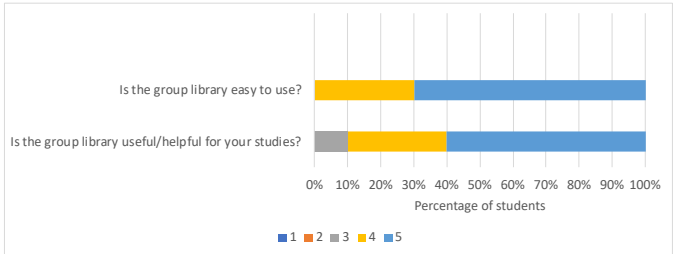

Fig. 16. Evaluation of group library

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