Designing and Evaluating Three Chatbot-Enhanced Activities for a Flipped Graduate Course

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***Abstract*—The purpose of this study is to discuss the implementation and evaluation of chatbot in a flipped graduate course run by the University of Hong Kong. Using the IBM Watson system, three chatbot activities were designed: (a) the first chatbot as a multiple-choice guide for learners' knowledge exploration; (b) the second chatbot as a case study facilitator for new information elaboration; and (c) the third chatbot as a bibliographic tutor to answer learners' FAQs related to the learning contents. All three chatbot activities were implemented as pre-class activities, combining with video lectures and online quizzes. Participants interacted with the three chatbots via the course web for an average of 20 minutes. After that, the participants completed a questionnaire and interview to yield insights related to their perceived social presence and interpersonal attraction about the chatbot. The findings of this study will help instructors gain valuable insights about students' attitude toward the three types of chatbot activities, the content of students' chatbot interactions, as well as recommendations for improving chatbot use in a flipped course.**

***Index Terms*—flipped classroom, chatbot, learner satisfaction, instructional design**

I. Introduction

The application of flipped classroom pedagogy or flipping a course in higher education is gaining momentum across various fields in the recent years [1,2]. A flipped course consists of two main components, a pre-class session, and a face-to-face (F2F) session. However, implementing flipped learning can be challenging. A majority of previous empirical researches have pointed out that one of the vital challenges of flipped learning is students' disengagement in online learning session (e.g., not completing the quiz) [3,4,5]. In this study, we looked at a master-program level course entitled "Engaging Adult Learner" conducted by an instructor at the University of Hong Kong. Students in this flipped course experienced three chatbot facilitated pre-class activities embedded in the course's learning management system (LMS). These chatbots, namely Multiple-Choice Quiz (MCQ), Case Study, and Dictionary chatbots, were designed to help students understand the subject contents better in one of the lessons on adult learning strategies – i.e., transformative learning theory. Our study attempts to analyze the following research questions: (1) What are the processes involved in the development of chatbot to enhance students' satisfaction? (2) Can chatbot-integrated learning decrease learners' sense of isolation during online learning session? (3) Can chatbot-integrated learning increase learners' interaction with the online learning contents? The team will address these questions in the following sections. Section II will give us an overview of the previous work done in the field. Section III will show us how the team developed these chatbots based on the lessons learned from the literature and the needs of the course. Section IV details the findings of the implementation of these developments and finally, in Section V will discuss the limitations that the team encountered in the development and implementation of these chatbots.

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II. Literature

A. E-Learning Design Challenges in Flipped Classroom

In this study, the flipped classroom is a pedagogical approach combining both face-to-face and online learning opportunities. In particular, the instructional design of the course moved traditional lecture materials to an online learning environment [6]. Students were provided with pre-class learning materials such as readings, and video lectures to read or watch before coming to the face-to-face class sessions. The flipped classroom format has a positive influence in higher education, with more and more institutions adopting this new paradigm. Further, several past research studies have shown that combining both online and F2F learning environment can reinforce facilitation in self-directed learning ability, problem-solving skills, and learners' ownership taking [7], active learning, critical communication and thinking [8].

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However, motivating the students to engage with the online course materials prior to the face-to-face lessons remains a major challenge for teachers in designing their courses. Moreover, students face the difficulty in receiving meaningful feedback in the asynchronous pre-class sessions, which could result in a decrease in learning engagement. For instance, students may want to seek for opportunities to check their understanding when they engage with their pre-class online course materials, but due to the asynchronous nature of the pre-class online environment, the teacher may not be available to give immediate feedback. Chen and Yao [8] state that learners feel isolated in a virtual learning environment (VLE) if timely feedback is not given or provided. This isolation is a major downside when integrating e-learning elements into traditional face-to-face learning. Nortvig, Petersen, and Balle [9] added that learners' sense of isolation during online activities might be the potential reasons for low success in achieving the learning outcomes.

In a similar vein, students' satisfaction is affected by two factors. First is the students' expectations and the second is the learning climate. On one hand, students' expectations are linked to the learning content features such as the use of "hypertext, graphics, audio and video, computer animations and simulations, embedded tests, and multimedia information" [9] or the design of the course. On the other hand, the learning climate focuses on the learners' interaction with e-activities and the learning management systems [10]. Lim and Morris [11] mention a similar finding, they mentioned that the quality of learning activities is one of the instructional variable impacting students' satisfaction. In addition, timely and interpersonal communication during students' interaction with online learning contents are important variables that can promote learners' satisfaction [12].

B. Chatbots Application in e-Learning Environment

Chatbot utilization as a conversation agent has over a half-century history, beginning with ELIZA which is the first chatbot developed in 1966 by Joseph Weizenbaum. In more recent studies, various fields of education explore the use of chatbots to improve content delivery. For example, LAWBO was created to help Indian lawyers to search for law cases [13], while CiboPoliBot was a chatbot designed as an educational game [14]. Moreover, AllergyBot [15] and Nombot [16] are just a few chatbots aimed at providing better living and healthy lifestyle.

In field of education, educators design chatbot with theoretical rationales underpinning different disciplines [17]. These chatbots are available to learners anytime and anywhere [18] enabling the teachers to support their students even after the synchronous session. These chatbots come in various interfaces from text-based, static image displaying, animated figure displaying, voice adding, to 3D animated interfaces. One example is Freudbot; a conversational agent designed to present the figure of Freud in three different interfaces: no image, static image and animated image with voice. Heller [19] examined Agent Evaluation and Social Presence and connecting it with learners' differences, including their visual, aural, read or write, and kinesthetic preferences.

However, these chatbots are tailor-made for a specific purpose as designed by the team who developed it and it will be difficult for us to remix these chatbots for our research project. Further, there is a dearth in the literature regarding chatbot used in a master program class, in particular in the topic of adult learning. This gap in the literature pushed the team to developed a chatbot to address the research questions which will be discussed in the next section.

III. CHATBOT DEVELOPMENT

We developed, using IBM Watson Assistant and implemented the three chatbots (see Table I) in a master-level course entitled "Engaging Adult Learners."

TABLE I. DETAILED SUMMARY OF THE THREE CHATBOTS

Chatbot Activity	Learning Outcomes	Learning Contents	Technical Design
MCQ Bot	LO1: Students will be able to memorize the definition and classify the four stages of transformative learning theory.	Definition; four stages (disorienting dilemma, critical thinking. rational discourse, new action), cores	A three-layer chatlog was designed consisting three multiple-choice questions with scaffolding questions.
Case Study Bot	LO2: Students will be able to analyze, evaluate, and apply transformative learning theory in action.	Guidelines in applying transformative le arning	A five-layer chatlog was designed, starting with a close-ended question, as well as scaffoldings.
Dictionary Bot	LO1: Students will be able to memorize the definition and classify the four stages of transformative learning theory.	Terms and concepts related to transformative learning	A two-layer chatlog was designed with directed question and response.

The course aims to discuss the application of six learning strategies' in adult education, namely self-directed learning, transformative learning theory, experiential learning, workplace learning, collaborative learning, and problem solving. The course is offered by the Faculty of Education at the University of Hong Kong. The team designed the chatbots to focused on transformative learning with different purposes adapted from the cognitive sequence of Bloom's Taxonomy: the first and third chatbot, which is the MCQ and Dictionary chatbot respectively, were built for learners' knowledge memorizing and understanding. The second one, Case Study bot was built to help students apply, analyze, and evaluate new information. The pre-class online learning session for this course was web-based, consisting video lectures, graded quizzes with instant feedback, and chatbots activities, combining with the F2F learning session. All three chatbots were text-based with one static icon as the instructor's image and three are sharing the same name - 7345 bot. The single name for all three chatbots creates a perception that there is only one chatbot accompanying the students throughout their

learning process. Further, this one-chatbot effect is primarily used as a learning companion for the students as they go through the materials to lessen the feeling of being isolated in a VLE.

In the IBM Watson Assistant system, a complete dialog consists of three components: #intents, @entities, and the dialog. Intents refer to users' possible question or responses. Entities are keywords or synonyms which help the chatbots to recognize user localize words. For instance, the entity "dilemma" is synonymous with "disorienting dilemma" or "the first stage" in the context of transformative learning. This entity enables the chatbot to recognize both "what is a disorienting dilemma?" and "what is people's first stage during experiencing a transformative learning?" as the same question. Finally, a dialog consists of #intents, @entities, and response which is the chatbot's reply to users.

A. MCQ Bot Design

Students interacted with the MCQ bot after they watched the video lectures to explore the basic concepts of transformative learning theory (see Fig. 1).

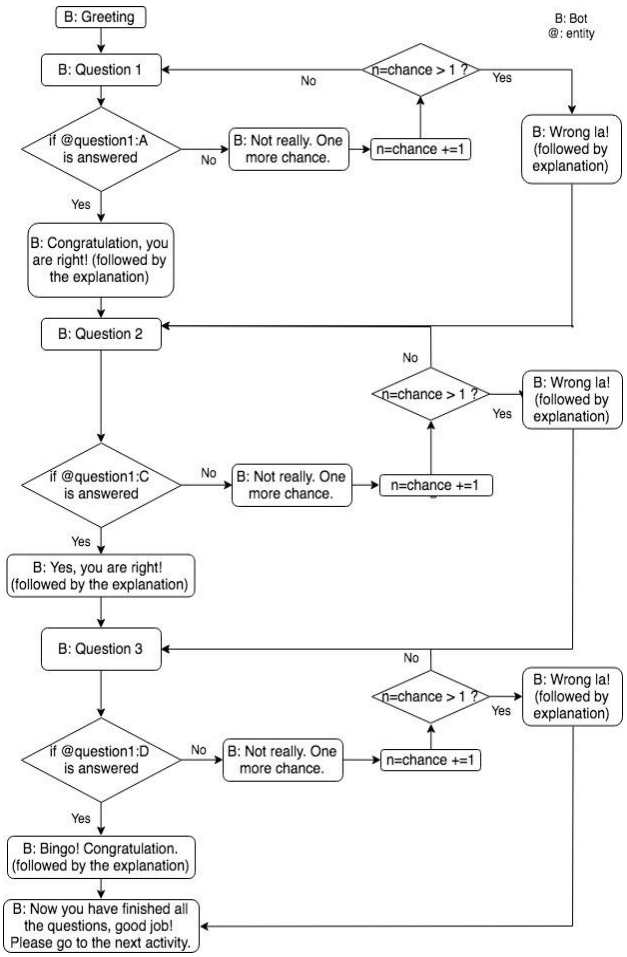

Figure 1. Multiple questions chatbot design.

In achieving LO1, we built three layers - question, options, and feedback. Each layer has three different questions. For example, question 1 asked the students "What is the second stage during transformative learning?" and gave four options which are "dilemma," "critical thinking," "rational discourse," and "new action." Students will have to choose one option, and if the students choose the right option, the chatbot will give the feedback "Congratulation!" and move forward to the next question. However, if they select the wrong option, a scaffolding question will be shown as "Nice try, but please think about the sequence of transformative learning. Once more chance". Then, the question 1 will come again. Further, if the student accumulated more than two wrong answers, detail explanations will be given to students, and they can continue to answer the next question.

The MCQ bot will be followed by a graded quiz task to check students' basic understandings of transformative learning. Notably, although chatbot and quiz activities were both designed for learners' concept memorizing, the MCQ bot can be a good self-assessment for learners to check their understanding before they move to the graded quiz task.

B. Case Study Bot Design

This chatbot activity, addressing LO2, was designed after the video lecture of a transformative learning application. Learners need to solve a practical case named Irene Case, a pedagogical application of transformative learning, and then learners will chat with the bot to evaluate whether Irene's actions are accurate (see Fig. 2).

With one close-ended question raised by the chatbot "Do you think her first teaching step is right?", students typed either "Yes" or "No." The team did not design an open-ended question to avoid irrelevant responses from students that may confuse the chatbot. Another reason is to get the students' attention to think about the transformative learning application sequence. Then the next question is "What should be her first step?" with the expected response related to "@dilemma." Once students' answers were categorized into "@dilemma," instant feedback "Good point!" will pop up and the next question will be raised. Otherwise, another two chances will be given to students with the guiding question "Are you sure? Please think about the four steps during application". Similar to the wrong counter in MCQ bot, this bot will bring students to the next question by providing the correct answer explanation of the previous question.

C. Dictionary Bot Design

In order to let learners quickly access to synchronous learning aids during their online learning session, the Dictionary bot plays a role as instant learning assistant to answer learners' frequently asked questions related to the terms and concepts of transformative learning theory (see Fig. 3). For example, the chatbot will classify learners' question "Can you tell me what rational discourse is?" into "#Definition" intent and then with recognizing "@rational discourse," and chatbot will provide the answer. On the event that the chatbot was not able to classify the questions into the right intents and entities, then, the chatbot will ask the students to rephrase their questions again. If chatbot still cannot identify the

students' questions with the existing intents and entities, then it will be included into "#irrelevant" intent, and it will give learners the following feedback "Sorry, I will fix this problem when I get more data." The irrelevant questions will be manually classified by teachers to supplement the chatbot database.

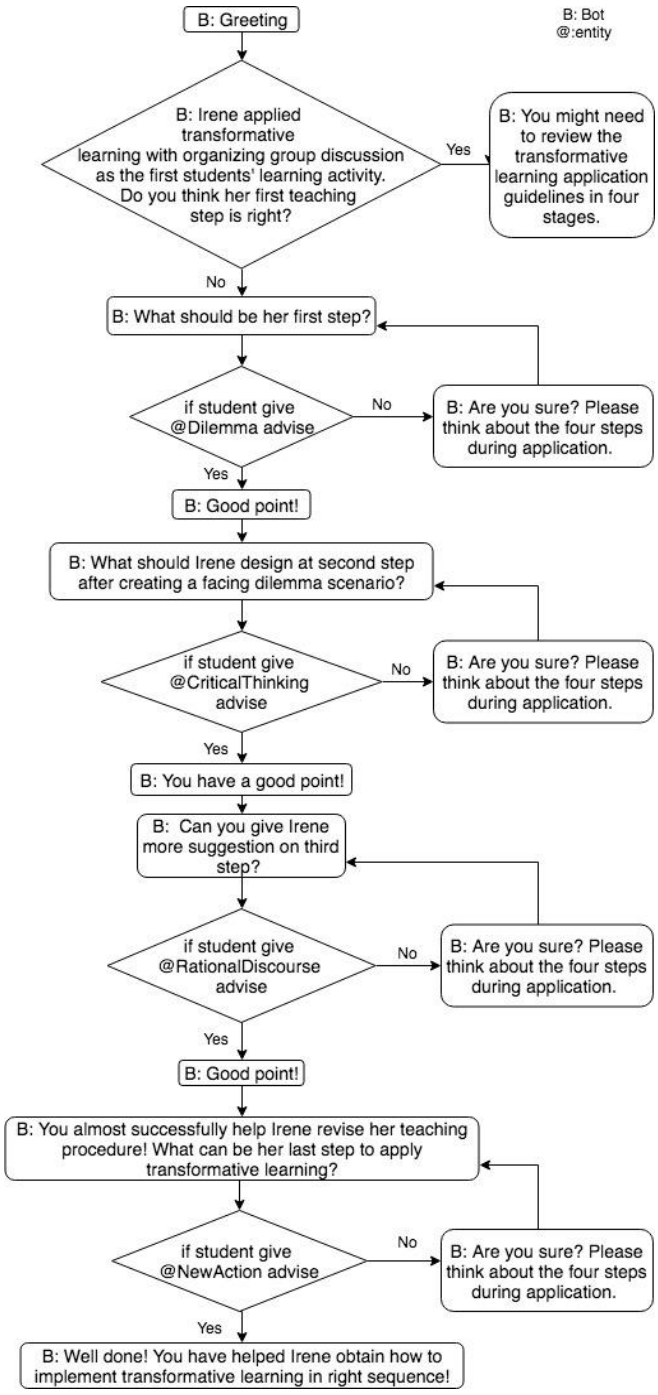

Figure 2. Case study chatbot design.

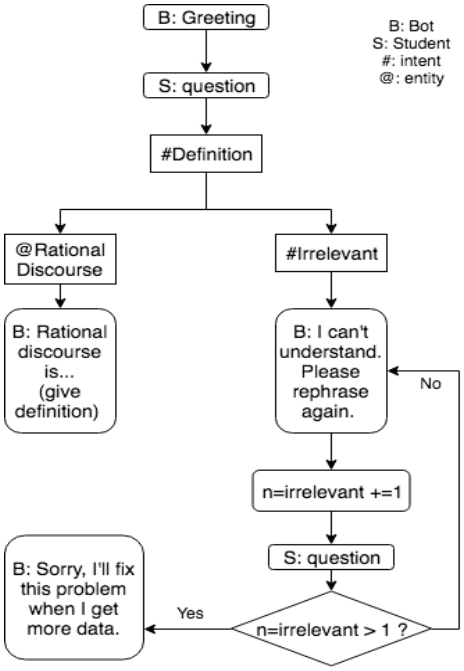

Figure 3. Dictionary chatbot design.

IV. Findings and Discussion

14 graduate participants received the invitation to try the chatbot activities, with 13 of them logging into the course, and ten completing the activities. Finally, seven participants finished the questionnaires and agreed to do the interivew. Adapted from Li, Kizilcec, Bailenson, and Ju [4], social presence was measured with six items while interpersonal attraction with four items (see Table II) in questionnaires. Both measures contained ten-point Likert scales from not at all (1) to absolutely (10). Then, the team asked the participant a set of semi-structured interview questions. These questions were the following, "Can you tell me about your feeling of learning with chatbot?", "Which kinds of chatbot (MCQ chatbot, Case Study chatbot, and Dictionary chatbot) do you prefer? And why?", "Could you give any comments or suggestions about chatbot implementation in out-of-class flipped course component?".

Participants were invited to experience the Engaging Adult Learners course via the University of Hong Kong's online learning website (https://learning.hku.hk/catalog/) and experienced several conversations with the chatbots. After that participants were asked to complete a questionnaire and were interviewed to give course evaluation about chatbot usage and their social presence and interpersonal attraction about the chatbot.

Overall, the results in Table II presented that learners' social presence and interpersonal attraction with chatbots gained a slightly positive acceptance from the learners. Results overall revealed learners' neutral and positive attitudes towards the chatbot. However, participants' willingness to spend more time with chatbots is slightly negative. This result supported the first finding that learning with chatbots might decrease e-learners' isolation, but they still treat chatbot as a virtual character. In one of the interviews, the participants mentioned that

she still "treat it as a machine than a learning partner..." and "...(chatbot) is basically working, while it still very hard to treat the chatbot as human being...", which suggested that in this study human being's character cannot be replaced by an intelligent chatbot for the time being.

TABLE II. DESCRIPTIVE STATISTICS FOR LEARNERS' SATISFACTION MEASUREMENT

Satisfaction	Conditions	M	SD
Social Presence (SP)	1. Interaction with an intelligent being	5.71	2.36
	2. Accompanied with an intelligent being	5.29	2.33
	3. Feeling of alone	5.71	2.30
	4. Involved with chatbots	5.86	2.33
	5. Responded by chatbots	5.43	2.13
	6. Communicating with chatbots	5.86	2.93
	Total	5.64	
Interpersonal Attraction (IA)	1. Learning with chatbots	6.57	2.20
	2. Liking chatbots	6.43	1.93
	3. Spending more time with chatbots	4.86	2.23
	4. Chatbots being a friend	5.29	2.33
	Total	5.79	

The second finding suggests an increased interaction and collaborative learning between e-learners and the chatbot. IA1 (learning with chatbots), the highest one rating among all conditions of effecting e-learners' enjoyment with the intelligent agent, showed that learners would like to learn with chatbots more. Moreover, one participant mentioned her preference to Case Study bot as she interacted with this bot more during the learning process.

Finally, the third findings showed that factual or conceptual learning outcomes could be achieved easier. From the interview section, four in seven participants stated they preferred MCQ bot while another two students liked Dictionary bot. Both chatbots were designed for knowledge remembering. One student said, "I only want to ask very conceptual questions (what is ...) from the chatbots, and as for some more complex questions (why..., how...), I prefer to ask a human friend". Another student indicated that he liked Dictionary bot as it could give him clear and more official definitions of the unknown term.

V. CONCLUSION

As a conclusion, this study points out significant insights about students' attitude toward chatbot technology in out-of-classroom sessions of a graduate flipped course, including learners' satisfaction reinforcement with reducing their sense of isolation and increasing student-chatbot interaction in directed fact or concept knowledge, as well as a closely chatbots' instructional design with other e-activities. However, there are several limitations to this study, including both research and chatbot design limitations. First, students' attitudes toward other instructional activities were not measured. As the chatbot activities are closely connected with other learning activities (like video lectures, online quizzes, and face-to-face student-teacher interactions), participants' satisfaction to chatbots might be affected by their experiences on other learning activities. Therefore, further research can examine the factors affecting students' engagement by comparing chatbots with other activities. The second limitation is the small participant sample size which constraints the generalizability of the findings. A larger sample of participants need to be gathered in the future studies in order to provide more valuable and widely-utilized insights in chatbot technology in the blended learning environment. Another limitation is that open-ended questions cannot be achieved in the three chatbot learning activities. For now, the chatbots cannot solve unstructured problems required by learners. Veletsianos and Miller [20] noted that interaction quality is realized more significant than the visual character's aesthetic design. Therefore, the quality of chatlogs contents should be paid more attention during instructional design and future studies can pay more attention to design chatlogs frameworks and more connections among different chatbots. For example, when students get several wrong answers in MCQ bot, the link for Dictionary bot can pop up and let students revise the knowledge again.

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