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# The Design of an Intelligent Chatbot with Natural Language Processing Capabilities to Support Learners

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**Abstract.** It would be ideal for the teacher to give individual attention to each student. However, this is infeasible as teachers only have limited time and they will be tired after long periods of consultation. Chatbots can be an effective tool to overcome this problem. A pilot was conducted on 11 Feb 2019 in which 27 students tried a chatbot prototype built by the author. The students compared the chatbot and a quiz website. The academic contents provided by the chatbot are exactly the same as the website. Over 80% of the students agreed that the chatbot is better than the quiz website in many aspects. However, about half of the students also indicated that the chatbot took them more time to complete the quiz than the quiz website. The author proposed using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework to conduct more research into this area. The knowledge would allow more teachers to create chatbots in more disciplines of study so that students are more motivated to achieve the learning outcomes better.

## 1. Introduction

Teachers often find it difficult to engage students in classroom. When students leave secondary schools and start their higher education, they often feel lost because the learning environment changed from prescriptive, with fixed textbooks and classmates, to a much bigger campus with no seating plans or fixed classmates [1]. This transition makes some students feel uneasy to approach their teachers for subject-related problems, especially the weaker students. The anxiety caused will possess negative effect on personal relationship and academic performance.

It would be ideal for teachers to give individual attention to each student, especially before major assessment tasks such as tests, assignments or examinations. However, this is not practical as teachers have limited time besides teaching and they may become tired and bored after long periods of consultation [2]. Besides, many students are too shy to approach their teachers for enquiry. They may be also reluctant to ask their own peers in order to maintain their social status [1]. As digital technologies become increasingly affordable and ubiquitous, teachers can choose to use technologies to better communicate with students. The common forms of such technologies used by teachers are the Student Response System (SRS), the Learning Management System (LMS), and mobile phone applications. While these tools are effective to a certain extent, they also have their own limitations.

The following sections will review the limitations of each of these tools. The benefits of using the chatbot as a tool to help solve the teacher-student communication problem will be discussed. Then the author will propose using the UTAUT framework for a full research.



## 2. Related Digital Technologies

This section will review related digital technologies to justify the need for chatbots in supporting learners to learn new technologies.

### 2.1. Student Response System (SRS)

The SRS is an effective and efficient tool to get responses from students in a classroom. In an SRS, the teacher broadcasts questions for students to answer on their mobile devices. Afterwards, the teacher can show the statistics of the students' answers and discuss them accordingly. Such usage means the teacher has to wait for all, or most of the students in the classroom to submit their answers, before starting the discussion. This limits the scope of the questions covered during lessons. The literature shows that many teachers only ask three to six questions per lecture using the SRS [3]. Another limitation is that the teacher may include hints in some questions, but many students do not actually need them. There is no way to differentiate which group of students get the answer right without the need for hints [4].

### 2.2. Learning Management System (LMS)

Major LMS, such as Blackboard or Moodle, allow the teacher to create online quizzes. The teachers often spend much time in preparing quizzes in the LMS with groups of questions covering different parts of the course [5]. However, these LMSs often do not allow the student freely navigate to quiz themselves on different parts of the course, and the quizzing mechanism is mechanical and boring to many students. Moreover, the students have to click through several web pages to navigate to different quizzes. Besides, most LMS cannot provide personalized feedback to the students based on their performances. As a result, many students may adopt a surface approach to learning, meaning that they will aim to "pass the course while doing as little work as possible" [6, p.148].

### 2.3. Mobile phone applications

Many LMS such as Moodle, have a mobile phone application version. There are also some mobile phone applications that can help students learn. However, many users are hesitant to download yet another mobile application because they already have too many applications installed [1]. Installing another application means that more phone memory will be consumed and they must learn to use the new software. There are also security concerns of the possibility of getting malicious software. In the author's institution, the Moodle application cannot be used because the IT department has disabled logins from the application due to security concerns.

## 3. Chatbot as a potential solution

Chatbots are also known as chatting robots, chatterbots or just bots. They can be defined as "computer programs designed to simulate human conversations in voice or text form, or both" [7, p. 271]. The first chatbot was created by Joseph Weizenbaum in 1966. Chatbots can carry out human-like conversations, but they will not be bored or become tired like humans. Therefore, chatbots have been used to teach students foreign languages, psychology and even interview skills [7-9]. For example, the following dialogue is reported in a research on the use of chatbots in English teaching [9, p. 402].

*Student: Where are you from?*

*Chatbot: I am from Taiwan.*

*Student: I am from Taiwan, too.*

*Chatbot: I am interested in where is Taiwan, too.*

Most research on the chatbot as a learning tool focused on the human-like conversation capability. The research on chatbots in education has been limited to only a few academic disciplines. Furthermore, no acceptance models have been used to explain its acceptance by students. Given the advances in chatbot technologies in recent years, there is a need to explore the potential of the chatbot as a learning tool that can help students in a wider set of disciplines.

The functionalities of the chatbot have extended to beyond engaging in dialogues with humans [10]. Many of today's e-commerce chatbots are programmed to infer the user's intent from just a few words using natural language processing (NLP) [2]. The chatbots can prompt users to reply quickly by choosing a button to click, while allow the user to input text if none of the buttons represent the right choice. The chatbots can also provide information in the form of text, as well as images. They are often integrated into social media websites such as Facebook.

The following is an example from the chatbot in the 'Learning is Fun' Facebook page developed by the applicant. The chatbot first greets the student using his first name, then it shows a question, which is followed by five 'buttons' – representing four choices and a hint.

*Chatbot: Hi, Mike. Let's do a little quiz on AWS Infrastructure to help you prepare for the certification examination by Amazon.*

*Chatbot: Which of the following are geographic areas that host two or more*

- 1. AWS Origins*
  - 2. Compute Zones*
  - 3. Edge Locations*
  - 4. AWS Regions*
- ①②③④ ☹Hint*

*Student: ④*

*Chatbot: That is correct, Mike!*

*Chatbot: Good job! You have attempted almost half of the questions already.*

*Student: .revise wrong*

In this example, the student also enters the command “.revise wrong” command, which tells the chatbot to show the questions that the student answered wrongly before. A few other commands are listed show:

- . scores - shows the current score*
- . keywords – shows a list of keywords in the current topic for the student to choose*
- . stop – stop the quiz*
- . help – shows this help message*
- .<keyword>*

In the last command above, the student will enter the actual keyword(s) to try the related questions. If the student enters a word that is not listed, the rule-based NLP will show the questions that are related to the word.

#### **4. Benefits of using the Chatbot in Education**

Traditionally, the chatbot must have excellent conversational abilities to be qualified as useful [10]. The modern day chatbot has some features that make it suitable for engaging students in higher education. The features are listed below, followed by some explanations.

- Easy and frequent access through social media platforms

- Quick replies
- Natural Language Processing (NLP)
- Multimedia feedback
- Multi-version response

#### 4.1. Features of Chatbot for Education

Firstly, chatbots are often integrated into social media such as Facebook, and almost all university or college students use the social media on a daily basis [11] [12]. Through social media, the student can request information or get answers at times even when it is inconvenient to the teacher [1]. Secondly, the chatbot can accept multiple input methods to the same question. As shown in the example of the prototype, chatbots can also use buttons to represent predefined replies. The student can freely text to ask for revision in specific topics. Thirdly, students can use commands and keywords to freely navigate to quiz themselves on different topics. Fourthly, the chatbot can give response in multimedia format such as images and voice [10]. In Figure 2, the smiley icon with sunglasses is shown when the student answered the question correctly. This can better motivate the student because it makes the learning more intriguing. Finally, the chatbot can provide multiple version for the same response. Hence, if a student provides a correct answer to a number of questions consecutively. The confirmation from the chatbot may be different from time to time, instead of just, “Good, you are correct!” every time. This reduces the mechanical feel and make the chatbot more humanistic.

#### 4.2. The chatbot is an under-explored educational tool

As an educational tool that may be applied to multiple disciplines, the chatbot is under-explored [1, 13]. The applicant performed a search for chatbot-related peer-reviewed academic papers in the academic database of Education Resources Information Center (ERIC). The criteria are the number of articles returned are listed below.

*14 articles for abstract containing "chatbot or chatterbot" and "students or teachers"*  
*9 articles for abstract containing "chatbot or chatterbot" and "students or teachers" and the full text containing "higher education or university"*

By examining the full text, it was found that 10 articles used empirical data are included, and only 7 of them involved higher education. This lack of research is partly because of the traditional view that chatbots are used only for conversation using human-like sentences. Another reason is that, until recent year, chatbots have been very difficult to implement because the need to learn programming languages and have a full-set of integrated development environment (IDE) installed on one's computer. Recently, certain chatbot providers have created visual programming (VP) tools for creating platforms. This opens the door to chatbot creation to non-IT teachers. A chatbot prototype developed by the applicant using VP was used in a pilot study as described below.

### 5. Pilot study

The applicant created a chatbot prototype using VP. On 11 Feb 2019, it was used by 27 final year university students to prepare for an online quiz as part of Amazon's certification examination. Both the chatbot and the online quiz asked the same 10 questions. The prototype provides textual and images as feedback and encouragement statements to the user when they are 40%, and 80% through the quiz. After the students used the chatbot, they did Amazon's online quiz. Both the chatbot and the vendor's quiz are completed anonymously by students. A follow-up survey was done afterwards. Some screen captures of the chatbot prototype are shown in Figure 2.

The survey results show that the majority (70% to 85%) of the students “agreed” or “strongly agreed” to statements that described the chatbot as better the online quiz in many aspects. However, over half (58%) of the students indicted that it took them more time to complete the quiz using the chatbot than online quiz.

While VP is easier to learn than programming languages, it takes more time to build the chatbot with the image feedback, and multi-version response. Therefore, there is a need to know which feature(s) of the chatbot are important to students when it is used a learning tool. The knowledge will help to create frameworks that combine the suitable features in the right way so that the teacher can focus on editing the contents into the program. Therefore this research aims to fill the gap in knowledge by exploring the factors affecting student acceptance of the chatbot as a learning tool in higher education.

## 6. Proposed Research Methodology

This research will be based on the Unified Theory of Acceptance and Use of Technology (UTAUT), which was developed by [14] by reviewing and combining a number of theoretical models that explain the factors affect the adoption of technology by users. They reviewed models including, but not limited to, the TAM (Technology Acceptance Model), DOI (Diffusion of Innovation), and TPB (Theory of Planned Behavior). The UTAUT has been successfully used in the field of educational technologies [15] [16]. The original constructs of the UTAUT, and the additional construct for this research, are listed as below. As this is an exploratory study, more constructs may be added, or some constructs may be removed as the research progresses.

- Performance Expectancy
- Effort Expectancy
- Social Influence
- Facilitating Conditions
- Hedonic Motivation (additional construct for this research)

### 6.1. Performance expectancy (PE)

PE is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance [14] p. 447”. In the proposed research, the students will access the chatbot to quiz themselves on the relevant concepts before the main assessment tasks for a subject. Therefore, in this research, PE is defined as the degree in which the student believes that using the chatbot will help him or her to attain gains in academic performance. In previous research on use of mobile phones for learning, it was found that the social media could distract students from the learning tasks. However, if the students believe that using the chatbot within Facebook can increase their academic performance, the competing force of distraction may be overcome.

### 6.2. Effort expectancy (EE)

EE is defined as “the degree of ease associated with the use of the system” [14, p. 450] . In this research, EE is defined as the degree of ease associated with the use of the chatbot. In previous research, it was found that students found mobile phone applications not easy to handle because they needed to download, install and learn to use the application before they can get useful information. It was suggested that to encourage student to use their mobile phones for learning purposes, developers must adopt user-friendly technologies and platforms to ensure compatibility and ease of use [15]. The chatbot in this research will be available through a social media website. Most of the students have already installed the application on their mobile phones. Also, natural language processing (NLP) will be used to help students to jump to a particular quiz directly.

### 6.3. Social influence (SI)

SI is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” [14, p. 451] . In this research, SI is defined as the degree to which the student perceives that the teacher believes he or she should use the new system. Students who felt that their teachers did not offer enough support in the use of mobile devices will be less motivated to be involved in mobile learning. In this research, the student will feel the support from their teachers through the personalized greetings and encouragements when the student uses the chatbot.

### 6.4. Facilitating conditions (FC)

FC are defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” [14, p. 453] . In previous research on education, this construct was about the technical infrastructure to support mobile learning [15]. In this proposed research, the infrastructure is defined as the Wi-Fi connection on the campus, and the social media website such as Facebook.

### 6.5. Hedonic motivation (HM)

HM is defined as “the pleasure derived from using a technology [17, p. 563] . It has been found that hedonic motivations have a positive correlation with one’s intentions to use technology. In this proposed research, the hedonic motivation is provided through visual feedback and multi-version feedback. Besides textual feedback such as ‘You are correct’ or ‘Your answer is wrong’, the chatbot will also provide an image to make the learning more interesting. The effective of using visual feedback like emoticons may have two competing effects. On one hand, previous research shows that the use of emoticons can improve computer-mediated communications [18] . On the other hand, it has been found that some people perceive use of emoticons as unprofessional [19]. Hence, there is a need to find out what the students’ perceptions when images like emoticons are used as part of the feedback. Furthermore, gamification elements, for example earning virtual “points” and level up after completing tasks, could be incorporated in chatbots to build a creating and fun learning framework. Under an edutainment approach, students may be more willing to engage in self-learning and understand subject concepts more effectively and precisely [20].

## 7. Conclusion

This paper reported the positive response from students in using a chatbot for revision in a programming course. It also proposed to add a new construct of Hedonic Motivation to a proven research framework, the UTAUT. The significance of this study is that it points to an innovative method for providing learning support to students whenever and wherever they need it. The stakeholders that may benefit from this study are the students and the teachers. The students can get immediate learning support by accessing the chatbot from a social media platform. The teachers can get more up-to-date feedback from students in terms of the quiz results collected by the chatbot. We propose two future research directions. The first direction is to adopt the proposed revised UTAUT to a larger sample size. The second direction is to enhance the NLP of the chatbot using artificial intelligence. This students to ask the chatbot using open-ended questions, in addition to selecting topics from a list.

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