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Chatbot and Bridge of Multiplayer Educational Game World and Summary Generation Service

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Abstract: *This work-in-progress paper presents the development of chatbot as an add-on to an existing multiplayer educational game world (MEGA World) and the chatbot bridge that accesses the existing summary generation service (Ask4Summary). The chatbot in the game world acts as an interface between the student and the course content. With the existing research's supports – as long as teachers can create virtual worlds in MEGA World to grant their students game-based learning and assessment opportunities and experiences and they can feed course relevant teaching and learning materials (in different text formats such as Microsoft Word docx file, Microsoft PowerPoint file, pdf file, or webpage in HTML format) into Ask4Summary – this on-going project can then provide students assistance in learning, to provide summaries for the questions according to the course materials, and to improve student's game-based learning experience and performance at the same time. In the end of this paper, the evaluation plan is also explained.*

Keywords: chatbot, natural language processing, educational game, human-computer interaction, online learning.

1. Introduction

Nowadays online learning is gaining popularity for reasons of the availability of high-speed internet and subject-specific e-contents. Online learning system: (i) is a learner-centric environment, (ii) enables learners to learn at their own pace and time at any location, (iii) offers optimized utilization of resources, and (iv) provides quality learning opportunities. Online learning can be broadly classified into two main modes: asynchronous and synchronous. Asynchronous learning is self-paced and involves studying learning materials independently. This mode may also include interaction with a tutor or instructor through discussion forums, emails or messaging. Synchronous learning, on the other hand, is tutor-led and takes place in real-time through pre-scheduled online classes using platforms such as Microsoft Teams, Google Meet, or Webex (Nagarajan & Wiselin, 2010).

The popularity of computer games, coupled with their engaging and immersive nature, has inspired academics to develop game-based online learning modules (Tobias & Fletcher, 2007). Game-based learning utilizes a similar concept by creating an engaging and enjoyable learning experience, allowing learners to acquire knowledge with greater ease and gradually increasing the difficulty level. Educational games are interacting, have motivational qualities, enhance the cognitive process, and have a gradual increase in difficulty level, hence, resulting in improved learning performance and understanding of the subject (Tobias, S. et al., 2011).

In educational games non-player controlled characters (i.e., NPCs) play an important role by providing necessary guidance, navigation, and even answers to the queries of the learners (Virvou & Katsionis, 2008; Yin, et al., 2021). These NPCs are mostly animated characters resembling humans or cartoon characters (Dehn & van Mulken, 2000). Chatbots –

can act like NPCs – are mainly conversational agents that are designed for Human-Computer Interaction (HCI) and provide a conversation platform much similar to human natural language conversation (Winkler & Söllner, 2018). Human-Computer Interaction (HCI) focuses on the design, evaluation, and implementation of interactive computing systems for human use. It involves the study of how people interact with technology and how technology can be designed to better support human needs and tasks (Rogers, Y. et al., 2011). Chatbots are using algorithms to process natural language and work mainly on a rule-based algorithm or artificial intelligence-machine learning (AIML). As an example, Chatbot A.L.I.C.E. is following the rule-based NLP algorithm (Wallace, 2009) and Charlie Chatbot is developed by Mikic et al. (2009) based on AIML to provide interactions with learners on an online learning platform.

Chatbots play important role in the education field, provide a desired interface between learner and learning setup, examples include the English learning chatbot BookBuddy (Ruan, et al., 2019), the intelligent course tutor chatbot Sammy (Gupta & Jagannath, 2019), and the MOOC collaborative chatbot colMOOC (Tegos, et al., 2019). The educational chatbots have a wider role and may have one or more of the following objectives: (i) to support and monitor learning objectives and progress, (ii) to respond learner questions, (iii) to get learners motivated, and (iv) to help human teachers/tutors understanding learner academic performance.

2. Existing Research – MEGA World and Ask4Summary

The proposed chatbot and its bridge has been considered, analyzed, and implemented on existing educational game world research, MEGA World (https://megaworld.game-server.ca/), and summary generation service, Ask4Summary (https://ask4summary.vipresearch.ca/). Both existing research are open access without fee so the outcome of this proposed research can also be accessible by everyone. MEGA World is a multiplayer game in which the learners (as players) can interact with non-player characters (NPCs), items, and other learners/players. MEGA World as an educational game platform was proposed and developed by Chang and Kinshuk (2010). In MEGA World, teachers can design as many learning activities with multiple learning objectives as they want and their students can explore the chessboard-like game world (see Figure 1) to complete the learning activities (Kuo, et al. 2010). In this game, players (i.e., learners) are offered a variety of different quests that are designed and can be used to measure their proficiency in school subject matters.

MEGA World supports any language and is capable of accessing any existing external resources (e.g., multimedia, materials, online meetings, etc.) (Chang & Kinshuk, 2010). Teachers can create their virtual worlds as well as create learning and assessment activities (i.e., quests in the game) for students. Students can learn specific knowledge and reach the learning goal by taking and solving those quests while playing (Kuo, et al., 2010). MEGA World currently has eight quest types include speaking (Chang, et al., 2019), greeting, item collection and delivery, sorting, treasure hunting and digging, calculation, fill-in-the-blank, and short answer quest type. Teachers are also provided editors like map and quest editors so they can freely expand their game worlds and design quests in different levels for different subjects/topics according to their own teaching plan.



Figure 1. MEGA World.

Ask4Summary (Pal, Chang, & Iriarte, 2021) has a system periodically running backend services to process text-based content (e.g., a course's learning materials). When Ask4Summary processes these text-based content, it uses Natural Language Processing (NLP) techniques that include tokenization, n-grams extraction, and part-of-speech (PoS) tagging. Ask4Summary allows teachers to upload their teaching and learning materials for the machine to read and digest a couple of days before the semester. After Ask4Summary has processed text-based materials (in different file formats like PDF, DOCX, PPTX, and webpages in HTML), it can start serve learners by generating summaries for their course relevant questions. It identifies the keywords from a user's question and uses cosine similarity to summarize the associated content and present to the user. Ask4Summary can serve learners via web system and Moodle plugin (Saleh, Chang, & Iriarte, 2022).

3. Chatbot and Its Bridge

The proposed research includes the development of the user interface in MEGA World (i.e., the Guardian in the game world), the bridge (i.e., the Bridge) between the user interface and Ask4Summary (referring the published algorithm and the source code of Ask4Summary Moodle plugin). The proposed components use multiple programming languages as well as frameworks, including Python for running backend services, PHP for server-side scripting, AJAX and JSON for communication endpoints and data package, MariaDB for database, and HTML, CSS, and JavaScript for the website development.

The chatbot (i.e., the Guardian) is added to the bottom of the game panel (see Figure 2). The Guardian panel has the option for learners (i.e., players) to edit/recreate their own Guardian avatar. By clicking on the Guardian avatar a window opens where the players can have a conversation with their Guardian.



Figure 2. Guardian Panel in MEGA World.

When a player signs into MEGA World for the first time, a Guardian is automatically created and linked with the player. In case the player isn't satisfied with the outlook of his or her Guardian, he or she can change its outlook or even create a new one. No matter what outlook the generated Guardians have, they have no difference at this moment in terms of responding to players' questions. In the future, however, the research considers making different Guardians to have different characteristics, personality, response styles, and perhaps emotions. Therefore, currently the research can have clear idea about what kind of outlook Guardians might need to have to make players satisfied; but in the future, the research can investigate what characteristics, personality, or response styles a chatbot should have so it can help learners more efficiently.

When a player asks his/her Guardian a question, the question is first stored in the database at the Guardian side (e.g., keep it in the Guardian mind) and then sent via AJAX to the Guardian Bridge (e.g., a librarian) to find the summary for the question. The Bridge returns a confirmation token which is later used by the Guardian for checking the job status. Upon getting the summary from the Bridge, the Guardian will talk back to the player. Figure 3 shows the workflow and the architecture of the Guardian and the bridge.

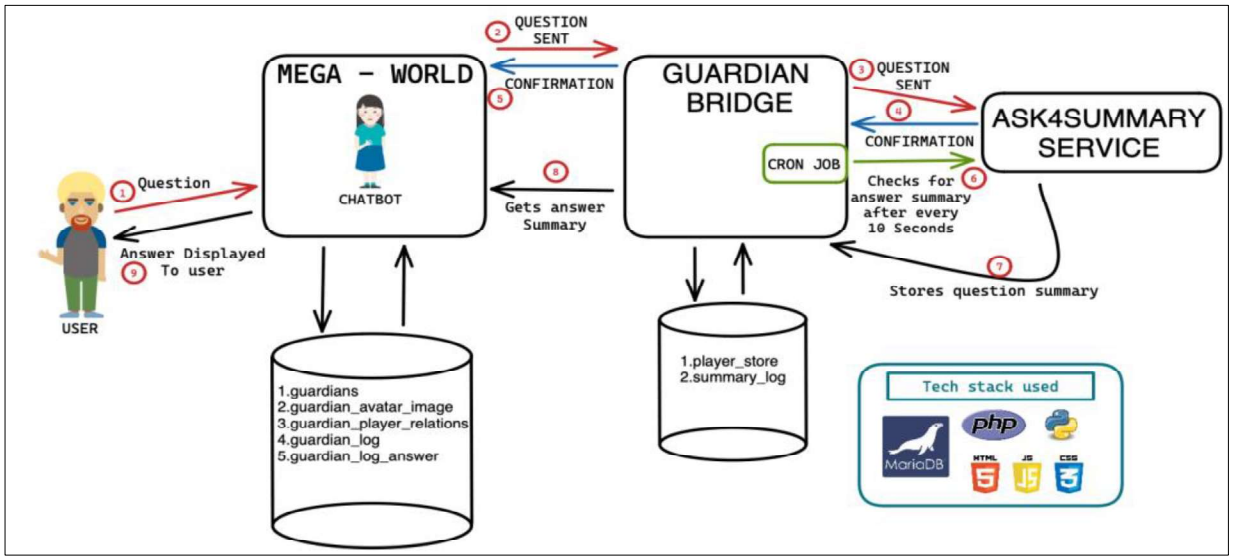


Figure 3. Chatbot Architecture

4. The Use Case

To use the Guardian players need to create an account and at least one avatar in MEGA World, will create an entry in Guardian_player_relations table which is responsible for linking the player to Guardian. Each avatar created by the players has its own Guardian. The conversations between an avatar and a Guardian are also remembered by individual Guardian.

As Figure 2 shows, the way for the players to interact with their Guardian is on the bottom game panel. The players can click the Guardian panel and change how their Guardian avatar looks the same way they can change their player avatar. When the players click their Guardian, a chat window for them to talk to the Guardian opens up. The chat window contains all the previous chat messages between the particular avatar – remember, a player can have more than one avatar and each avatar will have its own Guardian; the chat window will only show the historical records between specific avatar and its Guardian even when two avatars choose the same Guardian. Within this window, the players can send messages to their avatar's Guardian.

To ask a question the players can enter the question and either hit the Enter key on the keyboard or click the Send button on the screen. When the question is received by the Guardian, it will be stored in the "Guardian_log" table along with the "player_id" and "direction" (i.e., either coming from the players or the Guardian). After that, the Guardian sends the question to the "Guardian Bridge" which is further forwarded the question to Ask4Summary service. The Ask4Summary generates the summary related to the question and based on the course materials by finding the best matches with cosine similarity method. Figure 4 shows that the Guardian responds to the players for their questions with the generated summaries received from Ask4Summary.

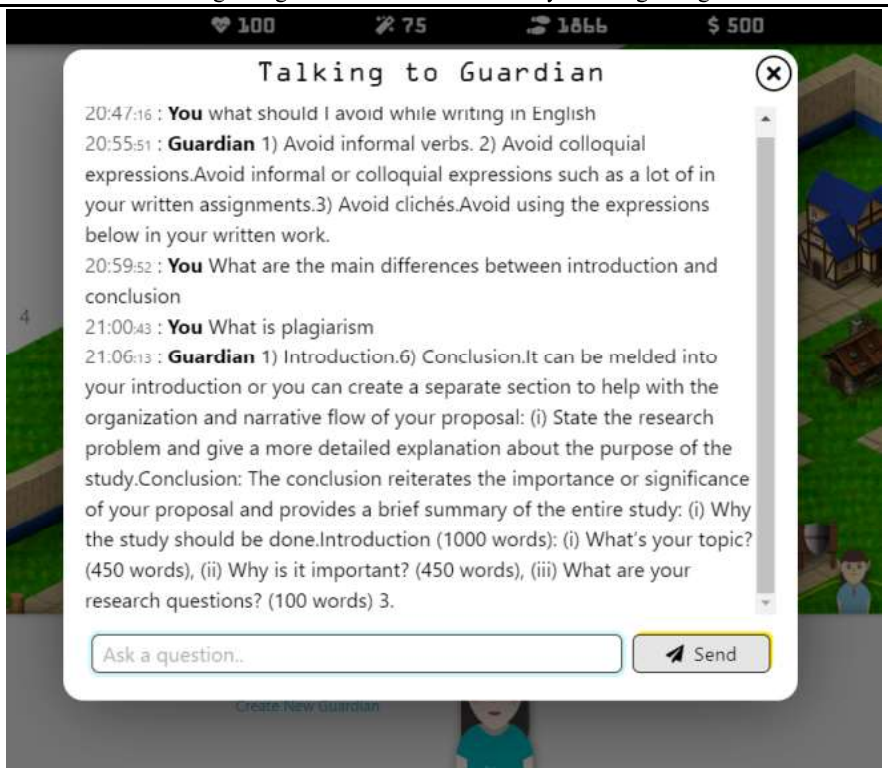


Figure 4. Guardian provides the generated summaries for players' questions.

The chatbot can assist students in completing in-game quests created by instructors. For instance, an English learning quest created by an instructor may require the student to write a sentence in English. Using the chatbot, a student can ask a question such as, "what should I avoid while writing in English?" The generated summary can then guide the student in formulating an answer and help them avoid errors that might occur when writing in English.

5. Evaluation Plan

The proposed research considers doing an evaluation with control and experiment group to assess the effectiveness of the Guardian feature in the educational game and the usability of the Guardian. Students in both groups will use MEGA World as a supplemental educational resource for a course. Students will be asked to fill out pre-survey questionnaires (include computer game attitude scale and learning motivation toward the course) anonymously – the evaluation will have no restriction on the player account and avatar creation; therefore, there is no way for the teacher or the research team to identify a student from his or her player account and avatar. Students in the control group will be provided the link to access Ask4Summary's web system by the Guardian, while the students in the experiment group will be able to ask their questions directly via the Guardian. At the end of the course, students will be asked to fill out post-survey questionnaires (include learning motivation toward the course and system usability scale toward the Guardian feature. With the collected data, the research team could have better idea on (i) whether the Guardian feature in the educational game is appreciated? (ii) would the usability of Ask4Summary-enabled Guardians be rated better? and, (iii) would the access of the game and/or the Guardian have impact on students' learning motivation? The research team can further do collaboration research on (iv) the effectiveness and correctness of generated summaries and (v) the impact of the satisfaction degree of generated summaries – rated by the course teacher – on students' perceived usability toward the Guardian feature.

6. Conclusion

The implementation of the chatbot in MEGA world allows students to ask more questions as it appears as an avatar within the game environment. In contrast, other available chatbots like BARD-google or chatGPT require students to leave the online learning platform. In the future, the chatbot's functionality can be improved by (i) limiting the user from asking additional questions while the chatbot generates a summary for the last question, (ii) altering the chatbot's persona based on the player's interaction, and (iii) using a faster NLP algorithm to generate summaries more quickly. However, the current chatbot is constrained by several factors, including (i) the quality and relevance of the corpus provided by the instructor, which affects the correctness of generated summaries, and (ii) limited computational resources that slow down the summary generation process.

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