Study-Buddy: A Knowledge Graph-Powered Learning Companion for School Students

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Abstract. Large Language Models (LLMs) have the potential to substantially improve educational tools for students. However, they face limitations, including factual accuracy, personalization, and the lack of control over the sources of information. This paper presents Study-Buddy, a prototype of a conversational AI assistant for school students to address the above-mentioned limitations. Study-Buddy embodies an AI assistant based on a knowledge graph, LLMs models, and computational persuasion. It is designed to support educational campaigns as a hybrid AI solution. The demonstrator showcases interactions with Study-Buddy and the crucial role of the Knowledge Graph for the bot to present the appropriate activities to the students. A video demonstrating the main features of Study-Buddy is available at: https://youtu.be/DHPTsN1RI9o.

Keywords: Knowledge Graphs · NLP · Personalized Education

1 Introduction

The emergence of Large Language Models (LLMs) such as ChatGPT has revolutionized the field of AI, enabling machines to process natural language and handle human-like conversations [1,5]. LLMs have gained significant attention in education, potentially enhancing students' learning experiences worldwide [3]. However, several challenges hinder their widespread adoption, including factual correctness, lack of personalization, and control over information sources [4]. These challenges are even more prominent in developing regions, where access to digital educational content is limited. In this paper, we present a demonstrator of a conversational AI assistant for school students, leveraging the latest advances in LLMs, Knowledge Graphs (KGs), and Computational Persuasion methods (Hybrid-AI). Our assistant is designed to run educational campaigns meeting each student's unique needs through multi-modal interactions. Powered by a KG, our assistant can connect teachers, students, topics, learning material, and learning sessions to enhance school students' study experience, improve their ability to retain information and increase their motivation and

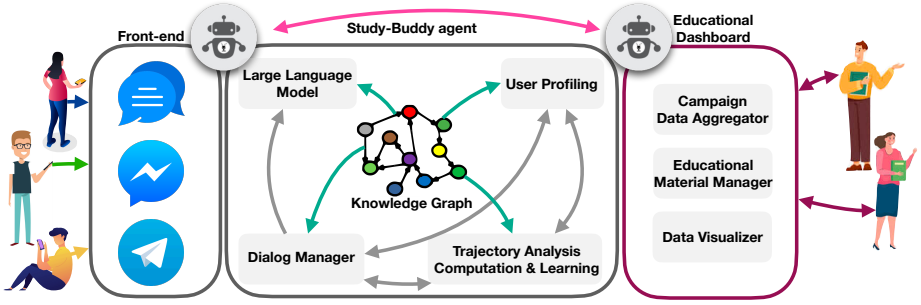

Fig. 1. Architecture of Study-Buddy: connecting students with content/teachers.

engagement with their studies. Through this prototype, we aim to showcase the potential of Hybrid-AI in developing educational tools that bridge the digital divide and empower students with equal access to high-quality educational content. The demonstrator is actively being developed/piloted in collaboration with two schools in Bolivia.

2 The Study-Buddy Architecture

Students interact with Study-Buddy via a chatbot agent deployed in Telegram, which uses computational persuasion principles to motivate students to review the learning material uploaded by teachers. Teachers can run learning session campaigns and visualize user engagement and interaction, adjusting to students' needs through the tracking of user behaviour in the Study-Buddy KG.

Knowledge Graph: A KG powers the Study-Buddy assistant, linking students with learning sessions on topics defined by teachers for different subjects. Figure 2 depicts the KG. These links help to identify specific topics and concepts that are not clear to students and need to be reinforced through the dynamic learning material of their preference. For dialog The KG links also support dialog management. Specifically, the KG is used to identify and retrieve information relevant to the current dialog context, i.e., the student's subject, grade, an learning path, which can help the LLM generate appropriate responses. The KG indicates not only the subjects of the dialog but also provide additional semantics that the LLM used to enhance the quality and relevance of its responses. The KG flexible model allows the integration of different activities in learning sessions, which teachers can supervise to follow up on the student's progress and strengthen weak areas. In this version of Study-Buddy, the learning path is based on paragraphs from a guiding textbook uploaded by the teacher for a specific subject with defined topics in the grade curricula. The application allows students to play in practice sessions to increase their scores. It is also possible to show a ranking per course and topic according to practice time and earned scores.

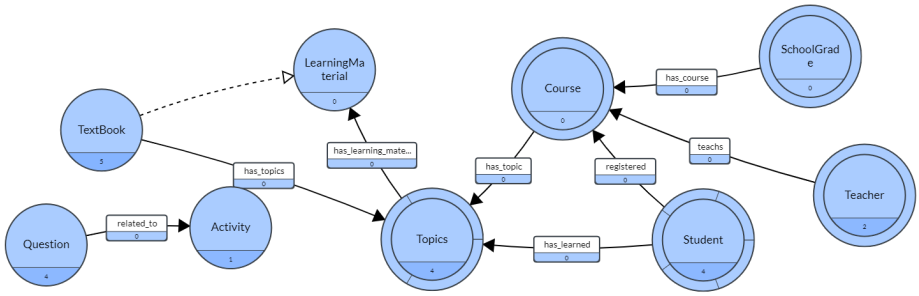

Fig. 2. Study-Buddy KG links students, teachers, courses, topics, textbooks, and learning sessions, making the discovery of unforeseen learning trajectory paths possible.

Conversational Agent and Learning Activities Platform: The Study Buddy chatbot is targeted for students aged between 13 and 18 to make studying more engaging and interactive. It is developed on RASA and connected to Telegram. It relies on a KG that models elements including grades, subjects, selected topics and related learning materials. The bot proposes study sessions with multiple-choice questions and possible rewards for correct answers. Users can switch between topics, choose to study a topic again, or enter into competition mode where they have to provide written answers without hints. The bot uses LLM models from HuggingFace to provide learning activities, such as Question Answering over Paragraphs and Tables, evaluating the user's answer, and providing feedback. Users earn points for each correct answer, and their scores can increase with rewards earned by studying.

Study-Buddy also provides a web platform with different learning activities to reinforce and clarify questions about topics. The web platform presents key concepts from the material so students can quickly assimilate the main ideas. The platform uses gamification techniques, i.e., earning points for each question about the topic in the paragraph or table, to motivate the user to continue learning a subject. We use LLMs to implement these activities for text analysis and question answering over tables (e.g., the TAPAS model[2]).

Educational Dashboard for Teachers: The educator can see reports of the student's progress, such as the average number of questions per day, percentage of time per topic, percentage of questions per topic, and the result of the tests of correct and failed answers of a student in a range of determined dates. This role has the functionality available to load the information on the topics such as texts and books.

3 Prototype Demonstrator

The demonstrator is focused on the learning experience for students, i.e., it will showcase students' interactions with the chatbot using Telegram and the

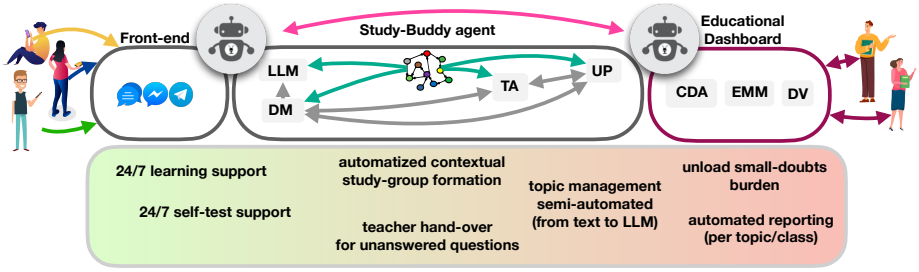

Fig. 3. Study-Buddy improves the learning experience and provides 24/7 support, automation of tasks, and intelligent analysis (see Figure 1 for acronyms).

learning activities platform. A registered student picks a topic to start studying. Then the bot will send a motivational message for correct answers; for wrong answers, it will send the correct one along with engagement elements. This loop only ends when the student explicitly asks for it. Then, the student moves on to the platform and makes questions related to the text proposed by the teacher. Next, the student explores a table containing the knowledge about a topic, e.g., history, and asks questions to learn the subject. Finally, after earning points with three different dynamics, the user returns to the chatbot and asks for the course topic ranking, which can be seen as a message or in a leaderboard on the web page. These activities motivate the user to continue learning.

Helping students to reach learning goals. Using competition through the gamification of a topic is a critical factor for engaging the student in practicing. Studying becomes a game, reducing the reluctance to complete the proposed activities. The main difference is personalizing the content proposed during the session, going beyond a pure memorization activity. Besides, the chatbot integration on Telegram allows the bot to reach the user whenever an event of interest happens. For example, if a student's ranking drops in a gamified learning environment, Study-Buddy can send a message encouraging them to continue practicing. Additionally, if the teacher adds new questions or content to a topic, Study-Buddy can notify the student, encouraging them to revisit and review the material. Those reminders keep the student taking at least a session per day. By leveraging the convenience and accessibility of chatbots, students can stay engaged and motivated to reach their learning goals.

Helping teachers to evaluate learning trajectories. Thanks to Study-Buddy, teachers can use technology to assess students' learning trajectories more accurately and comprehensively. With the help of Study-Buddy, teachers can gather data on students' learning behaviors and track their progress over time. For example, by analyzing the frequency and accuracy of students' answers to specific questions, teachers can identify areas where students may be struggling or making common mistakes. This data can then be used to adapt instruction better to meet the needs of individual students or the class. Additionally, once

Study-Buddy collects enough data, machine learning algorithms can be used to predict students' future performance based on their past performance, providing teachers with valuable insights that can be used to design personalized learning experiences for each student. Study-Buddy helps teachers evaluate learning trajectories more accurately, provide targeted support, and ultimately, help students achieve their full potential.

4 Conclusions

This demonstrator presents Study-Buddy, a personalized conversational AI assistant for school students, which uses Large Language Models, Knowledge Graphs, and Computational Persuasion methods to motivate students to review learning material uploaded by teachers. Study-Buddy provides a gamified learning experience for the students, and teachers can track learning trajectories. Study-Buddy is a promising tool for addressing issues such as factual accuracy, personalization, and control over the sources of information used in educational settings. The prototype is being developed in collaboration with two high schools in Bolivia, showcasing the importance of introducing digital education technologies in environments where access to pedagogical resources is limited and expensive.

We plan to expand Study-Buddy to other subjects, grades, and countries in future work. We also aim to implement additional features, such as sentiment analysis, to detect the students' emotions during the learning process to enable more accurate and personalized responses. Additionally, we plan to investigate using additional data sources, such as educational videos, to enhance the learning experience. Finally, they intend to conduct more extensive system evaluations, including user studies with students and teachers, to gather feedback and improve Study-Buddy's usability and effectiveness.

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