Chapter 6
Enhancing Project-Based Learning With a GenAI Tool Based on Retrieval Augmented Generation and Knowledge Graphs

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ABSTRACT

This chapter presents a novel GenAI tool, called PBL Support Chatbot, designed to support project-based learning (PBL) by integrating retrieval-augmented generation (RAG) and knowledge graphs (KGs). The aim is to address common challenges in PBL, such as project complexity and curriculum alignment. The tool provides students with real-time, adaptive support through a chatbot that assists in navigating PBL tasks. To illustrate its application, the authors introduce a scenario involving an introductory computer programming course where students develop

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a text-based adventure game. By offering personalized guidance, immediate feedback, and accurate answers to student inquiries, the tool aims to enhance critical thinking, learning outcomes, knowledge application, and student engagement in PBL environments. The initial prototype demonstrates the potential to improve the PBL learning experience. This underscores the capability of using RAG to create a dynamic, interactive learning environment that aligns with students' individual learning paths and educational goals.

INTRODUCTION

Project-Based Learning (PBL) is a dynamic educational approach that encourages students to solve real-world problems, enhancing their critical thinking and knowledge application. However, PBL presents challenges, such as project complexity, curriculum alignment, and navigating the educational process (Evenddy et al., 2023). Generative Artificial Intelligence (GenAI), including models like ChatGPT and LLaMA3, offer promising solutions by providing personalized, adaptive guidance to students. Despite its potential, GenAI faces several challenges. These include ensuring content accuracy and addressing outdated information. GenAI challenges can be mitigated through Retrieval-Augmented Generation (RAG) using Knowledge Graphs (KGs), which enhance the tool's ability to provide relevant and accurate information (Gao et al., 2024).

To investigate the integration of GenAI in supporting PBL, we propose a GenAI support tool enhanced by Retrieval-Augmented Generation (RAG) through Knowledge Graphs (KGs) (see Figure 1). This tool is designed to assist both students and educators in PBL by answering student questions, generating ideas, providing immediate feedback, offering personalized learning paths, and aiding instructors in project evaluation and assessment. The aim is to improve the PBL experience for both students and educators. It is important to note that this tool is still a work-in-progress, currently in its prototype stage, with ongoing research being conducted to refine and expand its capabilities.

This chapter will outline strategies for implementing GenAI using RAG and KGs to address PBL challenges. We will delve into the specifics of our proposed prototype system, highlighting its design, functionality, and potential impact on PBL. Additionally, we will explore other existing options, tools, and technologies that educators and institutions might consider when integrating GenAI into their PBL frameworks. By presenting a range of strategies and tools, we aim to inspire educators and researchers interested in using GenAI to enhance PBL.