Combining Large Language Models and Ontologies to build a collaborative learning digital environment

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1. INTRODUCTION

In today's complex and interconnected world, academic disciplines cannot operate in hermetic sealed compartments, to the point that, to respond to the needs of contemporary societal challenges, knowledge creation and problem-solving require a TransDisciplinary (TD) approach that bridges the gap between distinct fields of study, both in education [1, 2] and research [3]. Collaborative Learning (CL), intended as an educational approach to teaching and learning that involves groups of learners, challenged both socially and emotionally, as they listen to different perspectives working together to solve a problem [4], has been identified as one of the possible drivers of TD education and research [5, 6]. In this regard, [7] provides an example of a collaborative learning environment by proposing a TD methodology with the intent of allowing jurists to enrich their interpretative skills and contribute to an "inclusive legal argumentation", by "contaminating" juridical concepts with arts and humanities. The book proposed a methodology where a group of scholars (from private law, roman law, art, philosophy, computer science, literature, drawing, and pedagogy) collaborates to identify key concepts within their disciplines and, through discussion, gives their own point of view and listen to that of the others, on the same object of study, building concept definitions that are "contaminated" from all the disciplines and interconnections among these concepts. As in collaborative learning in general, the effort is in the construction of shared knowledge across different disciplines [8]. In fact, it is required to catalogue, organize, and interpret the vast array of disciplinary definitions, with the risk that collaborative efforts can become fragmented and inefficient, which is one of the main reasons that boost computer supported collaborative learning [9]. To respond to these needs, in reference to the methodology described in [7], this paper proposes an architecture for a novel digital system designed to support such an approach by fostering collaborative learning and knowledge integration across disciplines. The system, composed of an ontology, an Artificial Intelligence (AI) component, and a User Interface (UI), addresses the need to transcend disciplinary boundaries and create TD definitions of key concepts. The ontology, intended in the computer science meaning (i.e., as a structured way to formalise and store the archetypes, their classification, their taxonomy, and, most important, their relations [10]) serves as a standardized thesaurus that organizes and connects concepts across diverse fields, providing a structured way to map interdisciplinary relationships. The AI component, powered by Large Language Models (LLMs, intended as AI models are trained on massive amounts of text data and are able to generate human-like text, answer questions, and complete other language-related tasks with high accuracy [11]), interprets researchers' natural language queries, retrieving pertinent concepts from the ontology and highlighting connections and definitions across various disciplines. This facilitates the automatic generation of ontologies and assists in identifying relationships that may not be immediately apparent to researchers. The user interface serves as an entry point where researchers can log in, pose queries, and visualize concept connections, fostering a deeper understanding of how different fields overlap.

2. METHODOLOGY

The proposed digital system utilizes ontologies as a collaborative learning platform to facilitate a TD approach, aligning with the humanistic principles of the suggested methodology through an AI-driven natural language interface. The system comprises three primary components, the ontology, an AI-based component, and a User Interface (UI). The ontology provides a structured framework to formalize and store archetypes, including their classification, taxonomy, and most critically, their interrelations [10]. By doing so, it minimizes the potential for misinterpretation of these concepts and fosters a shared understanding [12] among researchers employing the methodology. The ontology component is instrumental to build a standardized thesaurus of concepts, architypes, and definitions across different disciplines, proving a means to map the connections among them. The AI-based component incorporates a Large Language Model (LLM) to interpret researchers' queries expressed in natural language and retrieve pertinent concepts from the ontology, including the interconnections and definitions of these concepts across various disciplines. LLMs, recognized as computational models

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capable of comprehending human language [13, 14], have demonstrated significant proficiency in information retrieval [15]. Finally, the UI serves as the entry point for researchers to access the system, where they can log in, pose queries regarding concept definitions and relationships, and visualize the connections among archetypes across multiple disciplines.

3. CONCLUSIONS

The proposed digital system is designed to meet the essential requirements of collaborative learning by fostering interaction, knowledge sharing, and co-construction of meaning across disciplines. Through its ontology component, the system creates a shared knowledge base where key concepts from different fields are standardized, enabling participants to access and contribute to a common framework. The AI component, with its ability to interpret natural language queries, promotes seamless communication among researchers by retrieving interconnected concepts and definitions, thus supporting a deeper understanding of how different areas of expertise relate to one another. Additionally, the user interface facilitates real-time collaboration by providing an interactive platform where users can pose questions, explore connections, and visualize the relationships between concepts. The proposed system, not implemented yet, faces limitations in the lack of experimental data, and raises ethical concerns in terms of LLM biases and hallucination. Future work will address these issues, refining the system's architecture. Furthermore, the ethical considerations around the use of LLMs in academic research must be thoroughly explored.

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