



Ai-Powered Platform for Cultural Heritage Education

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Abstract

This study presents the conceptualization and development of an innovative AI-driven platform designed to enhance cultural heritage appreciation among primary and secondary school students through Retrieval-Augmented Generation (RAG) technologies, such as Cheshire. Grounded in pedagogical principles, the platform aims to integrate advanced Natural Language Processing (NLP) with tailored educational methodologies to foster historical and artistic literacy in young learners. The platform's architecture incorporates a hybrid model that combines a curated knowledge base of historical and artistic content with generative AI capabilities, enabling dynamic, context-sensitive interactions. By leveraging RAG, the system retrieves accurate and contextually relevant data from extensive repositories, while generative algorithms translate complex information into age-appropriate narratives. This dual approach ensures that students are provided with both reliable and engaging content tailored to their cognitive and developmental stages. A key feature of the platform is its adaptive learning environment, which utilizes gamification, interactive storytelling, and scaffolded questioning techniques to promote engagement and critical thinking. For younger learners, the platform employs simplified language and visual aids, fostering curiosity and foundational understanding of cultural artifacts. For older students, more nuanced and analytical discussions are introduced, aligning with higher-order cognitive skills as per Bloom's taxonomy. The platform also incorporates inclusivity and accessibility features, such as multimodal content delivery, to accommodate diverse learning needs and preferences. It facilitates collaborative learning experiences, enabling students to explore cultural heritage in group settings, thereby emphasizing social constructivist approaches to education. This project not only underscores the pedagogical potential of AI in cultural education but also addresses contemporary challenges in heritage preservation by engaging younger generations in meaningful, technologically mediated dialogues with the past. Future research will evaluate the platform's efficacy through empirical studies, aiming to refine its capabilities and expand its application to broader educational contexts.

Keywords: Cultural Heritage, Digital Technology, Art, Education

1. Introduction

Heritage education in Europe emerged in the late 20th century with the aim of integrating cultural heritage into school curricula through interdisciplinary approaches. This perspective was formally recognized with Recommendation N.R. (98)5 (Council of Europe, 1998) [1], identifying it as a fundamental aspect of European educational policies. The Recommendation of the European Parliament on key competences for lifelong learning (Council of Europe, 2006) [2], part of the Strategy of Lisbon (Council of Europe, 2006) [3], reinforced this vision by positioning Europe as a leading knowledge-based economy.

At the national level, the 1998 Framework Agreement between the Ministry of Cultural Heritage and the Ministry of Public Education affirmed the right of citizens to knowledge and the protection of cultural heritage. This agreement encouraged the establishment of educational services within museums and territorial contexts. The Council of Europe further supported this approach through the Faro Convention (2005) [4], which emphasized the role of heritage in fostering citizenship and European identity. The Faro Convention introduced a novel concept of heritage, not merely as an object of preservation but as a resource for sustainable development and cultural diversity. Central to this vision is the active involvement of citizens in defining and enhancing cultural assets, promoting social cohesion and democratic participation.

The 2015 Plan for Cultural Heritage Education redefined the role of heritage in educational processes, in alignment with Law 107/2015 [5]. Legislative Decree No. 60 of April 13, 2017 provided a regulatory framework for the promotion of humanistic culture, the enhancement of artistic heritage, and the support of creativity [6]. This legal foundation reaffirms the right to culture, as outlined in Article 9 of the Italian Constitution [7] and the Universal Declaration of Human Rights (1948) [8], reinforcing heritage pedagogy as a tool for inclusion, active citizenship, and social development.



In the evolving landscape of education and digital technology integration, Artificial Intelligence (AI) emerges as a tool to enhance teaching and develop competences in accordance with European and national regulations. The Cheshire Cat framework provides an innovative solution for managing Large Language Models (LLMs), allowing the integration of AI in educational environments. With its flexible and agnostic structure, Cheshire Cat enables customized learning pathways, offering adaptive tools for content processing and accessibility.

The adoption of such technologies aligns with European educational policies, fostering an inclusive and dynamic learning ecosystem. AI is not merely a technical aid but a means to develop innovative teaching methodologies that enhance cultural heritage through interactive experiences, simulations, and personalized learning paths. In this regard, the Cheshire Cat framework plays a crucial role in designing digital learning environments that ensure equitable access to knowledge, promoting the right to culture and education as established by key legislative references.

2. The Role of Digital Technologies in Heritage Accessibility and Mediation

Numerous studies increasingly recognize the strategic role of cultural heritage and conservation sites in education (Rivoltella, 2014 [9]; Manca, 2017 [10]). According to Panciroli (Panciroli, 2024), digital technologies facilitate active participation and reinterpretation of heritage [11]). Digital platforms, social media, and Learning Management Systems (LMS) enrich the educational experience by integrating communication, gamified access, and informal learning, complementing formal education.

A fundamental concept in this field is the notion of heritage communities, introduced by the Faro Convention. These communities consist of individuals who ascribe value to specific cultural assets and commit to their preservation and transmission to future generations. The Convention highlights the importance of acknowledging the value assigned by heritage communities to cultural assets and advocates for digital tools that enhance heritage accessibility and engagement [12].

In the realm of museology and cultural heritage conservation, the primary objective is to constantly question exhibited objects and leverage new technologies to open innovative interpretative perspectives. Heritage education extends beyond knowledge transmission to become a formative process aimed at fostering active and responsible citizenship. It encourages conscious behaviors, transforming cultural heritage into an ongoing subject of research and interpretation, in alignment with lifelong learning principles [13].

3. Engaging with Cultural Heritage through a Virtual Assistant: The Didactic Use of Cheshire Cat

Cheshire Cat is a framework designed to enhance the efficiency, effectiveness, and customization of LLM such as GPT-4. Characterized by a modular structure, the framework facilitates seamless integration with various LLMs, making it agnostic to specific underlying technologies. This flexibility allows users to select the most suitable model for their project requirements.

In my case, I have employed this tool to promote awareness of the historical and artistic heritage of religious buildings along the Umbrian Apennine ridge. The objective was to develop a language suitable for both primary school children and high school students. Cheshire Cat is particularly well-suited for this purpose due to its open-source structure, which enables deep customization of educational tools. Its dockerized architecture simplifies deployment in educational settings with varying IT infrastructures, allowing educators to focus on content development rather than technical setup. The framework offers an intuitive interface that demystifies AI complexities for end users. Inspired by WordPress, its modular approach supports the integration of new components through educational plugins, which can be developed by the academic community [14].

The platform supports the development of domain-specific plugins tailored to cultural heritage education. Notable examples include an HTML parser for analyzing digitized sources, Dynamic-Language to facilitate multilingual interactions supporting CLIL methodologies, and Sentiment Analysis, which in my specific use case enables the study of social perceptions of heritage through natural language processing and machine learning techniques. Collected data, such as social media posts, surveys, and reviews, undergo preprocessing to remove irrelevant words and correct syntactic or orthographic errors. The analysis relies on algorithms that process words or phrases using specialized dictionaries, machine learning models, or a combination of both. The interpreted results provide feedback that informs the redesign of educational methodologies and content.

Moreover, Cheshire Cat allows for the customization of its core functionalities. The main process flow includes predefined adaptation points, known as Hooks, which modify system behavior at critical educational stages. These hooks enable the adjustment of response complexity to match students' cognitive levels. The framework also features an administrative interface, complemented by a web portal that educators can utilize. This portal enables administrators to configure settings, upload educational materials via URL or local



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files, and analyze AI-driven decision-making processes. By offering these tools, Cheshire Cat fosters an evidence-based approach to instructional design, allowing educators to validate the effectiveness of their pedagogical tools.

Cheshire Cat naturally integrates pedagogical constructivism principles, promoting experiential learning through active methodologies. Historical simulations based on archival documents encourage competency-based education aligned with key citizenship skills. One of the framework's most valuable aspects is its commitment to inclusivity. Ensuring equal access to knowledge is fundamental, and advanced technologies play a crucial role in overcoming cognitive and sensory barriers, making learning experiences more accessible and personalized.

Thanks to its multichannel approach, which integrates text, voice, and images, Cheshire Cat adapts to diverse content consumption modes. This significantly enhances accessibility in educational contexts, addressing the needs of students with learning disabilities, such as dyslexia, visual or auditory impairments, and special educational needs. The system dynamically generates and adapts textual materials, tailoring complexity levels to students' linguistic competencies. This feature is particularly beneficial for learners with dyslexia or reading difficulties, as it allows for the adjustment of font size, spacing, and text structure. Similarly, second-language learners benefit from built-in language simplification and automatic translation tools, ensuring content customization across different educational levels [15].

Additionally, advanced text-to-speech integration converts textual content into audio, facilitating access for visually impaired students, individuals with motor disabilities, or those who prefer an auditory learning approach. This feature enhances content retention through listening. Interactive voice functionalities further promote experiential learning, enabling students to ask questions, receive personalized explanations, and engage in interactive educational activities. The inclusion of images and graphic supports plays a crucial role in fostering inclusive education by offering more intuitive and engaging learning modalities. Cheshire Cat leverages image generation and analysis to create conceptual maps and visual schematics, aiding comprehension for students struggling with extensive textual content.

It enhances visual learning, which is particularly useful for students with specific language impairments or those who benefit from graphic stimuli for memory retention and integrating educational content in sign language through visual representation of concepts.

Open access to the framework's AI mechanisms encourages the development of critical thinking by prompting students to examine not only content but also the processes underlying knowledge construction. Furthermore, Cheshire Cat supports sustainability and educational community-building. Its open-source nature fosters collaborative creation of educational repositories, sharing of best practices among institutions, partnerships between local entities and schools, and adaptation to local contexts without licensing costs.

This technological-pedagogical ecosystem positions Cheshire Cat as a key platform for realizing the distributed laboratory of cultural heritage education advocated by recent ministerial guidelines. By integrating digital innovation with scientific rigor, it facilitates the training of future generations. Transitioning from textbook-based instruction to hypermedia models necessitates a redesign of learning environments. Frameworks like Cheshire Cat demonstrate how interactive databases can transform cultural assets into living entities. The use of RAG further enhances this process by enabling dynamic storytelling based on local heritage, cross-media linkage between archival sources, 3D reconstructions, and oral testimonies, and linguistic adaptability, adjusting content complexity to different audiences.

By applying these capabilities, educators can bridge theory and practice, designing targeted learning activities through Cheshire Cat. The process involves mapping cultural heritage, identifying relevant assets within the school's geographic area, digitizing literary sources, creating a multi-format repository of texts and images, contextual training, adapting generative models to domain-specific lexicons, developing interactive learning pathways with varying levels of complexity, and implementing adaptive assessment by refining content based on real-time student feedback. The integration of RAG in heritage education cultivates transversal competencies, ranging from digital literacy to historical analysis, civic awareness of cultural heritage, and creative problem-solving for heritage accessibility.

3.1 Challenges and Future Perspectives

Despite its potential, the implementation of AI-driven educational frameworks like Cheshire Cat presents challenges. These include technological accessibility disparities, the necessity for teacher training, ethical concerns regarding algorithmic bias, and financial sustainability. Addressing these issues requires integrated educational ecosystems that combine technological robustness, scientific rigor, and pedagogical accessibility, ensuring an inclusive and sustainable learning model.

4. Conclusions



Cheshire Cat represents an innovative tool for heritage education, offering a flexible technological architecture that integrates generative AI, advanced memory systems, and modular extensibility. These features make it particularly suitable for supporting interdisciplinary educational pathways, from primary to secondary education, enhancing engagement with cultural heritage through adaptive, interactive, and inclusive learning experiences.

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