Deliverable 4.5

Architecture of a knowledge management system for Arts and creativity training

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101016460.

Grant Agreement (GA) No: 101016460
Acronym: EU4ART_*differences*
Title: DIFFERENCES – ARTISTIC RESEARCH IN THE EUROPEAN UNION (EU4ART_DIFFERENCES)
Call/Topic: Support for the Research and Innovation Dimension of European Universities

Deliverable 4.5	Architecture of a knowledge management system for Arts and creativity training
Related Work Package:	WP4 - The Creative ecosystem
Lead Beneficiary:	ABARoma
Dissemination Level:	Public
Delivery type:	Report
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Due submission date:	31/12/2023
Actual submission date:	20/12/2023
Description:	An innovative knowledge management system for arts and creativity training will be implemented through the building of a virtual didactic platform and a system of indexing all the contents of the platform. (Interactive AI System for Enhancing Creative Knowledge in an Educational Multimodal Environment focused on artistic research)

Versioning and Contribution History			
Version	Date	Modified by	Modification Reason
v 0.1	19/11/2023	Andrea Guidi	First version

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1 Introduction

This report details the recent advancements in ’°’Kobi, a system designed to enhance education and creative ideation through innovative knowledge mapping and associative thinking. By incorporating Large Language Models (LLMs), ’°’Kobi enhances the exploration of collective knowledge, providing users with a deeper, contextual understanding of artistic concepts sourced from extensive databases of artistic publications. This integration reflects a broader academic trend of leveraging AI to enrich educational experiences.

Key advancements in ’°’Kobi include the implementation of AI-driven voice interactions, the AI-facilitated conceptualization and visualization of knowledge in 3D spaces, and the generation of creative outputs that mirror the user’s navigational path through the system.

A significant aspect of ’°’Kobi is its use of augmented reality, offering users an engaging, multimodal experience in a mixed-reality setting. Central to this approach is the concept of Knowledge Embodiment, which emphasizes the spatial representation of information in a 3D semantic space. This approach is rooted in experiential and embodied learning theories, which posit that learning is most effective when it is multisensory and interactive.

Section 2, "The Evolution of ’°’Kobi", provides an overview of the system’s progression from an art education tool to its present form, which integrates advanced LLMs. This section highlights the system’s enhanced capabilities for AI-assisted collaboration, embodiment of knowledge, and fostering creativity within an augmented reality environment.

In Section 3, "Methodology", the development strategies for each new feature are outlined. This includes discussions on data visualization for knowledge mapping, approaches to critical and embodied learning, the implementation of conversational AI, and considerations for inclusivity.

Section 4, "Architecture", delves into the architectural framework of ’°’Kobi, detailing the structural components that underpin its functionality. Section 5, "Demo", presents a real-world demonstration of ’°’Kobi, offering insights from its initial use by researchers, professors, and art students.

Section 6, "Conclusions", summarises the potential of the newly integrated features in ’°’Kobi. This section reflects on the effective incorporation of Large Language Models (LLMs) and augmented reality technologies, notably the Hololens, and how these innovations have advanced the user experience. It also delves into the practical outcomes observed from the application of these features, particularly in enhancing user engagement, and facilitating creative exploration in the realm of artistic and academic content. The conclusions drawn are based on feedback and insights gathered from the user base, which includes researchers, educators, and art students.

Finally, Section 7, "Future Directions", speculates on possible enhancements and expansions for ’°’Kobi. This section presents the next steps in the system development such as expanding multi-users functionalities, and developing AI tools for creativity, broadening research scopes to further unlock the system’s educational potential.

2. The Evolution of °’°Kobi

The recent enhancements in ’°’Kobi are rooted in contemporary academic research, particularly in the realm of art and design education. This chapter provides a literature review that serves as the theoretical foundation for the platform’s new features, drawing from key scholarly articles to underscore the academic motivations for these advancements.

2.1 Large Language Models in Education

The integration of Large Language Models (LLMs in ’°’Kobi represents a significant step in enhancing educational experiences. This development finds its foundation in the work of Vaswani et al. (2017), who introduced concepts in neural network attention mechanisms. Their research paved the way for models that could understand context and generate coherent and contextually appropriate language, which is crucial in educational tools like ’°’Kobi, where language understanding and generation are key functionalities. This aligns with ’°’Kobi’s aim to provide a deeper and more contextualized understanding of artistic concepts, transforming how students interact with and comprehend their learning materials.

2.2 Augmented Reality for Learning

Augmented Reality (AR) in learning environments has been another focal point in educational research. The meta-review by Radu (2014) emphasizes the benefits of AR in enhancing learning through interactive and engaging experiences. In ’°’Kobi, the implementation of AR technology represents a pedagogical strategy to create a more immersive and interactive learning environment. This aligns with the growing need for educational tools that are not only informative but also engaging and capable of maintaining student interest and involvement.

2.3 Embodied Learning in Semantic 3D Spaces

Embodied learning is yet another crucial aspect of contemporary educational technology, as explored by Lindgren & Johnson-Glenberg (2013). Their emphasis on the importance of embodied learning in education underpins ’°’Kobi’s approach to spatializing knowledge in a 3D environment. This method facilitates an enhanced understanding of complex concepts, as students can interact with and experience knowledge in a more intuitive and impactful manner. Furthermore, the research of Mayer (2014) on multimedia learning supports the multimodal approach adopted in ’°’Kobi. Mayer illustrates how the combination of visual and auditory information can significantly improve knowledge retention and understanding. This multimodal learning strategy is particularly pertinent in art and design education, where sensory engagement and diverse forms of information presentation are crucial for a comprehensive educational experience.

2.4 Conversational AI Interfaces in Educational Platforms

Conversational AI interfaces have become increasingly important in educational platforms, offering personalized and dynamic interactions. These interfaces facilitate a more natural and engaging mode of content delivery and query resolution, thereby enhancing the overall learning

experience. The inclusion of conversational AI in ’°’Kobi aims to make the educational interaction more intuitive and responsive to individual learner needs

2.5 Generative Art and Exploration in Latent Spaces

Generative AI’s role in architectural and artistic creativity, as explored in the work of I Paola & Choi (2023), and Huang et al. (2023), provides a new perspective on creativity in latent spaces. The concept of latent space, as a multidimensional realm where generative models create novel designs, aligns with ’°’Kobi’s focus on fostering creative exploration. The research by Huang et al. (2023) particularly underscores the potential of generative AI in creating unique and captivating visual narratives, a concept that ’°’Kobi incorporates to enhance creative outputs.

3. Methodology

The Methodology subsection of the document highlights the varied and integrated approaches underpinning the development of ’°’Kobi. Key to this is the use of knowledge mapping strategies for organizing and visualizing complex data, enhancing critical and associative learning. Crucial to this approach is computational linguistics, crucial for integrating Large Language Models (LLMs) and facilitating language-based interactions.

The platform is further enriched by experiential learning activities that provide immersive, hands-on experiences, deepening users’ understanding. Augmented and Mixed Reality technologies create an immersive space for exploring artistic concepts, while semantic analysis and synthesis tailor the learning environment to the user’s journey.

Physical user interactions as well as a multi-language voice-interface ensure that ’°’Kobi remains responsive for the global community of users. Additionally, embodiment principles enable a full sensory engagement with knowledge, enhancing the learning experience. These methodologies collectively ensure ’°’Kobi’s effectiveness in art and design education, promoting creativity and exploration through a technologically sophisticated yet user-centric platform able to explore, conceptualize, discuss, and create artistic content.

The video https://youtu.be/I4RKrQvinxw shows the capabilities of the AI voice interface as well as physical interactions performed while wearing Hololens.

3.1 LLMs

The development of ’°’Kobi’s semantic spaces is informed by cutting-edge practices in integrating Large Language Models (LLMs) into educational frameworks, particularly for art and design. This methodology revolves around harnessing the power of LLMs to enhance artistic conception and design ideation. The process begins with the extraction of essential knowledge from a vast database of artistic publications, creating a foundation for semantic exploration and contextualization.

The strategy for constructing semantic spaces within ’°’Kobi involves a multi-layered approach. Initially, key concepts and ideas are extracted from the knowledge database using computational

linguistics principles. This extraction focuses on identifying and understanding the relationships between various concepts, forming the backbone of the semantic space.

Next, these concepts are mapped into a structured semantic framework. This involves organizing the extracted information in a way that reflects the complexities and interconnections of the ideas within the knowledge base. The semantic mapping is designed to be intuitive yet comprehensive, allowing users to navigate through the information effectively.

3.2 Ratio and Expansion of Knowledge

A crucial aspect of this methodology is the expansion of the knowledge base. LLMs are used to generate paraphrases and alternative conceptualizations of the existing knowledge. This process enriches the existing content while introducing new perspectives and ideas, thereby broadening the semantic scope of the system.

The ratio of original to generated content is carefully managed to maintain a balance between preserving the core knowledge and introducing novel insights. This balance ensures that the semantic space remains grounded in the foundational knowledge while being dynamic and evolving.

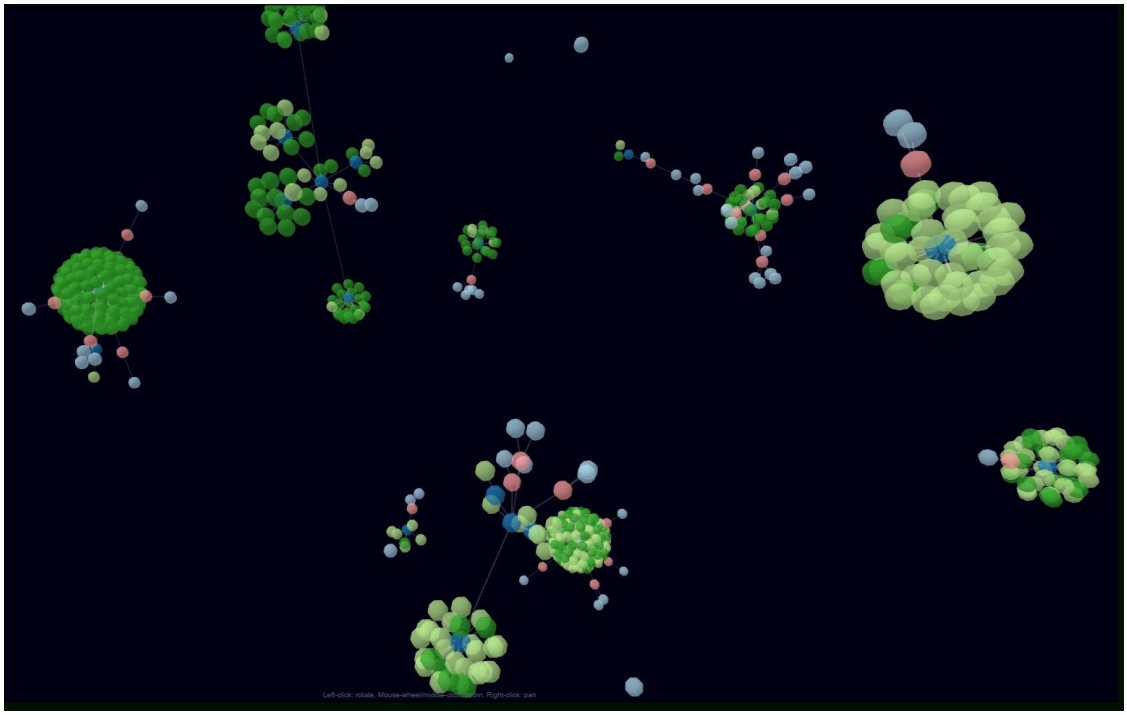

Figure 1: Knowledge 3D mapping and spatialization first prototype in ’°’Kobi

3.3 Knowledge Mapping and Embodiment

In ’°’Kobi, knowledge is represented through holograms within a 3D mixed reality environment, enabled by the Hololens technology. This approach reinterprets the Knowledge Mapping paradigm by Wexler (2001) to create an interactive, spatialized knowledge network visualized as a universe

composed by planets. Each planet can be either a publication, a concept or a keyword. Their reciprocal proximity is related to their semantic proximity. Figure 2 shows the visualization of the knowledge space in Hololens. The system's design allows users to experience and interact with these holograms, which bridge the gap between digital and physical realities, enhancing the embodied experience. This method of representing knowledge aligns with cognitive processes essential for creative thinking, such as abstraction, conceptual combination, and analogy as shown by Finke et al. (1992).

The concept of embodiment in '°'Kobi extends students' knowledge and experience in art, craft, and design, promoting exploration through sensory experiences—sight, sound, touch. This aligns with ddison et al. (2010), which emphasizes intertextuality and the phenomenological event of creation. This setup fosters an immediate aesthetic appreciation and invites deeper reflective investigation, resonating with concepts of flow and creativity outlined by Csikszentmihaly (1996). This multi-sensory approach to knowledge engagement reflects the cognitive perspective on creativity, valuing practical and embodied knowledge forms as discussed by Ward & Kolomyts (2010).

'°'Kobi's methodology extends students' experiences in art and design, promoting exploration through a variety of sensory experiences, including sight, sound and touch. This aligns with Greene's (1970) emphasis on imagination as a key factor in exploring possibilities and synthesizing ideas.

The system's design allows users to interact with knowledge either through bodily movement or voice commands. This interaction with the holograms is not just visual but involves a comprehensive sensory engagement. The proximity of holograms, representing concepts and media in close semantic fields, fosters rich contexts for creative interpretation and divergent thinking Runco (2012). This embodied interaction differs from traditional search methods, offering a more intuitive and holistic way of exploring knowledge.

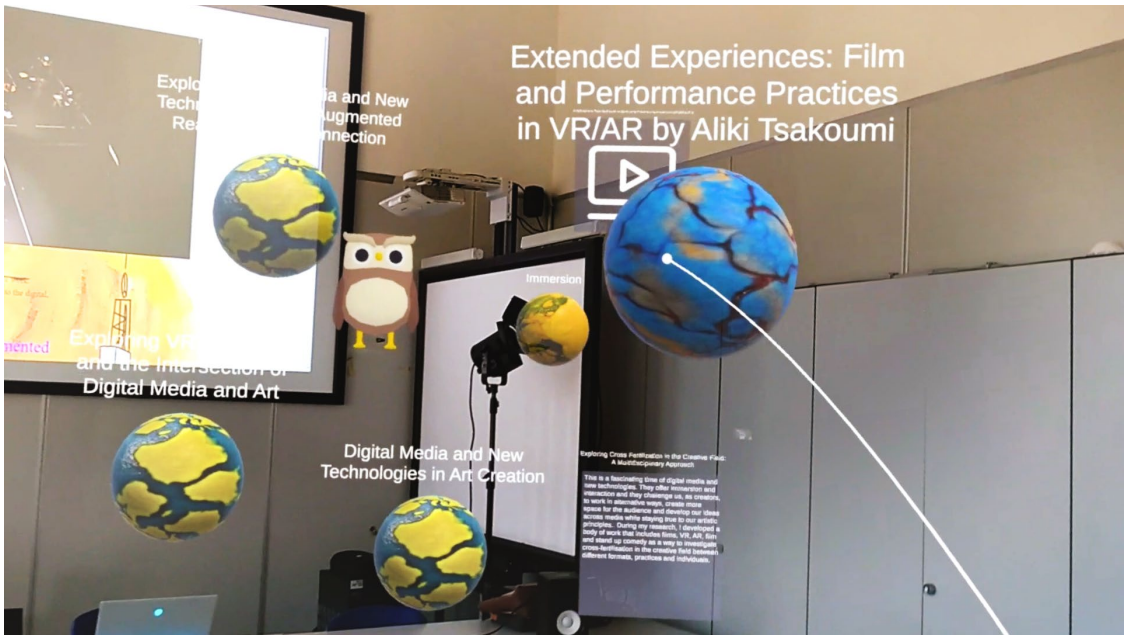

Figure 2: Hololens view of the Knowledge space in ’°’Kobi. Publications, concepts and keywords are visualized as holograms of planets.

Interactive elements in ’°’Kobi include:

- Sight: Eye-tracking technology within ’°’Kobi allow users to focus on and interact with specific objects in the knowledge space.
- Touch: Hand and finger tracking technologies enable tactile interactions within the 3D space, enhancing the sense of touch.
- Body: Body tracking technology ensures that users are always aware of their position within the mixed reality environment, fostering a deeper sense of immersion.
- Hearing: The inclusion of soundscapes and feedback voices adds an auditory layer to the exploration of knowledge, enriching the learning experience.
- Voice: Speech-interactive functionality in ’°’Kobi facilitates natural and intuitive communication.
- Mind: ’°’Kobi’s design promotes the complete embodiment of knowledge, engaging the user’s cognitive faculties for a comprehensive learning experience.

The embodiment approach in ’°’Kobi allow to experience and to understand the cultural nuances embedded within the knowledge ecosystem. By engaging with this multimodal system, users can achieve an immediate aesthetic appreciation and deeper reflective investigation, oscillating between aesthetic contemplation and analytical evaluation.

’°’Kobi’s approach to embodiment and spatialization of knowledge, grounded in multimodal interaction, resonates with contemporary pedagogical practices. It leverages technology to create

an immersive, inclusive, and interactive educational environment. This method aligns with the principles of learning through sensory experience and embodiment, fostering a deeper connection between abstract concepts and physical understanding, thereby enhancing the creative cognition process in art and design education.

3.4 Conversational AI and inclusivity

’°’Kobi integrates an AI conversational agent to facilitate idea generation by a process of question-answering informed by the principles of creative cognition. As Ward & Kolomyts (2010) suggest, the creative process is a collaborative activity of the mind and body, emphasizing practical and embodied knowledge forms. This aligns with ’°’Kobi’s approach, where the AI agent is not merely a tool for information retrieval but a facilitator of creative thinking. An example of a vocal interaction with Kobi is shown in figure 3.

Figure 3: Hololens View: a user perform a request using their voice. A comic indicates the system successfully received the user request: "Tell me about art creation Kobi"

The cognitive approach, as integrated into ’°’Kobi, addresses fundamental processes like abstraction, conceptual combination, and analogy. These processes are key in producing creative outcomes across various domains. The AI agent in ’°’Kobi aids in abstracting and combining concepts, fostering a environment fostering creativity.

Finke et al. (1992) characterize the development of new and useful ideas as the result of the interaction between generative and exploratory processes. In ’°’Kobi, the AI agent embodies this model by generating candidate ideas with creative potential and aiding users in exploring and expanding these ideas. This system allows for a dynamic interplay of cognitive processes that enhance the likelihood of a creative outcome.

Utilizing the advancements in computational linguistics outlined by Mitkov (2004), the AI voice interface in ’°’Kobi enables flexible terminological searches, expanding the semantic field of terms

and possibly incorporating specific corpora Speer et al. (2017). This functionality allows the AI to generate and understand complex associative networks, enriching the user's interactive experience with the system and enhancing the creative potential of their inquiries and commands.

The visual organization of content observed during authoring processes in ’°’Kobi offers a third type of association, akin to a gestalt-like nature, where spatially proximate elements of knowledge are considered more semantically relevant. This proximity principle emerges naturally in the knowledge mapping process and is utilized in ’°’Kobi as a further principle of semantic association, significantly enriching the AI's interpretative capabilities.

The AI voice interface in ’°’Kobi also supports the cultural component of creative thinking by enabling collaborative work technologies. This allows the creation of user communities that share information and interact in various languages, extending the functionality of semantic associations to create a rich knowledge ecosystem. The integration of different linguistic fields facilitates polysemous or metaphorical shifts in understanding, significantly beneficial for creative thinking Mednick (1962).

The AI in ’°’Kobi become an agent that craft narratives and provides explanations based on the user position in the 3D knowledge space. This feature enriches the learning experience by offering contextual and relevant information in response to user inquiries, making the interaction with ’°’Kobi both informative and engaging.

The integration of associative thinking into the AI voice interface in ’°’Kobi significantly enhances its functionality. By combining computational linguistics with the principles of semantic association and proximity, the system responds to user interactions and also aids in the creative exploration of ideas and concepts. This approach aligns with the cognitive dynamics of creative thinking, making ’°’Kobi a powerful tool for fostering creativity and collaborative learning in a multilingual and multicultural educational environment.

The AI voice interface in ’°’Kobi offers natural, inclusive, and versatile mode of interaction. By integrating this technology with Hololens, ’°’Kobi provides an immersive and interactive educational environment that is adaptable to diverse linguistic and sensory needs, thereby enhancing the overall effectiveness of the learning experience.

3.5 AI and Creativity

Using AI, ’°’Kobi can generate images, poetry, text, and soundscapes based on the semantic context where the user is positioned within the 3D knowledge space. This functionality leverages the reinterpretation of the Knowledge Mapping paradigm Wexler (2001) to support creativity. The AI uses advanced computational linguistics Mitkov (2004) and semantic association techniques to understand and interpret the user's position and context within the knowledge ecosystem, as described in the previous subsections of the provided text.

Figure 4: Artistic Creation: an image, generated by a participant during a demonstration

In line with the proximity principle, where spatially proximate elements are considered more semantically relevant Runco (2012), the AI generates content that reflects the interconnectedness of concepts within the user's current semantic field. The cultural component of creative thinking is also integrated, as '°'Kobi's AI supports collaborative work technologies, enabling the creation of a knowledge ecosystem where individual content production is semantically related Lyons (1997); Mednick (1962).

4. Architecture

°'°Kobi offers two distinct yet integrated versions: the Hololens version and the Desktop version. Each version addresses different user needs while maintaining the essence of °'°Kobi's interactive experience.

4.1 Hololens Version

The overall signal flow in °'°Kobi" is showed in Figure 5. It begins with the User, who is at the core of the system. The user interacts with the system primarily through their voice and gestures which are captured by Hololens. The user inputs data or queries are then channelled to the Speech and Gesture Recognition block. This block plays a crucial role in capturing and structuring the user's input, ensuring that it is in a format suitable for further processing.

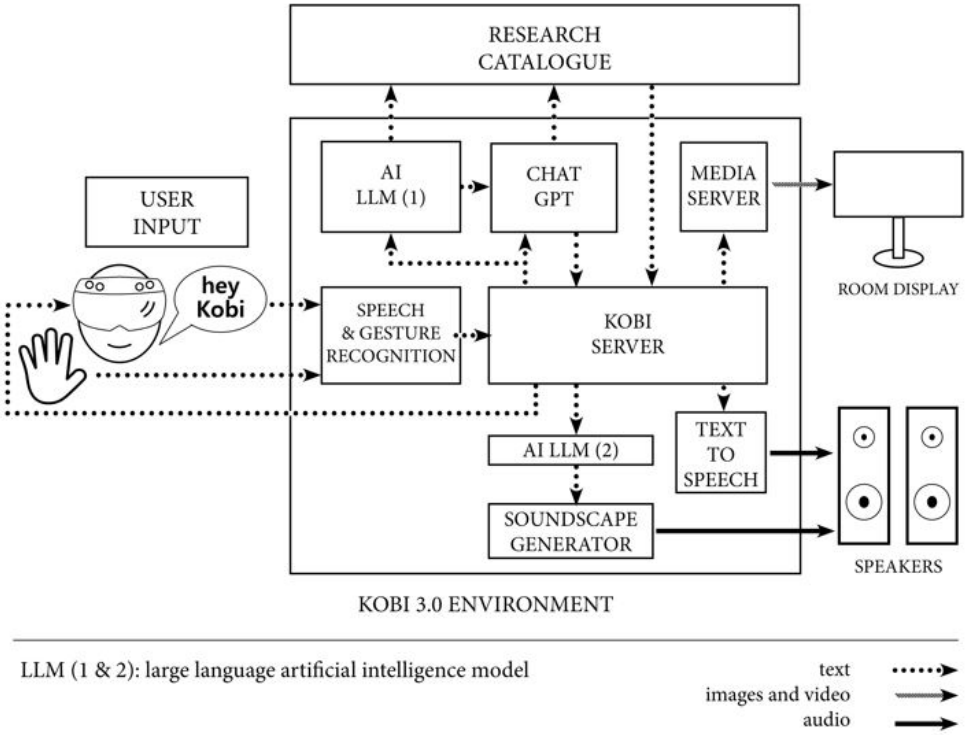

Figure 5: System Diagram of '°'Kobi's Interaction Flow - From User Input to Media Output

Once user input, its context and intention is identified, it is routed to one of the AI LLMs models. AI LLM 1 ensures the user input as well as the output are translated in the user language, while Chat GPT focuses on generating appropriate, conversational responses. This dual-AI approach ensures a comprehensive understanding and handling of the user's requests.

The Database is a critical component in this flow, serving as the repository for storing and retrieving media such as artistic publications and artworks as needed. It interacts closely with the AI models and the °'°Kobi Server, which acts as the central hub for managing and directing the flow of information. The °'°Kobi Server processes requests, fetches necessary data from the Database, coordinates with the AI models for processing and response generation, and ensures that these responses are accurately relayed back to the user wearing Hololens as well as to other users potentially in the room. Both can in fact experiencing text, images, web pages and videos either as holograms on Hololens or on a web browser showed on a display thanks to the Media Server. Chat GPT output is audible as a speaking voice thanks to a custom script based on the library Web Speech API.

As users interact with research materials and explore the 3D knowledge space, their actions are semantically processed by LLM 2. The model selects audio files which textual descriptors correspond to the current semantic context of the user's activity. These audio files then serve as the raw material for the soundscape.

This soundscape is played back through physical speakers and is characterized by its adaptability. It evolves in real-time, responding to the user's movements and interactions within the knowledge space. As the user's focus or location changes, the LLM 2 dynamically adjusts the soundscape, selecting new audio files based on the shifting semantic context. This results in a continually changing auditory environment that aligns with the user's exploration path.

4.2 Desktop Version

The desktop variant of °'°Kobi maintains the core functionality and principles of the Hololens version, yet adapts to a different hardware environment. Rather than relying on the Hololens' microphone and visor, the desktop version leverages a standard computer microphone. This allows users to engage in spoken dialogue with Chat GPT, initiating queries and interactions in a manner akin to the Hololens experience.

Furthermore, the desktop interface, accessible via the KOBI website, seamlessly replicates all functionalities available through the Hololens. This includes immersive navigation within the 3D knowledge space and comprehensive media visualization. This design ensures a consistent user experience across platforms, allowing for a flexible interaction with °'°Kobi's features whether on Hololens or a desktop setup.

Figure 6: '°'Kobi bridges the mixed reality environment with real life by enabling content interactions and media to be experienced on a physical display

Importantly, '°'Kobi also allows for the content interacted with in the mixed reality environment to be experienced in real life on a physical display (Figure 6. This feature enables students not

wearing the Hololens to participate in the learning experience, fostering an inclusive and collective educational environment. Such a setup is conducive to collaborative learning, allowing all students, irrespective of their access to mixed reality technology, to engage with the content and contribute to the collective understanding of complex concepts.

5. Demo

During the Artistic Research Days held at the Rome Fine Art Academy at the end of September 2023, ’°’Kobi was showcased in a demonstration where professors, students, and researchers were given the opportunity to experience the system. Each participant interacted with ’°’Kobi individually for five minutes, exploring its features and capabilities. The data gathered from this demonstration offers valuable insights into the user experience and the system’s effectiveness for the envisioned user base.

Figure 7: Exploring ’°’Kobi at the Artistic Research Days in Rome: Professors, Students,

The prototype of ’°’Kobi presented in this demo featured a knowledge base centred around artistic publications available on Research Catalogue, an online platform that serves as a comprehensive

repository of research materials, artistic publications, and multimedia resources.(for more information about the Research Catalogue and its role in the project, see Deliverable 5.2). This platform provided a vast pool of knowledge for the Rome demo, allowing participants to explore and reflect on a wide range of academic and artistic resources, thus showcasing ’°’Kobi’s potential. Notably, the soundscape generated during the demo used copyright license-free samples selected in real-time based on the semantic proximity of their descriptors and tags to the user’s semantic context in the knowledge space. These samples were sourced from Freesound Akkermans et al. (2011), a community-driven repository of sound samples. This integration enhanced the user experience by enabling ’°’Kobi to respond accurately and relevantly to user queries, creating a dynamic and immersive auditory environment.

The participants varied in age and professional background, including professors above 50, young students, and researchers. Their interaction with ’°’Kobi was assessed across multiple parameters such as learning time, ease of use, overall evaluation, and engagement. The feedback was generally positive, with most participants rating their experience as good to excellent. The ratings reflect ’°’Kobi’s accessibility and user-friendliness.

Several important observations were noted during the demonstration. Individuals tend to engage in less structured interactions when using a vocal interface. While issuing commands, they often included extra words, expressions, and engaged in parallel communication, such as uttering a few words to control the vocal interface, followed by a few words directed at others in the room, and then concluding with words to complete the command for the system. This phenomenon suggests that people tend to communicate more freely using their voices compared to traditional input methods like a mouse or keyboard. While this observation presents an intriguing opportunity for further research, it also underscores a specific area that warrants improvement—voice command recognition and system calibration.

Additionally, it was noticed that verbal interactions with nearby individuals at times triggered unintended commands or interactions with the system. Addressing aspects such as the positioning of speakers and microphone calibration could be instrumental in reducing unintended inputs and enhancing command detection.

Users encountered challenges when attempting to exit the chat function, indicating a need for a more intuitive method to end chat sessions. In the chat mode, users engage in free-form conversations with the AI conversational agent, which doesn’t rely on predefined commands. Users often asked questions like "tell me about...". Although the overall user self-assessment of the experience was positive, there is room for improvement in this area. Enhancements should be made to enable the AI to recognize when users wish to exit this mode.

These insights are crucial for refining ’°’Kobi’s user interface and enhancing the overall user experience. A copy of the data gathered during the demo is available at https://youtu.be/I4RKrQvinxw.

The positive response and constructive critiques from a diverse group of users underscore ’°’Kobi’s potential as a powerful tool for artistic exploration and education. The observations and

suggestions from this event will be instrumental in guiding the future enhancements and expansion of ’°’Kobi’s functionalities.

6. Conclusions

In conclusion, this deliverable provides a comprehensive overview of the recent advancements in ’°’Kobi, a transformative system designed to enhance education and creative ideation through innovative knowledge mapping and associative thinking. These advancements represent a significant step forward in the realm of art and design education, leveraging cutting-edge technologies to create a more immersive and interactive learning environment.

The integration of Large Language Models (LLMs) into ’°’Kobi enhances the exploration of collective knowledge, providing users with a deeper, contextual understanding of artistic concepts. Augmented reality (AR) technology offers an engaging, multimodal experience that aligns with contemporary pedagogical practices emphasizing embodied learning and sensory engagement.

Furthermore, the implementation of conversational AI interfaces facilitates personalized and dynamic interactions, making the educational experience more intuitive and responsive to individual learner needs. ’°’Kobi’s ability to generate creative outputs based on the user’s navigational path within the system enriches the creative exploration process.

The demonstration of ’°’Kobi with a diverse user base, including professors, students, and researchers, yielded positive feedback and valuable insights. However, it also highlighted areas for improvement, such as voice command recognition and user interface enhancements.

Overall, the recent advancements in ’°’Kobi represent a significant contribution to the field of art and design education, offering a technologically sophisticated yet user-centric platform for exploring, conceptualizing, discussing, and creating artistic content. The future directions outlined in this deliverable hold promise for further unlocking the system’s educational potential and expanding its functionalities to benefit a global community of users.

7. Future Directions

In conclusion, The Hololens and Desktop versions of °’°Kobi create an immersive and dynamic experience for users, leveraging advanced technology and intuitive design. Moving forward, there are several exciting avenues for further development and enhancement.

Future Collaborative Interactions: A key area of future work involves the introduction of collaborative features that allow multiple users to engage with °’°Kobi simultaneously. This enhancement aims to foster shared experiences and collective learning, enabling users to interact not only with the system but also with each other within the same semantic and creative space. By doing so, °’°Kobi will transcend individual experiences, promoting collaborative exploration and innovation.

Artificial Intelligence and Creativity: The conversational agent, a central component of °'°Kobi, is set to undergo advancements to better support learning and creativity. Future iterations will focus on enhancing the AI's ability to facilitate creative processes, offer tailored learning experiences. This involves not only refining the AI's responsiveness but also its capacity to understand and inspire creative thought and expression. Additionally, the development of the AI-driven content generation and artistic exploration in latent spaces is seen as a future direction. The generative feature demoed in Rome was received with interest and enthusiasm by the participants. This aspect will be pivotal in advancing '°'Kobi's capabilities for creative thinking and artistic research.

To further enrich the °'°Kobi experience, there will be a concerted effort to expand the range of media content available, possibly in collaboration with higher education institutions. This expansion will include diversifying the types of artistic publications, artworks, and other media, thereby offering a more comprehensive and varied repository of knowledge and creative works.

By fostering collaborative interactions, enhancing AI capabilities, and expanding content, °'°Kobi aims to redefine the boundaries of interactive learning and artistic exploration.

Publications

Portions of the work detailed in section 3 of this deliverable have appeared previously in the conference paper *Integrating Large Language Models in Art and Design Education* Giretti, Vaccarini, et al. (2023). Additional details described in this document have appeared in the poster *KOBI 3.0: A Knowledge Ecosystem for Creativity Research and Design* Giretti, Guidi, et al. (2023).

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