Navigating Digital Frontiers in Music Education: The MUSENSE Project's Contribution to E-Learning

Ioannis Deliyannis
Associate Professor, Department of Audiovisual Arts, Faculty of Audiovisual Arts, Ionian University, Greece

Yasin Özarslan
Professor, Department of New Media Faculty of Communication, Yasar University, Türkiye

Ioannis Toulis
Professor, Department of Music, Faculty of Audiovisual Arts, Ionian University, Greece

Raffaele Longo
Full Professor of Music Theory, State Conservatory of Music “Stanislao Giacomantonio”, Cosenza, Italy

Minas Emmanouil
Assistant Professor (tenured), Department of Music, Faculty of Audiovisual Arts, Ionian University, Greece

Naoum Mylonas
Assistant Professor, Department of Tourism, Faculty of Economic Sciences, Ionian University, Greece

Abstract

The integration of digital technologies into music education, particularly through the MUSENSE project, marks a pivotal evolution in teaching and learning practices within this creative domain. This research paper explores the project’s innovative approach to leveraging state-of-the-art technologies that include AI (Artificial Intelligence), IOT (Internet of Things), robotic and eXtended (XR)/virtual (VR)/augmented (AR) reality and other emerging technologies to enhance music education and performance. With the advent of the COVID-19 pandemic, traditional music education faced significant challenges, catalyzing the need for alternative, technologically driven pedagogical strategies. MUSENSE addresses this gap by facilitating the digital transformation of music education, aiming to enrich learning experiences and broaden access to music performance education. This is implemented through a mixed-methods research approach that utilises an open repository designed to collect, decompose, present the functions of the basic functional components and elements of appropriate case studies. In addition, through the collection of stakeholder interviews and expert contact information, the project reports on the current state of emerging technology adoption in music education, assesses the educational implications of these technologies, and explores their potential to foster innovative teaching and learning practices. Initial findings suggest a positive impact on music education through immersive learning experiences provided by state-of-the-art technologies, alongside an increasing receptivity among educators and students towards integrating digital tools. However,
challenges such as the digital divide and the need for curriculum adaptation emerge as critical considerations. This paper contributes to the discourse on digital innovation in music education by highlighting the opportunities and obstacles presented by integrating digital technologies, offering insights for educators, policymakers, and technology developers in navigating the future of music education in the digital age.

Keywords: Digital Transformation in Music Education, Cyber Performance Technologies, Immersive Learning Experiences, Educational Technology Integration, MUSENSE Project.


Introduction

In the rapidly evolving landscape of music education, integrating digital technologies has emerged as a pivotal factor in shaping the future of teaching and learning practices. This paper presents and discusses the project's contributions to e-learning in music, addressing the urgent need for adaptive, resilient educational frameworks in the wake of global disruptions such as the COVID-19 pandemic and the extension of e-learning technologies to new application domains. Existing literature provides a foundation for understanding the integration of educational technologies in various disciplines, yet there remains a gap in specific explorations of their impact on music education and performance.

In our previous work (Deliyannis, Toulis et al. 2023, Deliyannis, Toulis et al. 2023) we have identified a wide range of application domains and case studies from the literature. These technologies have been shown to enhance creative thinking among middle school students (Zhang, 2022), provide access to high-quality music education in remote areas (Crawford, 2013), and shape collaborative music compositional practices (Dobson & Littleton, 2016). They also facilitate the combination of various teaching elements, making abstract theories more understandable (Qionggang, 2009), and play a creative role in music teaching (Ruthmann et al., 2008). Furthermore, they contribute to the development of musical creativity (Maba, 2020) and support technology-enhanced music learning and teaching. However, the effective integration of these technologies requires rethinking about music education and the development of specific technology competencies among music educators (Dammers, 2019).

Within the wider transformation domain, the MUSENSE project stands out as a beacon of innovation, blending state-of-the-art technologies such as AI (Artificial Intelligence), IOT (Internet of Things), robotic and eXtended (XR)/virtual(VR)/augmented (AR) reality Virtual Reality (VR) and other emerging technologies tools in its quest to redefine music performance and education. The introduction of novel cyber performance technologies into music education can clearly offer unprecedented opportunities for immersive learning experiences, transcending
traditional boundaries of space and time. However, adopting such technologies also presents significant challenges, from the digital divide to the need for pedagogical adjustments. This dichotomy underscores the importance of comprehensive research and the presentation of good practices in order to navigate the complexities of digital transformation in music education. This study contributes novel insights into the practical application of novel technologies and digital tools, highlighting innovative pedagogical strategies and the potential for enhancing accessibility and engagement in music learning.

Materials and Methods

The research design is anchored in a mixed-methods approach, combining qualitative case studies from the MUSENSE repository with quantitative data collection through surveys and interviews. The aim here is to provide a platform that will allow all those who wish to learn how to use the proposed technologies and techniques and ultimately include them in their teaching/learning or performing practices. Therefore, the methodology utilised facilitates the presentation of the technological and pedagogical innovations introduced by the MUSENSE project, including the use of Virtual Reality (VR), the Metaverse, 360° cameras, and network performances. This information is provided by the project’s repository, also featuring all the necessary information that will allow interested parties to use it: technical and configuration data and settings, video examples, actual VR footage and comments, links and access to those who implemented the configuration in practice and other related content. The depth and breadth of information, therefore, is not limited to a description and a video of the project but instead to its bits and bytes, as one would expect from such a repository.

One major case study section from the MUSENSE repository features a wide range of examples. An example is VR environments that can be used by music students in order to allow them to perform in a simulated concert hall environment. The aim here is to provide them with the tools and opportunity to experience the acoustics and ambience of a live performance space from the comfort of their classroom or home or enable them to practice and improve their techniques virtually. Both those implementations may employ advanced spatial audio technologies, if needed, in order to recreate the immersive sound and allow enhanced immersion. Different technologies can be used in this particular domain; therefore below, the ones already implemented are listed.

The first use case utilizes 360° cameras for creating an immersive video where performances and music practice are recorded and broadcasted in that particular video format, live and then the broadcast is stored as a video file available for future use. This content is either immediately accessible to the audience in the form of a live performance or to the student and teacher participating in an immersive practice session, while other students, teachers and audiences can access it later on via VR headsets, allowing them to experience the session as if they were in the audience, providing a unique perspective on the nuances of live music performance, practice and teaching. Instructions on how to set up each configuration can be accessed through the repository, and one may decide to embed this information as part of their curriculum, enabling teachers or performers to efficiently re-create the environment and use it in an out-of-the-box experience. Clearly, setting up two or more cameras allows interaction scenarios to multiplex, enabling students and teachers to communicate from different physical locations or viewers to interactively switch
between performers or performance points of interest by selecting the appropriate streaming camera. From the interaction perspective, therefore, the possibilities are enhanced with the introduction of complexity, while technical issues such as delays may arise depending on the network bandwidth and usability issues from ill placement of the video capturing equipment, particularly due to the limited field of view offered by such cameras.

Another case explores using the Metaverse for remote music collaboration and performance. In this scenario, students and instructors from geographically disparate locations come together in a virtual space to conduct rehearsals, performances, and masterclasses. This approach leverages the Metaverse's capacity for creating a sense of presence and community among participants. Here, the metaverse environment is used as a meeting space, enabling users to set up performance parameters that cannot be altered within 360° environments. For example, performers can use a model of the auditorium in order to set up their seating positions, discuss the aspects of the performance, and virtually visualise the conditions of the setup.

Network performances is a highly interesting domain that addresses the challenges and opportunities faced by technology, where musicians perform together in real-time over the internet. The MUSENSE project, through the use of the repository, enables the investigation of existing technological solutions that offer latency reduction and the implications for ensemble coordination, offering insights into the future of distributed music performances.

The depth and breadth of tools included can extend to every conceivable domain, including using Artificial Intelligence recommendation and analysis tools and technologies that may be included in the supported processes. Clearly all the above domains can be creatively combined by providing anything ranging from small technological solutions to large-scale implementations that can be combined to cater for specific performance requirements. Therefore, it is interesting to see how those combinations will evolve in the near future.

Data Collection, Analysis and Contributions
Quantitative data were collected through surveys distributed to music educators and students participating in the MUSENSE project to assess their experiences with and attitudes towards the integrated technologies. The project partners from Yaşar University collected a wide plethora of data under the following MUSENSE project tasks:

Task 4: a comparative analysis of the technological infrastructure and remote systems used in the partner HEIs (information on real long-distance learning departments, kind of infrastructure, available resources, finances, actual courses are done, kinds of testing and evaluation, and how educators managed to improvise online courses that were (up to Covid) taught in the class, expansion of long-distance systems);

Task 5: discern local literature on the need and related international literature on social aspects of blended distance learning and performances in the Creative Industries (articles, books, other print media, podcasts, videos, lectures, and events that are directly related to this topic. It will be similar in format to annotated articles found in academic research guides);

Task 7: project needs and topics regarding the 2030 Agenda for Sustainable Development on inclusive and equitable quality education (a comparative study that includes a discovery of what the 2030 Agenda prerequisites actually are compared to the aims or intents of the MUSENSE project);
Task 8: measuring the current and the potential capacity of partners and stakeholders to conduct such activities (implemented as a metadata analysis of Task 4).

Qualitative data were derived from the above mentioned tasks and the in-depth interviews with project participants, including educators, technologists, and students, to gain a nuanced understanding of the pedagogical impacts of these technologies. The analysis employs a thematic approach, identifying common themes and patterns related to the adoption, challenges, and educational outcomes of the technologies introduced by the MUSENSE project. This includes examining the pedagogical strategies developed to incorporate these technologies into music education and the perceived benefits and limitations as reported by participants. This is a common practice in other domains, such as programming, where platforms like GitHub provide the necessary tools and documentation to clone projects and evolve them into new implementations. Most importantly, what actually derived from this research is the fact that for the first time, we were able to identify which are the particular characteristics that need to be included in the repository in order to assist in the implementation of custom scenarios and, therefore, the effective integration of digital technologies into music education.

Novel Contributions

The contribution of this research lies in its holistic examination of cutting-edge technological integrations in music education through the lens of the MUSENSE project. By showcasing specific case studies alongside broader data analysis, this paper provides valuable insights into the potential of VR, the Metaverse, 360° cameras, and network performances to transform music education. This work not only contributes to the academic discourse on digital innovation in music education but also offers practical implications for educators seeking to navigate the integration of these technologies into their teaching practices.

Early Findings

Technological Infrastructure and Remote Systems (Task 4): The comparative analysis reveals a significant variance in the digital readiness and infrastructure across partner Higher Education Institutions (HEIs). While some institutions demonstrated robust online course delivery mechanisms, others faced challenges in improvising previously in-person courses for online platforms. This variance highlights the critical need for tailored strategies to enhance digital infrastructure, ensuring equitable access to quality music education. The improvisation of online courses, driven by the necessity during the COVID-19 pandemic, underscores the resilience and adaptability of educators but also points to the necessity of systemic support and resources.

Literature on Blended Learning and Performances (Task 5): The review of local and international literature on social aspects of blended distance learning in the Creative Industries provides valuable insights into best practices and emerging trends. It indicates a growing recognition of the potential for blended learning models to enhance accessibility and engagement in music education. However, it also underscores the importance of addressing the social dimensions of learning, such as community building and interactive engagement, which are essential for the holistic development of music students.

Alignment with the 2030 Agenda for Sustainable Development (Task 7): The project's exploration of its objectives in relation to the 2030 Agenda reveals a commitment to
inclusive and equitable quality education. This alignment emphasizes the MUSENSE project’s commitment to fostering an inclusive, equitable, and quality-focused music education environment. This strategic orientation towards sustainable education not only aligns with global objectives but also sets a precedent for how music education projects can contribute to broader societal goals.

Capacity for Conducting Digital Education Activities (Task 8): The metadata analysis provided a clear assessment of the current and potential capabilities of partners and stakeholders in conducting digital education activities. It underscored the importance of capacity building in ensuring the effective implementation of digital technologies in music education. This analysis also informed the development of a repository that aids in the customization and application of digital tools in educational settings, a crucial step in addressing the unique needs and contexts of various HEIs.

Discussion

The thematic analysis of the MUSENSE project's data sheds light on several key areas of interest in the integration of digital technologies in music education:

**Digital Infrastructure Disparities:** The variance in digital readiness among partner HEIs underscores the need for targeted investments in technological infrastructure and training to ensure that all institutions can fully leverage the benefits of digital education. This is critical for reducing the digital divide and ensuring equitable access to innovative educational experiences.

**Pedagogical Innovation:** The project's findings reveal a strong interest among educators and students in utilizing digital technologies for music education, highlighting the potential for VR, the Metaverse, 360° cameras, and network performances to enhance teaching and learning outcomes. These technologies offer new avenues for engagement, allowing students to experience immersive performances, participate in remote collaborations, and access a broader range of educational materials.

**Social Aspects of Blended Learning:** The social dimensions of music education, such as community building and interactive engagement, are essential for student development. The project's literature review indicates that while digital technologies can enhance access and flexibility, educators must also devise strategies to foster a sense of community and interactive learning experiences in digital and blended environments.

**Sustainability and Education:** The alignment with the 2030 Agenda for Sustainable Development underscores the project's broader commitment to sustainability in education. This focus on inclusive and equitable quality education resonates with global educational goals, highlighting the importance of integrating sustainability into the curriculum and pedagogical practices.

**Customization and Repository Development:** The development of a repository to assist in implementing custom scenarios represents a significant advancement in the digital transformation of music education. This tool enables educators to tailor digital technologies to their specific pedagogical needs and contexts, providing a practical framework for effectively integrating advanced digital tools into music education programs.
Conclusion

The MUSENSE project's comprehensive exploration of digital technologies in music education offers valuable insights into the potential for enhancing educational practices and outcomes. The findings highlight both opportunities and challenges in integrating digital tools, from the need to improve digital infrastructure to the potential for creating immersive and engaging learning experiences. The project's alignment with global educational sustainability goals further emphasizes the importance of inclusive and equitable education practices.

As the field of music education continues to evolve, the insights and methodologies developed through the MUSENSE project will serve as a valuable resource for educators, policymakers, and researchers. The project not only contributes to the academic discourse on digital innovation in music education but also offers practical guidance for the effective integration of these technologies into educational settings. By addressing the unique needs and contexts of music education, the MUSENSE project paves the way for a more inclusive, equitable, and dynamic future in music learning and performance.

References


Deliyannis, I., I. Toulis, R. Longo and M. Pergantis (2023). Extending the MUSENSE project from the Music Industry to the Wider World of Performance. DCAC Conference, Ionian University, Corfu, Greece


