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Transdisciplinarity and digital innovation in the professional training of bachelors of musical arts

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Abstract

Relevance. Music education programmes need to adapt to the rapid development of digital technologies that are changing all aspects of modern life, including education. Given the significant impact of digitalisation on the industry, the revision of traditional teaching methods and the introduction of modern tools and approaches are essential to ensure that educational programmes meet modern requirements.

Purpose. The study aims to explore the possibilities of introducing digital innovations in music history, music theory, and introduction to the speciality, as well as in practical aspects of teaching, such as piano, sound design, computer arrangement, vocal and choral arrangement, vocal performance, conducting, choir, and vocal ensembles.

Methodology. This study evaluated the impact of digital innovations on music education by reviewing scientific literature, analyzing educational and cognitive development theories, and examining practical case studies from various institutions. The research involved systematising information from diverse sources to ensure a balanced and objective assessment.

Results. The integration of digital tools in music education significantly enhanced student engagement, learning effectiveness, and educational quality. Notable improvements were observed in music history, theory, and practical courses, particularly with the use of computer arrangement software and digital audio workstations.

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Conclusions. Digital technologies have shown substantial potential to improve music education by fostering greater student motivation and providing high-quality, dynamic learning experiences. Addressing challenges and leveraging the benefits of these innovations can align music education programs with modern requirements.

Keywords: digital learning; technological innovations; educational adaptation; latest methods; multidisciplinary; art pedagogy; technology integration.

Introduction

The study examined the impact of digital innovations on music education, which has become particularly relevant in the context of rapid technological development. The digitalisation of music education created an opportunity to use interactive teaching methods such as virtual simulations, online masterclasses and digital portfolios, which allow students and teachers to significantly expand the scope of traditional pedagogy. At the same time, the integration of these technologies calls for new research to assess their effectiveness and impact on the learning process, which leads to a rethinking of the role of the teacher and the reformatting of the educational environment. Questions arise about the creativity and autonomy of students, and how digital instruments affect the development of musical skills and abilities, which are key to the training of qualified musicians.

The relevance of digital innovations in music education is steadily increasing, as modern technological advances open new horizons for improving the quality and accessibility of learning. Digital technologies, such as composition software, digital musical instruments, and collaborative music-making platforms, allow students to experiment and improve their skills in an environment that traditional music environments cannot offer. Innovations contribute to the individualisation of the learning process, as each student can learn at a pace that meets their personal needs, which is important for the development of creative abilities. Education that incorporates digital technologies also contributes to the development among critical thinking and analytical skills of students through opportunities for independent analysis of musical works and performance techniques.

The relevance of digital innovations underscores the need for further research into their impact on music education and the adaptation of educational programmes to meet the requirements of the present. This is also determined by the need to adapt to changing cultural and social contexts characterised by the rapid spread of information and globalisation. Digital platforms and tools allow musicians and students to easily share their efforts with a global audience, going beyond classical performances to live and traditional classes. This creates new opportunities for collaboration and cultural exchange, making learning more integrated and open. The use of digital technologies in music education not only contributes to the technical development of students but also fosters the concept of digital literacy, which is critical in modern digital world. Thus, digital innovations not only improve music education but also adapt it to the needs of the modern digital age.

The theoretical background of this study is based on a significant body of work analysing the impact of digital innovations on music education. The topic of digital innovations in contemporary music has been considered by both Ukrainian researchers and American and European

authors. For instance, N. Shelepnytska-Govorun [1] studied how vocal culture among music professionals in Poland is shaped in the context of global digital trends and cross-disciplinary interactions that influence educational methods and approaches. S. Gorbenko [2] analysed how art education can be reimagined through a person-centred approach that uses digital tools to create a more interactive and integrative learning environment.

L. Garkusha et al. [3] investigated how the choice of pedagogical repertoire for pianists can integrate digital technologies to expand educational opportunities and prepare students to work in the modern musical landscape. O. Lucianinova [4] studied the possibilities of STEM/STEAM education in higher education institutions, considering how the integration of science, technology and art can enrich music education and promote the development of complex skills in students. L. Likhitska [5] focused on an integrative and axiological approach to music teacher education, exploring how the interaction of values, digital innovations and music methods can prepare teachers to work more effectively in a transdisciplinary educational context.

E. A. Randall [6] highlighted the concepts of an open philosophy of music education, analysing how digital innovations contribute to expanding learning horizons through greater inclusion and democratisation of educational processes. A. Maharaj and A. Gill [7] explored the challenges and opportunities that digital technologies bring to music education, through the latest methods of teaching and creativity. K. Burwell [8] addressed studio instrumental training, emphasising the role of technology in the development of performance skills. J. Wierzbicki [9] addressed the impact of cultural changes in the United States in the fifties on music education, providing a historical context for understanding current trends.

J. Russell [10] addressed how cultural diversity affects music education and how digital tools can contribute to a more inclusive learning environment. P. Schmidt and R. Colwell [11] analysed the political aspects of music education, including the challenges and opportunities associated with integrating technology into educational standards. R. Cutietta [12] described how parents could assist in music education for children in the digital age, emphasising the importance of early introduction of digital tools for the development of musical abilities. S. Young [13] explored the peculiarities of early childhood music education in the context of digital technologies, assessing their impact on child development. J. Martinez et al. [14] discussed strategies for integrating technology into modern music education, emphasising the importance of innovative approaches to preparing students for a music career.

The study aimed to explore in depth the impact of digital innovations on learning processes and practice in music education, as well as to develop recommendations for the effective implementation of these technologies in

music education programmes. To achieve this goal, the study set the following objectives: to investigate how music schools and universities use digital tools; to assess the effectiveness of these tools in enhancing cognitive and creative development of students; to investigate how digital innovations affect student motivation and engagement in the learning process; to identify potential barriers and limitations that may hinder the effective use of digital innovations; to analyse changes in student performance, motivation and engagement before and after the introduction of new technological solutions.

Materials and Methods

The study conducted objective assessment of the impact of technology on educational processes, which is due to the careful selection of sources and systematisation of information. The research involved a wide-ranging review of scientific publications, articles, books and conference materials dealing with digitalisation in education in general and music education in particular. The study analysed the impact of digital technologies on educational processes, student motivation, and the integration of innovative tools into curricula. This created a balanced view of potential challenges and opportunities, as well as ensured the objectivity and depth of analysis of the impact of digital technologies on the educational process.

An in-depth theoretical analysis of the concepts and models that explain the mechanisms of technological impact on the educational process was also conducted. Learning theories, educational psychology and information theories that help understand how technological changes affect cognitive development and creativity were addressed. The authors identified the most relevant theoretical areas for the study of the impact of digital technologies on music education. In particular, theories of educational technologies, theories of motivation and learning, as well as works that consider innovative approaches to education were covered.

An assessment of how theoretical discoveries can be used to improve music education with the use of digital technologies was made. The study also analysed practical cases of digital innovation in various educational institutions. Examples of successful integration of technology into the educational process were studied, which identified effective methods and strategies. Particular attention was devoted to the study of the impact of interactive platforms and software on the development of musical skills, as well as their ability to stimulate creativity of students.

The study analysed different points of view and opinions of scholars on the benefits and challenges offered by digital innovations. This included an assessment of potential barriers and strategies to overcome them, as described in scientific papers. The key aspects that were critically analysed were identified. This included the effectiveness of technology use, changes in pedagogical methods, the impact on cognitive development of students, and potential risks and challenges. For each aspect, theoretical findings were compared with data from real-world studies, which was used to assess the actual applicability and correctness of theoretical models. During the analysis, contradictions between different studies and theories were identified and discussed. Arguments from

different sources were compared to identify possible dissonances and inconsistencies in approaches.

The data obtained were carefully studied and systematised. The data collected was organised by grouping similar ideas and concepts. This included highlighting themes that were frequently repeated or had significant connections to each other, which helped to structure the material. Interactions and dependencies between different concepts and findings were assessed to understand how one idea influences another or how they are interconnected in the context of digital innovation in music education. The combination of different theoretical sources and their findings were used to form a comprehensive view of the current state and prospects of digital technologies in music education.

Results

Transdisciplinarity is an approach to research and education that transcends disciplinary boundaries, drawing on and integrating knowledge, methods and perspectives from different scientific fields to create new synthetic approaches. This method is aimed at developing solutions and theories that respond to complex, multidimensional problems of the modern world, crossing traditional boundaries between disciplines [15].

In this context, transdisciplinarity means not only the involvement of tools and techniques from other scientific fields, but also the deep integration of pedagogical, technological, cultural, and psychological aspects that contribute to the development of music education. Digital tools employment, such as virtual musical instruments or composition software, shows how technological innovations can be integrated into pedagogical methods. Teachers use these tools to create more effective and interactive lessons that stimulate creativity and critical thinking among students. Digital innovations in music education also promote greater cultural interaction and exchange [16]. Online platforms and social media allow students from different cultures to communicate and co-create music projects, paving the way for multicultural learning and understanding.

The use of digital technologies also has important psychological aspects, such as increasing student motivation and engagement. The interactivity and flexibility provided by these tools help to maintain a high level of interest in learning, which is critical for an effective educational process. A transdisciplinary approach also encompasses the ethical dimensions of technology in education, including issues of privacy, accessibility and equity. Ensuring that all students have equal access to digital resources is a fundamental aspect of developing and implementing innovations in music education. A transdisciplinary approach promotes critical thinking among students as they learn to integrate and apply different types of knowledge and skills within a single discipline. Digital technologies provide students with the opportunity to use analytical tools to analyse musical compositions, analyse structures and create their projects, which requires a deep understanding and the ability to solve complex creative problems.

As part of a transdisciplinary approach, music education can be enriched by integrating with other disciplines such as mathematics, physics, engineering, and

the humanities. This is especially important in the context of sound design, where an understanding of acoustics, electronics and programming can significantly improve ability to create innovative sound effects and compositions among students. This integration contributes to the development of deep and comprehensive knowledge and skills. The transdisciplinary approach supports the idea of continuous learning and adaptation to the rapidly changing conditions of the modern world. Digital innovations in music education allow students and teachers to constantly update their skills and methods, which is key in preparing for future professional challenges.

Thus, the transdisciplinary approach in music education opens up new opportunities for the integration of different fields of knowledge and experience, contributing to the creation of a more comprehensive and in-depth educational model [17]. This not only improves the quality of education but also provides students with the skills and knowledge necessary for successful adaptation and development in a multidisciplinary world.

The introduction of digital innovations in educational courses has significantly transformed music education, making it more interactive and accessible to students of different levels. One of the key results was an increase in the use of digital audio workstations (DAWs) in music composition and arrangement courses. Students who used DAWs were able not only to master complex musical concepts more effectively but also to implement their musical ideas faster, which increased their creative expression and motivation [18]. Significant progress was also made in music theory courses, where the use of interactive software and applications has allowed students to visualise complex theoretical concepts in real-time. For instance, programs for virtual modelling of chord progressions and harmonic functions facilitated the process of learning harmony, thus “demonstrating” students the musical relationships and understand them better.

In vocal and instrumental courses, digital instruments have also brought about significant changes. Students who used digital metronomes, tuners, and sound analysis apps showed significant improvements in accuracy and intonation. This is especially noticeable in the early stages of learning, where accuracy is critical to developing the right performance skills. In addition, the integration of digital platforms for collaborative music-making and composition-sharing has made it easy for students and teachers to collaborate regardless of their geographical location. This has created new opportunities for collaboration projects and masterclasses, attracting professionals and experts from around the world, which has strengthened the international dimension of the educational process. Thus, the introduction of digital innovations in educational courses has not only improved the accessibility and quality of music education but also contributed to the formation of a more global and interactive learning community [19].

Digital platforms, such as interactive timelines, virtual exhibitions and e-books, have introduced the latest methods of teaching music history, allowing students to dive deeper into the context of eras and cultural trends. These tools were used at the University of Music and Performing Arts Vienna, where students had access to

visually rich materials that helped them better understand the chronological sequences of musical styles and famous composers. In music theory courses, the use of music composition and harmony modelling software, such as music notation software, has become a key element in enhancing understanding of musical structures and theoretical concepts. The use of these tools has shown an improvement in the ability to analyse musical works, identify harmonic progressions and determine the formal features of compositions. In a study conducted at The Juilliard School in New York, students made extensive use of Sibelius and Finale music notation software, which improved skills in analysing musical works and harmonic progressions.

Digital instruments were also used to conduct interactive classes, where students could instantly put their theoretical knowledge into practice by simulating various musical scenarios. The introduction of mobile applications was particularly significant, allowing students to continue their studies outside the classroom. The use of these applications has provided students with access to learning materials at any time and place, which has facilitated self-study and revision as needed. At Berklee College of Music, the introduction of mobile applications such as iReal Pro allowed students to continue their learning and practice outside the classroom, which increased their motivation and learning efficiency. This approach has significantly increased the flexibility of the learning process and student motivation. Thus, digital instruments in music theory courses have contributed not only to improving educational outcomes but also to developing critical thinking skills and creative activity among students. The use of these technologies transformed the traditional study of music theory and history into a more dynamic and interactive process [20].

Significant advantages were found in piano training, sound design and computer arrangement. Piano simulation software and virtual musical instruments have had a particularly positive impact, allowing students to practice and learn a wide range of musical pieces without the need for access to traditional pianos. In a study conducted at the Royal Academy of Music in London, the use of digital pianos such as the Yamaha Clavinova significantly improved the frequency and effectiveness of student practice. With high-quality sounds and touch-sensitive keys, digital pianos gave students the ability to practice at any time, significantly increasing the frequency and effectiveness of their practice. In the field of sound design, the use of digital audio workstations (DAWs) has revolutionised the learning process, as students have been able to put their theoretical knowledge into practice by analysing and modifying sounds immediately.

For example, programs such as Ableton Live or Logic Pro allowed students to experiment with layering sounds, mixing tracks, and mastering, giving them unprecedented control over the final sound. This study was also conducted in Berkeley, where students actively used DAWs to create and analyse musical compositions. The use of built-in sound libraries and plug-ins allowed for the development of audio design, which could later be used to create soundtracks for video and computer games. Computer arrangements have also seen significant progress thanks to digital innovations. Not only has it simplified the notation

process, but it has also allowed students to dive deeper into the structure and harmony of musical works. At the Royal Conservatoire of Scotland, students used computer-assisted arranging software to improve their skills in notation and harmony.

Being able to reproduce the arrangements through virtual instruments, students were able to immediately evaluate the aesthetic and functional aspects of their arrangements, which increased their understanding of compositional techniques. The digital arrangement also improved project collaboration efficiency among students, enabling them to share project files and work together on musical compositions regardless of the physical presence of participants. This contributed to the development of teamwork and communication skills among students and

provided new opportunities for intercultural musical exchange and cooperation [20].

The integration of digital technologies into the practical aspects of music education has strengthened the understanding of a professional music environment that is increasingly dependent on digital resources and technologies. The introduction of these innovations has not only improved the efficiency of the educational process but also provided students with skills that are critical for their future careers in the music industry. Digital instruments in education have thus become not only a way to improve musical skills but also a tool for developing adaptability and innovation among future musicians [20]. The table below shows the main teaching methods in terms of innovative technologies, as well as their main characteristics Table 1.

Table 1. Comparison of different theoretical aspects of teaching methods

Teaching method	Theoretical basis	Main learning objectives	Means of implementation	Main advantages
Traditional lectures	Transfer of knowledge	Mastering basic theoretical knowledge	Presentations, reports	Structured and consistent training
Video lectures	Visual learning	Involvement of visual and auditory resources for learning	Recorded videos, multimedia content	Flexibility of viewing, accessibility
Interactive simulations	Constructivism	Developing practical skills through interaction	Simulators, interactive software	Practical experience, active learning
Practical exercises	Experiential learning	Applying the theory in practice	Laboratories, workshops	Deep learning of the material, development of skills

Source: compiled by the authors

Digital technologies have not only changed approaches to teaching and practice in music but have also become a catalyst for cultural change in music education, increasing its accessibility, flexibility, and adaptability to modern requirements and expectations [21]. The use of digital pedals and virtual modelling applications has allowed pianists and other instrumentalists to emulate different types of pedals without the need for real hardware. This not only simplified the process of learning and practice but also reduced the cost of music education for many students. Important progress has also been made in the field of distance education, where the use of online platforms and video conferencing has significantly improved the accessibility and flexibility of training courses. Students living in remote regions or unable to attend traditional classes could participate in webinars and masterclasses in real-time, gaining access to quality education. Thus, digital innovations in music education have not only improved the pedagogical process but also created new opportunities for talent development, access to education and intercultural exchange. Thanks to the use of these technologies, music education is becoming more inclusive, innovative and adaptive to the needs of modern students [22].

The introduction of digital innovations has also significantly transformed training in the fields of vocal performance, conducting, and working with choirs and vocal ensembles. Digital technologies contributed to improving the quality of vocal education using specialised voice analysis software that allows for a detailed examination of the tone, pitch and vibration of voices in

students. For example, Vox Tools can be used by vocalists to analyse and correct their singing in real time, which has significantly improved their vocal technique and ability to control their voice. In the field of conducting, digital music laboratories and simulation programmes have allowed conductors to improve their skills by working with virtual orchestras. This made it possible to experiment directly with different styles and techniques of conducting without the need to involve live musicians, which is a great advantage for educational institutions with limited resources.

Maestro Simulator, for example, helped students visually observe the orchestra response to their commands, increasing their understanding of the dynamics of orchestral performance [23]. Choirs and vocal ensembles have also benefited from digital innovation. The use of online platforms for collaborative rehearsals and performances has allowed choirs to maintain regular sessions even during the restrictions of the COVID-19 pandemic. For example, the JamKazam app provided choirs with the opportunity to conduct live online rehearsals where conductors and singers could perform music in sync, providing an irreplaceable experience of collective performance.

Digital innovations have not only improved the technical aspects of music education but have also created new opportunities for creative expression, increased access to educational resources and the globalisation of music practice. In the context of choral singing, digital tools have helped conductors and singers better coordinate their

performances by providing tools for precise timing and synchronisation of parts. For example, apps that allow for the visualisation of musical accompaniment and tempo have helped choirs perform more complex pieces of music with greater precision and artistry. Such technological support has made it possible to perform more ambitious projects that previously required significantly more resources and longer preparation time.

For conductors, the integration of digital technologies has simplified the rehearsal planning process, as they can use specialised software to create and distribute sheet music, plan performance scenarios, and store recordings of previous performances for analysis and improvement. This not only improved the logistics of rehearsals but also increased the overall productivity and quality of performances. The use of digital technology in vocal ensembles and choirs has also changed the way they learn and perform, opening new opportunities for musical creativity and collaboration on a global scale. Through online platforms and social networks, ensembles were able to exchange ideas and projects with colleagues from other countries, which facilitated cultural exchange and learning through music. Such innovations not only strengthened the educational process but also made a significant contribution to the development of the international music community [24].

Digital instruments also greatly enhance creativity by providing them with tools that facilitate an innovative approach to music and composition. Software can be used to manipulate sounds at incredibly complex levels, thus opening new horizons for sound design experimentation. Students can create unique pieces of music by integrating non-traditional sounds and digital effects that would be impossible or very difficult to achieve with traditional instruments.

Digital technologies contribute to the development of independence, as they can control their learning process. This is especially evident in the use of online platforms and learning applications that allow students to plan their study schedule, choose the materials to study and set personal learning goals. This approach not only increases student motivation but also teaches them to be responsible for their

learning, which is an important aspect of adult education. Digital technologies make music education more accessible to a wider range of people, including people with disabilities, who may have previously faced barriers in traditional learning. For example, specialised apps and adaptive tools allow people with visual and hearing impairments to engage with music using special interfaces and audio cues [25].

A comparison of digital innovations with traditional teaching methods in music education highlights the significant benefits that technological innovations bring. Digital teaching methods not only increase interactivity and student engagement but also provide greater adaptability and personalisation of learning processes. Traditional teaching methods are often based on the one-way transfer of information from teacher to student. Whereas digital tools, such as interactive music apps and collaboration platforms, allow students to actively participate in the learning process. For example, the use of composition software allows students to create music in real-time, make adjustments and receive immediate feedback.

Traditional methods can be difficult to adapt to the individual needs of each student. Digital technologies, such as music learning apps, provide more flexible settings and personalisation options. For example, vocal training apps that analyse pitch and sound quality allow students to customise exercises according to their vocal ranges and specific needs. Traditional teaching methods require students to be physically present at a specific location and time, which can limit access to education for students from remote areas or those with work or family commitments. Digital technologies, such as online courses and video tutorials, provide the opportunity to learn at any time and place, making education more accessible. Studies show that students who use digital tools often perform better than traditional learning methods. Digital tools provide a more dynamic and efficient learning experience, as well as help in tracking progress and assessing knowledge of students. A summary of the comparison between traditional teaching methods and digital innovations is presented in Table 2.

Table 2. Differences and advantages between traditional teaching methods and digital innovation methods

Category	Digital innovation	Traditional teaching methods
Interactivity and engagement	Digital tools such as interactive platforms and applications allow students to actively participate in learning	The transfer of information is mostly unilateral from the teacher
Adaptability and personalisation	Individual customisation and adaptation of curricula to the needs of each student	Generalised curricula, less ability to adapt to individual students
Flexibility and accessibility	Learning is possible from anywhere and at any time, using online resources	Learning usually requires physical presence at a specific time and place
Performance	High, due to the possibility of immediate feedback and analysis of results	Depends on the quality and methods of teaching, often with a delay in feedback
Independence	Promotes independent learning and responsibility among students	More dependent on the timetables and structure provided by the educational institution
Cooperation	Increases opportunities for international and intercultural cooperation through online platforms	Limited to contacts within the same educational institution

Inclusiveness	Technology makes learning accessible to a wider range of people, including people with special needs	Often there are physical or geographical barriers that may limit access
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Source: compiled by the authors

Thus, the results of the comparison indicate that the use of digital technologies in music education not only improves the overall quality and accessibility of learning but also provides students with a deeper and more individualised approach to learning. The study confirmed that the integration of digital innovations into music education brings significant improvements in various aspects of the learning process, ranging from enriching the learning experience through enhanced interactive and multimedia capabilities that help students learn more deeply.

Digitalisation is also making education more accessible and inclusive, providing a level playing field for a wider range of learners, including those with disabilities. With the help of digital resources, students are motivated to learn independently, receiving tools for self-monitoring and self-assessment, which develops their self-management skills. In addition, digital platforms facilitate collaboration and intercultural exchange, creating new opportunities for cooperation between students from different cultures and countries. Teachers also benefit from the use of digital tools that provide powerful analytical and didactic tools, improving lesson planning, assessment and feedback, which generally improves the quality of learning. These changes not only improve existing practices but also create new opportunities for the development of music education, making it more adaptive, inclusive and relevant to modern educational and social challenges.

The introduction of digital technologies also opens new perspectives for the realisation of creative potential, allowing them to experiment with complex musical compositions and sound designs that would be unattainable with traditional instruments alone. The digital environment not only promotes technical mastery but also the development of important social skills, such as teamwork and intercultural communication, as students can easily come together for joint projects regardless of geographic location. In this environment, the development of critical thinking is prioritised, as the analysis and criticism of musical works using technological tools become more accessible and visual. Thus, digital innovations not only modernise music education but also pave the way for the formation of a new generation of musicians who will be able to function and create effectively in a rapidly changing and intensely digital world.

The digitalisation of music education also contributes to the democratisation of access to high-quality educational resources. Music students in different parts of the world now have access to courses, masterclasses and resources that were previously only available to a limited audience. This is especially important for talented students from less affluent regions or countries, who can now develop their abilities and fulfil their potential on a global scale. In addition, digital tools allow music educators to more effectively assess and customise their teaching approaches, engaging students through interactive and multimedia tools that make learning more engaging and motivating. As a result, digital technologies are not only transforming

teaching methods but also opening up new opportunities to transform pedagogical practice, stimulating innovation and creativity in music education.

Global availability of digital resources improved the inclusiveness of music education, including not only standard music disciplines but also the latest technological areas that were previously inaccessible. The use of virtual reality, artificial intelligence in music analysis, and various music emulation programmes allow students to dive deeper into modern music production and expand the traditional boundaries of music education. This approach not only enhances technical skills but also fosters adaptability and readiness for future innovations in the music industry. Digital innovations contribute to a more connected and creative music community, where cultural and creative exchange plays a key role in shaping the next generations of musicians.

Discussion

The results highlight the importance of integrating digital technologies into music education. Digital tools, such as virtual musical instruments and composition software, help to expand pedagogical methods and stimulate creativity. Such innovations not only increase the effectiveness of lessons but also provide greater interactivity and engagement in the learning process. The use of digital platforms and social media allows students from different cultures to communicate and collaborate on music projects. This fosters greater cultural interaction and understanding, which is important for the development of multicultural competence in modern music education environment. Digital innovations are essential for increasing student motivation and engagement. The interactivity and flexibility provided by these tools help to maintain a high level of interest in learning.

C. Christopher [26] addressed how virtual vocal ensembles are formed and performed in the YouTube environment, and how this platform affects the mediation and perception of musical performances. This study analysed how digital communication technologies and social media allow musicians to come together and perform music collectively, despite geographical distance. The author concluded that YouTube not only serves as a platform for the distribution of musical performances, but also actively influences the way performers interact with each other, customise their performances, and develop new forms of musical activity.

This may include considering aspects such as the changing role of the performer, the impact on music education, and new opportunities for creativity. This work overlaps with the current research in the sense that both studies examine the impact of digital technologies on music education. Both emphasise how technological advances are opening up new learning opportunities, performing and disseminating music, and transforming traditional approaches to music education and training. There is a similarity in the conclusions that digital instruments increase student engagement and promote

intercultural learning. They also point out the need to reform curricula to adequately respond to the digital age and develop the skills that are important for modern-day musicians.

E. Morgan-Ellis and K. Norton [27] addressed aspects of community singing, including its social, cultural, and psychological dimensions. The work covers topics related to the organisation of community singing, its impact on the community and individual well-being of participants, as well as the role of these events in cultural and social development. Community singing helps to strengthen communities, provides psychological support to participants, and plays an important role in the transmission of cultural values. The researchers note that singing in communities can be an important tool for social integration and cultural interaction between different groups.

Both studies emphasise the importance of music and music education not only as a means of aesthetic expression but also as an important factor in social cohesion and cultural exchange. While the researchers addressed a specific aspect of music practice – community singing – the research within the transdisciplinarity theme demonstrated how digital innovations can expand opportunities and methods of music education, including the promotion of public participation and community singing. Both works demonstrate the importance of music in the life of communities and confirm its role as a powerful cultural and social element. The researchers, similarly to this study, emphasise the inclusiveness and accessibility of transdisciplinary approaches in the context of music education.

J. Colson [28] explored how digital technologies such as music software, virtual simulators, and conducting apps are affecting traditional rehearsal techniques. These tools can help conductors plan, coordinate and analyse ensemble performances by providing virtual platforms for rehearsals and musical interaction. The researcher highlighted the benefits, such as improved accuracy in measuring tempo, dynamics and intonation, that are made possible by digital tools. In the context of the current study, the work of the researcher can be substantial.

Both studies emphasise the importance of introducing the latest technologies into music education. Whereas the study by the researcher points to specific methods and practices of conducting in the context of digital technologies, this article expands this perspective to include the impact of digital innovations on a wide range of music education and practice. The results of both studies highlight the importance of developing critical thinking and analytical skills. Both studies together highlight the potential of digital innovations to improve the quality of music education, accessibility and professional effectiveness of music teachers and students.

B. Silvey [29] investigated how the quality of an ensemble performance affects the assessment of the expressiveness of conducting. The author determined that a better and more coherent performance by the ensemble increases the perception of the expressiveness of a conductor. This shows that conducting does not exist alone, but interacts with other elements of musical performance. It is the latest digital technologies, such as virtual reality, interactive conducting software and

simulations, that can be understood to have a significant impact on the development of conducting skills. Digital tools can allow conductors to more effectively analyse and adjust the performance of ensemble in real-time, increasing the overall expressiveness and effectiveness of the performance.

Comparing this study with the present article, it is important to note that both works emphasise the importance of integrating new approaches and technologies into music education and practice. While the researcher focuses on the interaction between the conductor and the ensemble, the study on transdisciplinarity and innovation explores the wider range of opportunities that digital technologies offer for the development of all aspects of music education. Both studies emphasise the need for teachers and students to adapt to modern changes to remain relevant in the contemporary music education context.

S. Morrisson [30] mentions the importance of digital innovations in the musical culture of today in general and in conducting. The author analysed the influence of the expressiveness of the conductor on the evaluation of musical ensemble performances. This is a study of how different aspects of conducting influence the overall perception of the quality of ensemble performances, including dynamics, intonation, and emotional reproduction of music. With the development of technologies such as digital audio production and virtual rehearsal platforms, conductors can have more flexibility in influencing ensemble performance, using digital tools to adjust and enhance musical expression.

As in the works of the above researchers, the results of this study emphasise the importance of revising traditional approaches to conducting and encouraging the introduction of digital technologies into the profession. In the context of this article, the work of the researcher has common points due to the focus on the importance of expressiveness and technical excellence in musical performance. Both studies emphasise how technological tools can enhance music performance and learning. The transdisciplinary approach discussed in the article on digital innovation includes the integration of technology to enhance the educational experience and training of students. It enables them to develop new competencies and better understand the interaction between technology and musical expression. In this way, the study by the researcher adds to the broader context of digital innovation in music education, highlighting the importance of the interaction between traditional skills and modern technological capabilities.

Based on the analysis of research by various authors, it is possible to generalise that digital innovations have a significant impact on music education, increasing engagement and interactivity in the learning process. Digital platforms allow for virtual collaborations that promote global cultural exchange and multicultural learning. Interactive music programs and analysers not only motivate students but also allow them to apply theoretical knowledge in practice.

Conclusions

The study confirmed the significant impact of digital technologies on improving the effectiveness of the learning

process, in particular through increased student engagement and improved academic performance. Digital tools, such as interactive music apps and virtual simulations, have not only enhanced learning but also made education more accessible to students from different social and geographical backgrounds. Given these findings, it is recommended to focus on investing in technical infrastructure, teacher training, and the development of interactive learning content to maximise the benefits of digital technologies. Such an approach not only promotes student motivation but also develops their critical thinking and analytical skills. The findings demonstrate that the introduction of digital innovations in music education not only contributes to the interactivity of learning but also stimulates the all-round development of students, including their creativity and critical thinking. Digital tools play a key role in the formation of multicultural competence, making the educational process more inclusive and accessible.

Digital technologies, including virtual musical instruments and composition software, expand the pedagogical possibilities in music education. Not only do they increase the effectiveness of lessons, but they also create a more interactive and engaging learning environment. This helps increase creativity and their overall interest in learning. These innovations play an important role in shaping modern music education programmes that meet the rapidly changing demands of the professional world. The use of digital platforms and social media facilitates greater cultural interaction between students from different parts of the world. This not only allows for the exchange of musical ideas and projects on a global level but also a deeper understanding of

multicultural influences in music. This approach contributes to global music education by equipping students with the competencies necessary to work in an international music environment. Digital innovations in music education are important for increasing student motivation. The interactivity and flexibility of digital tools support a high level of engagement in learning, which contributes to active learning. In addition, the ability to analyse and critically evaluate musical works using these tools develops critical thinking, which is key to the training of qualified music professionals. Thus, the integration of digital innovations into music education is not only important for the technical improvement of teaching methods but also contributes to the formation of well-rounded, creative and professionally trained music specialists who can adapt to the rapidly changing conditions of the modern world.

Future research should address the impact of digital innovations on different music disciplines, assessing the long-term effects of digital innovations, and developing new learning models that would maximise the potential of digital technologies to train qualified professionals in the music industry. This will not only highlight the importance of digital innovations in music education but also provide a basis for their further development and integration into educational processes, ensuring adaptation to modern educational challenges and needs.

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Conflict of Interest

None.

References

- [1] Shelepnytska-Govorun N. Priorities in the formation of vocal culture of music professionals in Poland. *Acad Not Ser Ped Sci*. 2021;197:50-54.
- [2] Gorbenko S. Artistic education of students in the projection of a personally oriented approach. *Acad Not Ser Ped Sci*. 2021;195:14-18.
- [3] Garkusha LI, Ekonomova OS, Butenko TM. Selection of pedagogical repertoire as a basis for the development of vocational training for pianists. *Acad Not*. 2017;133:60-68.
- [4] Lucianinova O. Stem/STEM education in higher education: Theory and practice of the issue. In: Proceedings of the III All-Ukrainian Scientific and Practical Conference "Innovative Practices of Science Education". Kyiv: Institute of Gifted Children; 2023.
- [5] Likhitska LM. Integrative and axiological construct in the practical work of students within professional training them as music teachers. *Sci J Dragomanov Ukr St Univ Ser 14 Theory Meth Arts Ed*. 2022;28:22-29.
- [6] Randall EA. *Remixing the classroom: Toward an open philosophy of music education*. Bloomington: Indiana University Press; 2016.
- [7] Maharaj A, Gill A. Technology in music education. *Can J Learn Tech*. 2023;49(2):113-128.
- [8] Burwell K. *Studio-based instrumental learning*. London: Routledge; 2012.
- [9] Wierzbicki J. *Music in the age of anxiety: American music in the fifties*. Indianapolis: University of Illinois Press; 2016.
- [10] Russell J. Cultural diversity in music education: Directions and challenges for the 21st century. *Br J Mus Ed*. 2007;24(1):128-130.
- [11] Shmidt P, Colwell R. *Policy and the political life of music education*. Oxford: Oxford University Press; 2017.
- [12] Cutietta RA. *Raising musical kids: A guide for parents*. Oxford: Oxford University Press; 2003.
- [13] Young S. Early childhood music education in the digital age. *Res Stud Mus Ed*. 2016;38(1):9-21.
- [14] Martinez JS, Cerda J, Garcia W. New technologies for music education. In: *Second International Conference on E-Learning and E-Technologies in Education*. Valencia: Polytechnic University of Valencia; 2023:149-154.
- [15] Takeuchi MA, Sengupta P, Shanahan MC, Adams JD, Hachem M. Transdisciplinarity in STEM education: A critical review. *Stud Sci Ed*. 2019;56(2):213-253.

- [16] Johansen GG, Holdhus K, Larsson C, MacGlone U. Expanding the space for improvisation pedagogy in music: A transdisciplinary approach. London: Routledge; 2020.
- [17] Jankowska L. Reflections on the concept of interdisciplinary virtuosity in new music performance. Huddersfield: University of Huddersfield; 2021.
- [18] Gaunt H, Duffy C, Coric A, Delgado I, Messas L, Pryimenko O, Sceidahl H. Musicians as “Makers in Society”: A conceptual foundation for contemporary professional higher music education. *Front Psych*. 2021;12:713648:1-12.
- [19] Dahlstedt P. Evolution in creative sound design. In: Evolutionary Computer Music. London: Springer; 2007:79-99.
- [20] Sonnenschein D. Sound design: the expressive power of music, voice, and sound effects in cinema. New York: Amazon KDP; 2001.
- [21] Basanta A. Extending musical form outwards in space and time: Compositional strategies in sound art and audiovisual installations. *Org Sound*. 2015;20(2):171-181.
- [22] Miranda E. Computer sound design. New York: Routledge; 2002.
- [23] Browder L. Contemporary vocal pedagogy in the choral ensemble rehearsal: A guide for secondary educators. Columbia: University of South Carolina; 2023.
- [24] Garnett L. Choral conducting and the construction of meaning. London: Routledge; 2009.
- [25] Bell J, Matuszewski B. SMARTVOX – A web-based distributed media player as notation tool for choral practices. Paris: Sorbonne University; 2017.
- [26] Cristopher C. Virtual vocal ensembles and the mediation of performance on YouTube. Champaign: University of Illinois Urbana-Champaign; 2016.
- [27] Morgan-Ellis E, Norton K. The Oxford handbook of community singing. Oxford: Oxford University Press; 2024.
- [28] Colson JF. Conducting and rehearsing the instrumental music ensemble. Lanham: Scarecrow Press; 2012.
- [29] Silvey B. The effect of ensemble performance quality on the evaluation of conducting expressivity. *J Res Mus Ed*. 2011;59(2):162-177.
- [30] Morrisson J. The effect of conductor expressivity on ensemble performance evaluation. *J Res Mus Ed*. 2009;57(1):37-49.

Трансдисциплінарність та цифрова інновація у фаховій підготовці бакалаврів музичного мистецтва

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Анотація

Актуальність. Освітні програми у сфері музичного мистецтва необхідно адаптувати до швидкого розвитку цифрових технологій, які змінюють усі аспекти сучасного життя, включаючи освіту. Враховуючи значний вплив цифровізації на галузь, стає важливим переглянути традиційні методики навчання і впроваджувати сучасні інструменти та підходи, що забезпечать відповідність освітніх програм сучасним вимогам.

Мета. Метою дослідження було вивчення можливостей впровадження цифрових інновацій у курсах історії музики, теорії музики, вступу до спеціальності, а також у практичні аспекти навчання, як-от гра на фортепіано, звуковий дизайн, комп'ютерне аранжування, вокально-хорове аранжування, вокал, диригування, хор, та робота вокальних ансамблів.

Методологія. У цьому дослідженні оцінювався вплив цифрових інновацій на музичну освіту шляхом огляду наукової літератури, аналізу теорій освіти та когнітивного розвитку, а також вивчення практичних випадків з різних установ. Дослідження передбачало систематизацію інформації з різноманітних джерел для забезпечення збалансованої та об'єктивної оцінки.

Результати. Інтеграція цифрових інструментів у музичну освіту значно підвищила залученість студентів, ефективність навчання та якість освіти. Значні поліпшення спостерігалися в історії музики, теорії та практичних курсах, особливо за використання комп'ютерних програм для аранжування та цифрових аудіостудій.

Висновки. Цифрові технології показали значний потенціал для поліпшення музичної освіти шляхом сприяння більшої мотивації студентів та надання високоякісних, динамічних навчальних досвідів. Вирішення викликів та використання переваг цих інновацій може вирівняти музичні освітні програми з сучасними вимогами.

Ключові слова: цифрове навчання; технологічні інновації; освітня адаптація; новітні методики; мультидисциплінарність; педагогіка мистецтва; інтеграція технологій.