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Digital Ecosystems for Music Teacher Training: ICT, Social Media, and Online Learning Environments

Vasyl Frytsiuk
Faculty of Arts and Art-Educational Technologies
Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
Vinnytsia, Ukraine
ORCID: 0000-0002-4466-9019
vasyl.frytsiuk@vspu.edu.ua

Iurii Kshyvak
Department of Musicology, Instrumental Training and Choreography
Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
Vinnytsia, Ukraine
ORCID: 0009-0008-0396-432X

Iryna Baranovska
Department of Art Subjects of Preschool and Primary Education
Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
Vinnytsia, Ukraine
ORCID: 0000-0003-0033-4425
iryna.baranovska@vspu.edu.ua

Olena Teplova
Department of Musicology, Instrumental Training and Choreography
Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
Vinnytsia, Ukraine
ORCID: 0000-0001-8763-891X
olena.teplova@vspu.edu.ua

Anna Novosadova
Faculty of Arts and Art-Educational Technologies
Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
Vinnytsia, Ukraine
ORCID: 0000-0002-6215-5759

Anna Khilya
Sistemas Microinformáticos y Redes IES IFACH,
Department of Primary Education
Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
Calp, Spaine
ORCID: 0000-0002-1287-2901
annkhi@alu.edu.gva.es

***Abstract* — The increasing digitalisation of education has significantly impacted music teacher training, integrating information and communication technologies (ICT) and online platforms into pedagogical practice. This study explores the role of digital ecosystems, particularly social media platforms like YouTube and TikTok, in shaping new approaches to music education. These platforms function not only as entertainment hubs but also as powerful educational tools that foster interactive learning, expand access to high-quality musical instruction, and engage students in dynamic ways. We analyse both the theoretical and practical aspects of ICT integration in music teacher education, highlighting how digital tools transform teaching methodologies. Special attention is given to social media as an educational resource, evaluating its benefits—such as accessibility, engagement, and diverse content—while also addressing challenges like quality control and information overload. Through expert analysis and case studies, we assess the effectiveness of blended learning models that combine traditional and digital education. As a result, we propose a structured model for integrating social media and online tools into music teacher training, aiming to enhance interactive engagement and professional development. This study contributes to the ongoing discussion on the modernisation of music education, offering practical recommendations for embedding ICT and social media into curricula. By leveraging the potential of digital learning environments, future music teachers can not only adapt to contemporary pedagogical challenges but also develop innovative teaching methodologies tailored to the needs of digital-native students.**

Keywords – Digital learning tools; Digitalization; Higher education; ICT; Interactive content; Music applications; Music pedagogy; social media; Technological adaptation.

I. Introduction

The contemporary landscape of higher education - particularly in the field of music teacher training - has undergone transformative changes due to global and regional challenges, including:

- quarantine restrictions (2019–2021) and military aggression (2014–2022, with further escalation);
- new forms of social interaction via messengers (e.g., Viber, WhatsApp, Skype, Telegram) and social media platforms (e.g., Facebook, Instagram, TikTok, YouTube, Twitter);

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- the shift toward online and blended learning environments (e.g., Moodle, Google Classroom, Zoom, MeetToGo, Microsoft Teams).

These phenomena have significantly accelerated the implementation of blended and distance learning formats, compelling educators to reconsider traditional pedagogical models and embrace digital transformation. Educational changes in this context typically undergo multi-stage validation processes to ensure their effectiveness, alignment with educational standards, and relevance to national culture and societal needs.

Amid these developments, the integration of information and communication technologies (ICT), social media, and generative artificial intelligence (AI) into music education has become not only relevant but essential. The role of digital ecosystems—encompassing platforms such as YouTube, TikTok, BandLab, and AI-powered composition tools—has shifted from being supplementary to serving as a core component of instructional strategies and student engagement.

This paper explores the impact of digitalisation on music teacher education by examining how digital tools reshape pedagogical approaches, learning environments, and professional preparation. Special attention is devoted to the Ukrainian context, where the digital transformation of education is both urgent and socially significant.

Research Objective. The main goal of this study is to propose a structured model for integrating digital tools and AI technologies into music teacher training programs. The model seeks to support curriculum innovation, promote interactive and reflective learning, and enhance the digital competences of future music educators.

II. MATERIALS AND METHODS

This paper explores proposals for the use of digital technologies to enhance the music education ecosystem in the training of music teachers in higher education institutions.

The first step involves analysing the changes influencing the development of the music field, the music industry, and the transformation of pedagogical models in traditional, distance, and blended music education.

The next stage of our research focuses on presenting the technical solutions currently used by music teachers to implement demand-driven educational programmes. This includes considering trends and tendencies that encourage young people's interest in music. Specifically, we review digital platforms and tools such as YouTube, TikTok, Soundtrap, BandLab, MuseNet, AIVA, Amper Music, and OpenAI Jukebox in the context of training future music teachers. Additionally, we systematise modern approaches to integrating digital technologies into teaching music disciplines based on theoretical research.

The final step in selecting technological solutions and proposals in music pedagogy addresses the interaction between musicians and generative models of artificial intelligence. We identify both their advantages and limitations concerning the future of the music industry.

As a result, we have formulated a new model that can be considered when structuring the educational process in higher music education.

To achieve this, we employed the following research methods:

- Theoretical analysis and literature review to examine current scientific studies on the impact of digital technologies and AI on music pedagogy.
- Content analysis of digital platforms to determine their role in music education.
- Review and classification of generative AI programmes for creating musical compositions.
- Systematisation of collected data to develop recommendations for the use of generative AI and digital technologies in music teacher training.

To identify lesser-known or previously unaccounted-for music programmes, we conducted targeted searches in music forums and utilised generative AI tools. The collected data were categorised according to the identified areas of music training and assessed based on their expected effectiveness.

III. RESULTS AND DISCUSSION

A. Music pedagogy in higher education

Music pedagogy is perhaps one of the most sensitive pedagogical disciplines to change. Why is this the case? Because music and sound are an integral part of personal development, social development, daily communication and socialising.

Therefore, the music industry is very sensitive to changes that occur, for example, through research on the impact of music on our bodily reactions related to emotions, changing the level of dopamine, serotonin, cortisol, endorphin and oxytocin, as well as affecting cardiovascular parameters, blood pressure and heart rate [1].

Through emotions, music penetrates our lives and stimulates the autonomic nervous system, limbic and related biological systems, including endocrine and hormonal responses [1], which make it possible to create the necessary atmosphere of psychological influence or maintain attention in the educational process.

Why did we focus on the medical industry? Because the dynamics of changes in the medical industry through the use of body area network (BAN) devices has led to the fact that we have direct access to statistical data collected through special devices (fitness bracelets, smart watches). These devices are in direct contact with the individual's body and measure their performance and, depending on the built-in functions, can offer programmes to improve health, sleep, etc. This to some extent reduces, but does not eliminate, the need for specific medical tests to analyse the

functioning of the brain and body (EEG, FRR, GBA, ELAN, ERAN, MMN, MRI, VBM, MEG, etc.) [1]. Each of the proposed measurements collects gigabytes of data that help us understand how the brain works, how different stimuli affect different parts of the cerebral cortex and the body as a whole.

And, among this data, we can distinguish the data of musical influence on our brain, body, and mental health. This, in turn, helps to develop new concepts in neuropsychological science by regulating human activity, changing patterns of behaviour and reactions to social stimuli.

For music pedagogy, it is important not only to have data on the effect of music on the body, but also to be able to choose the right piece of music to activate the necessary functions of the body, mental operations, concentration, or to calm the nervous system, reduce stress, both physiologically and psychologically. That is why music pedagogy today is no longer a subject of purely theory and music notation, particularly in online education. It is a subject that combines theoretical knowledge, exercises in performing musical works, creating musical compositions and, most importantly, studying and understanding their impact on the human body through personal practical experience. And, as we noted earlier, music pedagogy is intertwined with technology and changes under its influence.

To this end, during our research, we have studied the educational programmes offered at different levels of higher education in Ukraine, in particular those implemented at Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University. After all, to outline organisational issues and areas of use of digital solutions for music pedagogy, we needed to balance and identify areas of music teacher training. Thus, we analysed the bachelor's and master's degree programmes offered by three university departments. These are the Department of Artistic Disciplines of Preschool and Primary Education, the Department of Musicology, Instrumental Training and Choreography, and the Department of Vocal and Choral Training, Theory and Methods of Music Education.

As a result of the analysis, we obtained ten areas, which are presented in Fig. 1, and identified disciplines through the basic elements of music pedagogy, which allowed us to investigate which digital solutions would best allow us to realise the main goal of teaching in the implementation of a particular area.

Theoretical and historical foundations of music	(harmony, solfege, analysis of works, history of Ukrainian and foreign music)	Perfect Ear, Ultimate-Guitar, Tenuto, MusicTheory.net, Theory Lessons (musictheory.net), Complete Ear Trainer, EarMaster, Meludia, Hookpad, Odesi, CAMA (Computer Added Musical Analysis), MuseLab Conductor.
Music performance and interpretation	(instrumental training, solo singing, vocal ensemble, main musical instrument)	Tuner, Metronom, Simply Piano, Yousician, Virtual Drumming, Guitar Tuna, Cleartune, Cadenza, MyPianist
Choral art and conducting	(choral class, choral conducting, methods of working with a choir, choral arrangement)	MuseScore, Sibelius, Finale, Noteflight, Flat.io, Rhythm Sight Reading Trainer, Interact Music Project, Doodle Bach
Orchestral art and ensemble playing	(orchestra class, chamber ensemble, instrumentation, orchestral conducting)	BandLab, Soundtrap, SoundJack, Zoom + Jamulus, Soundation Studio, Transcribe
Methods of music education and pedagogy	(methods of music education, theory and methods of music education, methods of teaching in higher education)	Soundtrap for Education, Google Classroom, Moodle, PlayScore 2, SmartMusic, ClassDojo, Rhythm Trainer, Modacity
Musical and pedagogical practice and stage activities	(music practice, stage performance, concertmaster class, voice training)	Lick of the Day, Voicify AI, Music AI: Cover Song & Video AI, LimeWire AI Music Studio, Ableton Live, FL Studio, GarageBand, MuseNet, Novaxe Project
Innovations and digital technologies in music	(computer music editors, music and computer technologies, the latest Ukrainian music)	Ardour, Audacity, Audiotoolset, Bear Audio Tool, LogicPro, Song Maker (Chrome ML), Boomy, Soundraw, AIVA, Mubert, Ecrett Music, Beatoven.ai, Loudly, Caset - AI music generator, Magenta Studio, Amper Music, Endlesss, Suno AI, Folk-RNN, Web Audio API, Ethereum
Music therapy and health technologies	(music therapy, art technologies, psychological aspects of musical activity)	Incredibox, Kahoot, Learning Apps, Madlipz, Menti, Mentimeter
Artistic and pedagogical analysis of music	(analysis of programme material, music source studies, interpretation of choral works)	ConservatorioVirtual.com, Note Recogniser, SangeetKosh, VEMUS
Music literacy and general competences of the teacher	(teacher's music literacy, basics of artistic activity, aural training workshop)	Easy Music Composer Free, Adagio, Prime Phonic, Soundcloud, Spotify, YouTube

Fig. 1. Digital solutions for music education.

B. Digital solutions for music education

As we continue our research into the impact of digitalisation of music education, we need to understand that before the quarantine restrictions (2019), the changes were more about performing arts and the music industry. These spheres of musical influence had to respond to consumer demands and be publicly accessible, responding to market needs in a timely manner, creating content for social media, soundtracks and ringtones, adapting music to end-user preferences, digitising and improving old audio recordings, etc.

At the same time, music pedagogy (particular in Ukraine) continued its measured existence. Using

traditional approaches to teaching and learning disciplines from music theory, solfege to conducting and methods of teaching the same subjects. Occasionally, synthesisers and multimedia devices are used to demonstrate materials, including audio recordings of music or backing tracks, if necessary. But for the most part, the use of digital solutions in music education was limited to this list within the framework of educational programmes.

Another aspect of the transformation was the need to transfer not only the theoretical part of the disciplines, but also the practice into the digital environment. On the one hand, the use of distance technologies saves time, provides flexibility and mobility of the educational process, which focuses primarily on the student, but at the same time 'loses' the practice of 'live' music making or music creation [2]. Here we can agree with our colleagues, because there is indeed a limitation in emotional involvement, following group dynamics and directing the process of creating a piece of music or actually making music. Also, there is the problem of self-organisation, which affects the choice of methods and forms of control as means [2], because not all students have developed time management skills necessary to achieve better results of independent activity before studying at a higher education institution.

However, in our opinion, the limitations mentioned earlier can be overcome through the use of music ecosystems, communities, social media and networks. After all, one of the main advantages of information technology in music education is that it is accessible to everyone in any environment [3]. This is incredibly important for the Ukrainian audience in the context of intensifying military aggression since 2022. And, even more importantly, it is a focus on the child, his or her interests and preferences, and the impact on their development through the inclusion of social media (YouTube), in the world of musical art [3]. For our part, we propose to use music trends and trends that spread through other social networks, TikTok, Instagram, video games, and streams.

Therefore, the development of music pedagogy courses needs to be periodically amended. Usually at the beginning of the year to ensure that they truly meet the updated needs of music education and the industry. This approach will allow us to borrow advanced teaching methods [4] from other business-oriented practices and disciplines. That would be used to retrain existing employees by providing micro-degree programmes, with the student choosing courses in line with the current strategic directions and plans of employers [4]. In our case, the music industry or the gaming industry. And, as our colleagues point out, the advantage of this method will be that it will increase the motivation of students, partner companies, and teachers through joint contribution and fulfilment of the requirements for a quality music product.

In this aspect, if we focus on the music industry, we can see a few computer technologies and software for music creation: arrangement, audio and video editors, sound libraries, virtual synthesisers, audio processing programs, video recording programs, audio content analysis programs, etc. More examples in relation to the identified areas can be seen in Fig. 1, which presents our search for digital solutions to achieve the goals and objectives of educational programmes, browsing forums, searching for relevant queries, refining information using a neural network, as well as through the analysis of solutions proposed for music pedagogy by scholars and practitioners, in particular in scientific papers, to determine the practical aspects of interaction during distance education of music teachers [1-4, 6-13]. Analysing the international educational space, we have found a few proposals that we believe should be taken into account when digitalising the music educational ecosystem [1-4, 6, 9-13].

In addition, based on the analysis, we plan to add the following structured materials and topics that can be easily applied when planning practice-oriented activities within music teacher education programmes. In particular: analysis, generation and synthesis of sound; sound effect as an artistic medium; interpretation, improvisation and stage creativity; creating backing tracks; creating, recording and basic editing of a musical piece; music in audiovisual narrative; music and video games, etc [12].

Knowledge of the proposed digital solutions, in our opinion, will contribute to the development of high-quality musical creativity, promote basic knowledge of music theory for creating arrangements and producing music, support motivation to learn and facilitate the completion of higher education [14]. In turn, high-quality training and awareness of music teachers in the world of modern digital music will allow them to easily work in their speciality. That is why, in some cases, the training of future music pedagogues should be not only about higher education, but also about general secondary education institutions. This is where the trained specialists will teach in the future.

Secondary education in music also requires mastery of technological skills related to music, as nowadays there are sound sequencer editors and applications for recording and mixing sound, as well as technological resources that simulate the interpretation of instruments and instrumental groups, which was possible only in recording studios and can now be used in music education [6]. Such skills will make it possible to capture the attention of adolescents in an interesting and easy way and will help to attract children to music.

In addition, the introduction of technological solutions in the music classroom involves not only new ways of approaching composition, interpretation and response to the musical phenomenon, but also contributes to the acquisition of digital competence and the development of interconnected educational communities, which play a fundamental role in structuring educational ecosystems and in achieving certain sustainable development goals [12]. Proposals for the introduction of an online platform in the music classroom as an educational resource focused on creating, storing, editing and discussing content, which helps to align the interests of students and the didactic

resources used, providing contextualised information and to some extent simplifying the work of the teacher [10]. The use of such platforms allows solving the whole range of educational tasks through the integration of tools for the development of hearing at the melodic, rhythmic and harmonic levels, as well as access to semantically related information resources of the teacher [10].

Particular attention should be paid to the student's personality, which can influence the curriculum and technological solutions chosen by the teacher through their choice, experience and ambitions. After all, students' professional orientation and learning goals should be considered when organising the educational process, which will allow to meet the demand for music education in a qualitative and effective way, which should be more inclusive and represent the diversity of students and musical tastes [11].

Thus, technology can enhance the impact of music and the quality of music education, in online or blended learning, in some cases complementing the practical parts of the course with the latest technologies.

C. Generative AI-based solutions for music education in higher education

Given that the Internet has become an alternative artistic solution for the music industry. Which has turned to streaming music services [9], repositories specialising in didactic proposals, social interaction [10] to interact directly with a wide audience. We have a significant use of the potential of social networks, elements of knowledge sharing to develop joint didactic proposals with students [10].

And, as our fellow researchers point out, the gradual introduction of artificial intelligence into the educational process has become a major revolution in music teaching, as artificial intelligence pushes music education towards more efficient and intelligent interaction, where resources are personalised, commitment to the discipline is strengthened, and new opportunities for developing artistic and creative skills are offered [5]. The scenarios of adaptive learning platforms based on artificial intelligence create an individual educational trajectory, allowing the student to independently assess their level of musical competence and personalise the pace of learning, adapting learning tasks and goals to their needs and abilities [5].

For example, the most popular artificial intelligence systems today are chatbot, microsoft copilot, and Gemini [13]. Each of them is available in the public domain or by subscription. Their potential is proposed to be used to transform various sectors, including higher education, conversational interaction, and visualisation, as they are already changing education through their representative innovative technologies and capabilities [13]. But these models are not the ones that can offer solutions for music education.

Although today there are already developments that generate music based on written instructions [5], creating a serious threat to the future of not only the music industry, but also music education, which leads to the loss of basic knowledge and skills. Although, at the same time, there is another side to the use and application of artificial intelligence, which includes

- Creating a musical composition by generating ideas and motifs or entire works with the user's personal input, but with an understanding of different compositional techniques, methodologies and styles. Allowing the imitation of different musical styles by offering different scenarios to encourage creative experimentation, hybridisation of genres and styles, leading to the development and enrichment of compositional skills;
- offering simulated accompaniment for solo practice, which adapts to the pace and style of the student [5].

And so, based on the available and open technologies, we understand that the exponential level of development of neural networks and the use of artificial intelligence has achieved an incredible result. However, we have high risks associated with the chaotic and uncontrolled use of these technologies by students. We can also observe the incredible solutions that a neural network allows us to implement. These changes have also affected the music industry and, in particular, music pedagogy. So we can recall the programmes that our colleagues and we often include in the educational process, including:

- Boomy. A music platform that allows users to create original compositions using AI and distribute them on streaming platforms.
- Soundraw. A powerful service that allows users to create an unlimited number of songs for various needs, such as background music for videos, podcasts, games, etc.
- Suno AI. An innovative platform that changes approaches to music creation with the help of AI, allowing to create compositions based on text prompts.
- LimeWire AI Music Studio. A service that allows users to enter a description of a song they want to hear, and the application generates a corresponding composition.
- Music AI: Cover Song & Video AI. An application that uses advanced AI technology to create unique musical compositions easily, even without any experience in music composition.

These apps can be useful for integrating AI into the music creation and learning process. However, the music space is not limited to these apps today, as for the sake of convenience and at the request of the audience, programs and applications are being developed and distributed that are easily installed on mobile devices, have extensive functionality, integrate into social networks and media, and launch and distribute user-generated content in seconds.

Among such applications, we can consider:

- Soundraw – generates music in different genres, allows you to adjust the tempo and mood.
- AIVA is an AI composer that creates classical and electronic music.
- Mubert – createes unique tracks for videos, ringtones, and streams.
- Ecrett Music is a tool for generating background music for videos, games, and TikTok.

It is easier to use and can be mastered even by a child:

- Song Maker (Chrome Music Lab) is an intuitive music construction tool for children.
- Melobytes – generates music from words or images.
- Beatoven.ai allows you to create music without knowledge of production.

There are also specific programmes and applications used by users of TikTok and other social networks and media. These apps are convenient for creating ringtones and quickly generating tracks. They include:

- Loudly – generates tracks for TikTok and YouTube, has ready-made templates.
- Voicify AI - creates music mixes and AI covers of popular songs.
- Caset – AI music generator - helps to quickly create short tracks.
- MuseNet (OpenAI) - creates music in different styles and genres, can combine instruments.
- Magenta Studio (Google AI) - works on the basis of neural networks to generate melodies, expand rhythms and harmonies.
- Amper Music - allows you to quickly create music based on the choice of genre, tempo, and mood.
- Endlesss is an AI tool for music jams and soundtrack experiments.

Other products include the previously mentioned Boomy platform that allows creating music in one click and is popular among TikTok creators.

Of course, these are not all the products that are available on the music industry market today. But these are the most well-known and accessible to a wide audience.

D. A model for optimising the use of generative AI and digital technologies in music teacher education

As we can see, significant changes have taken place in the Ukrainian realities of music education, which required a revision of the entire spectrum of both teaching methodology and student practice in teaching music to students in general secondary education.

But what were the changes and how can digital tools and AI be strategically embedded into this evolving pedagogical context?

To address this question, we propose a model for optimising the use of generative AI and digital technologies in music teacher education. The model is based on core pedagogical needs and practical observations in the field, and it includes the following key components:

- Annual review of curricula and regular updates of digital content in accordance with current trends in the music industry, to ensure life relevance and practical orientation;
- Support for theoretical and historical courses (e.g., harmony, solfeggio, composition analysis, Ukrainian and global music history, choral conducting) through accessible software and digital tools. These can enhance engagement, such as enabling students to conduct video performances instead of imagined orchestras;
- Incorporation of individual music preferences into practical training, focusing on the emotional and psychological impact of music choices. As studies suggest, the benefits of music on well-being are maximised when individuals are free to select music they enjoy [Hallam];
- A dedicated course on digital literacy for musicians, aimed at developing skills for identifying AI-generated content, evaluating ethical risks, and understanding legal implications such as copyright and plagiarism.

These components reflect broader shifts in the educational landscape. Specifically, they are shaped by:

- New collaborative technologies (e.g., videoconferencing, open-source tools, virtual classrooms);
- Societal transformation from industrial to digital economies, which has redefined foundational skills and knowledge;
- Emerging digital cultures that support transparency, openness, and multidimensional collaboration.

Based on these considerations, we propose the Digital Integration Framework for Music Teacher Education, which consolidates the identified tools and strategies into a structured system (see Figure 2).

The proposed Digital Integration Framework combines three main groups of tools: ICT infrastructure, social media platforms and AI applications. These clusters are brought together through focused pedagogical design and alignment with specific courses. The framework emphasises the development of digital competences, the critical use of generative tools, and adaptive strategies that respond to learners' needs and contextual challenges. It serves as a guide for curriculum designers and pedagogical faculty to integrate the digital environment into music pedagogy.

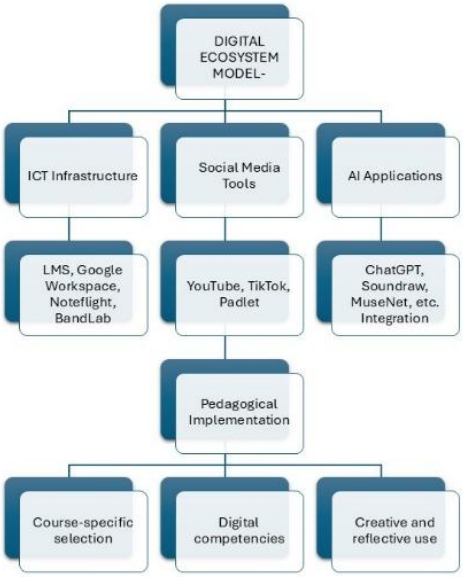

Fig. 2. Digital Integration Framework for Music Teacher Education.

IV. Conclusions

Having analysed the impact of the digital ecosystem – including social networks, online services, and generative AI tools – on the methodology of teaching music disciplines, we have identified a wide range of digital solutions that support the realisation of educational goals in music teacher training and in broader music industry contexts. Furthermore, this study has outlined key components that should be incorporated into revised educational programmes to optimise the integration of generative AI and digital technologies in music pedagogy.

We offer the following generalisations:

- Digital tools such as BandLab, Noteflight, Google Workspace, and AI-powered platforms like ChatGPT are becoming increasingly vital in music education.
- Social media platforms can significantly enhance creative expression, peer feedback, and informal learning.
- The integration of generative AI opens new horizons for automated content creation, personalised learning pathways, and adaptive assessment.
- Ukrainian music education, shaped by adversity, demonstrates notable resilience and contextual innovation, serving as a compelling example of adaptability in crisis conditions.

Based on these findings, we recommend the following practical steps for implementation:

- Tool alignment: Select and align digital tools with specific course types (e.g., composition, music theory, performance analysis).
- Risk awareness: Address ethical considerations and foster critical engagement with AI-generated content and digital surveillance.
- Competence development: Embed digital literacy, media fluency, and AI-related self-regulation into teacher training curricula.
- Framework implementation: Adopt structured models for integrating digital ecosystems into educational modules.
- Ongoing evaluation: Establish continuous monitoring of the pedagogical effectiveness and potential limitations of digital instruments.

Finally, the Ukrainian case provides unique insights into how digital transformation can be applied within complex socio-political contexts. We believe this contribution will support further research, policy development, and innovation in the field of music education.

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