https://doi.org/10.53656/str2024-5s-26-pos

Education in the Information Society
Образованието в информационното общество

POSSIBILITIES FOR THE APPLICATION OF ARTIFICIAL INTELLIGENCE SYSTEMS IN THE EDUCATION OF STUDENTS OF PEDAGOGICAL SPECIALTIES

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Abstract. This paper is based on a study of the possibilities of using artificial intelligence systems in music education within the degree courses of "Preschool and primary education" and "Primary education and foreign languages." It is known that in the process of music education without special musical training, future educators as well as teachers face certain challenges. The variety of artificial intelligence systems creates conditions for music education that are more accessible and applicable in different areas of music practice.

The focus of this research is music learning through interaction with music generation systems, in which the learner assumes a new role: from perceiving and performing music, he/she becomes a co-author and co-creator of a musical piece with all the peculiarities and regularities of musical language. The idea of a musical product thus acquires a new meaning and the students develop not only their musical creativity but also their digital competencies.

Keywords: music education; artificial intelligence; music generation systems; music education process; music disciplines; pedagogy

1. Introduction

Artificial Intelligence (AI) is increasingly entering all areas of modern technology. In music, artificial intelligence has a variety of applications. It can analyse musical structures, process music, manage, control and balance music and different sound sources, and also compose music. AI is transforming many areas of human activity, including education. In the context of music education, AI systems offer innovative approaches for learning theoretical knowledge, developing practical skills and stimulating students' creativity. This paper explores the possibilities of applying AI in the music education of future educators. It is the responsibility of the university as a whole to provide support to students and faculty in the generation of innovative and creative solutions. This can be

achieved by implementing educational models that stimulate student and faculty creativity and innovation (Beloeva&Antonova 2023).

2. AI systems implementable in music education of students of pedagogical specialties

2.1. Examples of AI programmes that provide learners with theoretical and practical knowledge and competences

There are a number of AI-based software applications that support the learning of music theory and develop students' practical skills.

As posited by (Hu 2021; Luo 2024), AI-enabled systems can enhance musical performance and facilitate individualised learning strategies. The academic literature frequently emphasises the role of AI in improving students' information retrieval skills and learning efficiency. The utilisation of AI in music education is particularly beneficial for the creation of interactive and effective learning environments (Holland 2000; Yu 2023). Other authors, such as (Yu 2020), have also highlighted the potential of AI in preschool music education, particularly in the creation of interactive learning systems.

The selected examples presented in this report are representative of those that facilitate the acquisition of music knowledge and practical skills at different levels. The specific programmes discussed are illustrative of those that:

a) support the learning of a musical instrument;

b) provide theoretical knowledge about music;

c) enable music making with specific competences and experience in conducting as well as in collaborative music making in general:

Meludia: This app offers interactive lessons in solfege, harmony and musical analysis;

Semi-Conductor: The app provides the opportunity to virtually conduct an orchestra, giving learners feedback on their gestures and interpretation;

Yousician: An interactive music learning platform that offers instrument lessons and vocal training in a variety of styles;

Frettable: The tool expands performers' musical competencies and can generate sheet music and tablature. The proposed AI systems are suitable for the preparation of students of pedagogical specialties without special musical education. The selected programmes provide examples of the ways in which they can be integrated into music education.

2.2. A selection of AI programs that can be implemented in music education with pre-schoolers and students is provided below.

Artificial intelligence (AI) can also be used effectively in music education for children and students. There are numerous AI applications that contain exercises and games designed to develop musical hearing in all categories, including pitch, meter, timbre, and so forth. The self-learning aspects and active learning opportunities are particularly suitable for this context.

The Google Experiments platform offers a range of music apps and games that employ engaging interactive elements and have the potential to stimulate musical development in younger children. Such examples include: ***The Perfect Ear*** app is an example of an app that exercises to develop musical hearing, presented through multiple solfege exercises with interactive elements. The ***Ocean platform*** offers the possibility of collaborative music making, providing a dynamic space for creating music on the internet. A comparable opportunity for engaging learning through experimentation is the ***Chrome Music Lab***, a music lab for sound and music projects. ***Google Music Experiments*** is a set of interactive music experiments designed to make music more accessible and enjoyable. The accelerated evolution of interactive technologies has led to the emergence of novel standards. The digital generation, in particular, has come to expect interactivity in learning (Atanasov & Ivanova 2022).

It can be observed that there is a degree of analogous functionality between the AI programs that have been classified for the two distinct categories of learners. The idea of such a distinction is not only related to the obvious differences and approaches to music literacy, but is also dictated by the musical training needs of students who are future educators. The lack of specialised musical training and the need for concentrated acquisition of basic and specific competencies represents a particular challenge. In light of the impending emergence of pedagogical specialists in the field of music education for children across a wide age range, it is imperative to guarantee the provision of scientifically substantiated training and conceptually coherent practical guidance. To educate children in a conscious and positive attitude towards art, it is essential to establish clear criteria of artistic value, musical content and aesthetic considerations

3. AI systems for music generation

Several systems that generate music in different styles and genres are currently gaining popularity (AIVA, Suno, Beatoven, Amper etc.) These systems analyse existing musical works and create new compositions using algorithms.

Artificial intelligence (AI) can be employed to generate a vast array of resources, encompassing any structure, composition, or style, with minimal human intervention (Stefanov 2023). It is possible to create compositions that enrich the musical environment with innovative motifs, which suggests that there is a promising avenue for creativity using AI technology. The convergence of traditional compositional practices and the advent of AI powered music creation has the potential to deepen interdisciplinary collaboration, thereby accelerating the evolution of music composition technology (Zhu et al. 2023).

4. Investigating the feasibility of AI systems for student music generation

Artificial intelligence has the potential to enhance and optimise the educational process as a whole. However, teachers themselves must also undergo a specific

form of training in order to integrate the new possibilities into their pedagogical practice. The implementation of web based training courses for teachers is becoming increasingly sustainable. Additionally, educators developing such courses face challenges in creating digital content with high educational value and effectiveness (Harakchiyska 2010).

This paper presents a research project conducted with students from Angel Kanchev University in Ruse. The project focused on the application of AI systems in music education. The research was conducted with students from the Bachelor's and Master's programmes in Preschool and Primary School Pedagogy. Additionally, students from the Bachelor's and Master's programmes in Primary School Pedagogy and Foreign Language at Ruse University "Angel Kanchev" participated. In the second semester of their studies, students enrolled in the Bachelor's and Master's programmes in Preschool and Primary School Pedagogy study the music disciplines of Elementary Music Theory and Music Theory and Methodology in kindergarten. The present study was conducted in the summer semester of the academic year 2023/2024. The lectures and exercises in the disciplines were conducted by the author of the article, who is also the holder of the music disciplines studied by the students in the aforementioned majors.

The purpose of this study is to determine the effectiveness and feasibility of AI systems for music education and preparation of student educators.

The next objective of the study is to familiarise students with AI systems that support, complement and optimise traditional music education. In addition, the study aims to develop critical thinking regarding the functionality and place as well as the pedagogical value of AI systems. Furthermore, the study seeks to build the ability to appreciate the artistic value in AI-generated products. Finally, the study will look for attractive and effective aspects in musical experiments – learning by doing.

The following is a description of the stages of the experiment:

The initial stage of the project involves the introduction and implementation of the music learning programmes described in sections 1.1 and 1.2. The music experiments were conducted with all students on an interactive board during the practical exercises of the aforementioned disciplines: Elementary Music Theory, Theory and Methodology of Kindergarten Music (Bachelors), and Methodology of Kindergarten Music (Masters).

Stage 2. Introduce students to the systems for composing music described in the article, providing illustrative examples. The AI systems and the music examples are presented on an interactive presentation system in an in-person tutorial.

Stage 3. The implementation of video examples of the use of generative AI for music composition by the teacher, which demonstrate in detail the possibilities of working with two of the programs. The selection of the specific music programs is

tailored to: 1. The level of difficulty and technological background of the students must be taken into account.

Stage 4. Students are introduced to the programmes independently and have the opportunity to experiment and then ask questions and share impressions.

Stage 5. The finalisation of the musical composition and its dissemination in a dedicated virtual environment.

Stage 6. Conducting a survey of students' views on the effectiveness, benefits, level of engagement and attractiveness, technical challenges and attitudes towards the generated musical product.

Stage 7. Summarizing the results and formulating conclusions about the prospectivity and applicability of AI systems for music education and professional training of students.

5. Survey Results

A questionnaire survey was conducted with 50 students from the BSc and MSc programmes at Ruse University, "Angel Kanchev". All participants submitted their written work and completed the survey. The survey is conducted online and comprises closed questions pertaining to the students' opinions on the following matters:

1.The benefits of the application of AI systems for their music education;

2. The availability of higher efficiency in learning music theory and practice;

3. A deeper understanding of the importance of the whole process of making music – from the creation of the work, to its performance, recording and distribution;

4. Comparing two different AI systems with similar functionality;

5. Critical thinking and analysis of the achieved artistic result;

6. Self-evaluation in terms of pedagogical impact on own musical development;

7. Evaluating prospectivity and applicability in future professional practice.

Fig. 1 presents the results of the survey in relation to the respondents' understanding and awareness of music and art activities. The results of the survey indicated that students perceived the systems as offering the opportunity to experiment with different musical styles (54%). Some students emphasised the importance of learning new things during the experiments. In terms of the potential for AI systems to create a digital resource that is applicable in practice, the generally positive response of students is noteworthy. Seventy percent of respondents indicated that the generation of resources would enhance their pedagogical practice. A significant proportion of respondents (64%) indicated that working with AI music generation systems has enhanced their knowledge of music. A greater proportion (66%) of respondents indicated that the integration of AI systems into traditional teaching methodologies enhanced the overall learning experience.

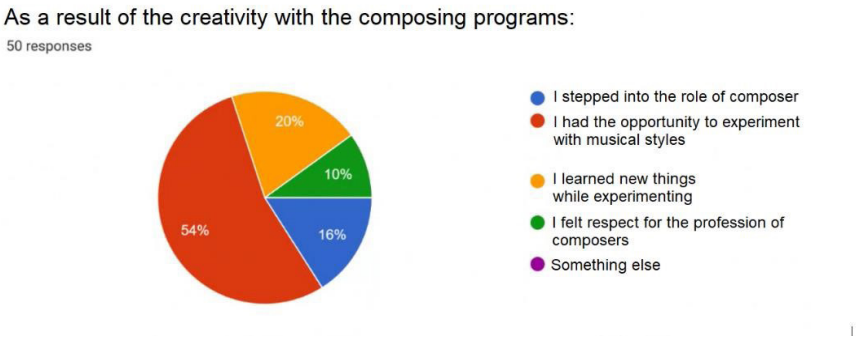

Figure 1. Students' awareness of music and art activities

Fig. 2 presents the results of the survey in relation to the following aspects:

1. The expansion of music knowledge as a result of the application of AI music generation systems;
2. The benefit in future teaching activities;
3. The creation of an independent, original resource applicable to teaching;
4. The integration of learning with AI systems into traditional music education;
5. Assessing professional preparation and qualifications in relation to future teaching activity in general.

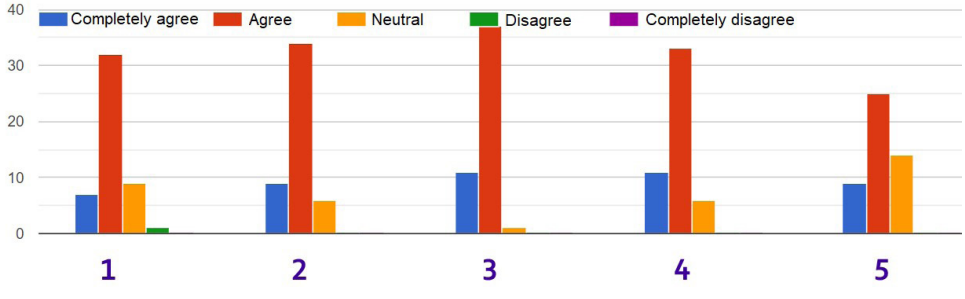

Figure 2. Respondents' reactions about the expansion of music knowledge as a result of the application of AI

3. Conclusion

The following conclusions are drawn from the conducted study:

Artificial intelligence systems facilitate learning through direct experience.

Through experimentation with musical examples with AI systems, knowledge about music, musical genres and elements of musical expression can be acquired.

Incorporating work with AI music composition systems can complement traditional learning.

AI composing systems are a modern and accessible way to create resources applicable to other knowledge areas or contexts.

By gaining experience with AI systems for composing music, future teachers feel more prepared to teach music and do better in their future profession as a whole.

Acknowledgments & Funding

This study is financed by the European Union - NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project № BG-RRP-2.013-0001-C01.

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