POTENTIAL IMPACT OF STEAM EDUCATION ON THE OUTCOMES OF MUSIC TEACHER TRAINING

Di Liu
Postgraduate Student, Sumy State Pedagogical University
named after A. S. Makarenko, Ukraine
e-mail: diliu@fizmatsspu.sumy.ua, orcid.org/0009-0007-2323-3826

Summary

The article aims to analyze the potential impact of STEAM education on the outcomes of music teacher training. Based on analysis results STEAM education holds significant potential for transforming the outcomes of music teacher training. STEAM encourages a more holistic approach to teaching and learning by integrating the arts with science and technology. Music teachers benefit from this approach as it fosters creativity, critical thinking, and problem-solving skills, all essential in today's rapidly evolving educational landscape. We showed that STEAM equips future music teachers with the technological proficiency necessary to utilize modern tools and digital platforms, making music education more engaging and relevant to students. The interdisciplinary nature of STEAM encourages collaboration and innovation, enabling teachers to connect music with broader concepts in STEM fields. Practical value of analyzing the potential impact of STEAM education on the outcomes of music teacher training lies in understanding new opportunities for improving their professional competencies: it allows for adapting teaching methods to modern technological trends, which is especially important given the rapid development of digital tools and software. Music teachers can introduce innovative forms of instruction, including interactive platforms for creating, recording, and editing music, thereby increasing student motivation; STEAM fosters the ability to integrate interdisciplinary knowledge, promoting flexible thinking in future teachers. Thus, analyzing the impact of STEAM education enables the development of more effective and relevant training programs for music teachers, enhancing the quality of their teaching and their readiness to meet the challenges of modern education.

Key words: STEAM, music teacher, education, educational technology, music teacher training.

DOI https://doi.org/10.23856/6610

1. Introduction

In the modern educational space, monitoring the development of the latest pedagogical approaches and their impact on the training of specialists is a key task of the scientific community. Currently, scientists have different approaches to solving the current problems of professional training of music teachers. As the analysis of scientific sources shows, its improvement takes place in the following areas: introduction of a comprehensive, integrated, interactive approach to the process of professional training; modernization of the content part of vocational training; taking into account the specifics of music lessons and, accordingly, the peculiarities of the practical activity of a music teacher; study of certain aspects of vocational training.

With the development of IT and the consequences of humanization and humanitarianization of education, one of these promising areas is the direction of STEM *(Semenikhina et*

al., 2022) and STEAM, which is recognized as effective and innovative for developing the educational industry. STEAM (Science, Technology, Engineering, Arts, Mathematics) becomes a methodological approach in education and a guiding principle for forming deep and comprehensive knowledge. Because of this, the question of STEAM education's impact on training a music teacher is especially relevant and potentially effective. At the same time, music as an art has its unique properties and interacts with other branches of knowledge. In STEAM education, music becomes an object of study and a means of achieving a deeper understanding and application of concepts from various fields.

Research on implementing elements of STEAM education is underway in the USA, Canada, Australia, South Korea, Thailand, etc., which is confirmed by several scientific and pedagogical studies related to STEAM from H. Baba, W. Loh, M. Albahar, Y. Jia, B. Zhou, X. Zeng, D. Jantassova, D. Churchill, Y. Hu, Q. Jiang, M. Meletiou-Mavrotheris, E. Paparistodemou and others.

Ability to attach the "art" element in the abbreviation STEAM, as evidenced by the analysis of the experience of implementing STEAM education, are quite colorful, and they are spreading along with the advancement of students at the main levels of education. The experience of English researchers is interesting, noting that in kindergartens and junior grades, such a branch of physics as acoustics can serve as an element that combines STEM and STEAM. According to the researchers, acoustics is ideal for STEAM because it is closely related to one of the branches of art – music. This idea is described in more detail as the Acoustics Research Group's experience of collaboration (learning) at Brigham Young University (BYU) with primary school teachers who have successfully combined art and reading activities over time *(Goates et al., 2017)*. In Chicago *(2011)*, the "Scientists for Tomorrow – SfT" initiative was supported, which focused on the use of STEAM-based curricula and is a partnership for higher education institutions, out-of-school organizations, and non-formal education providers *(Caplan, 2017)*.

A report by the U.S. Board of Education defines STEAM education as an approach to learning that teaches students to demonstrate innovative and critical thinking and creative problem-solving at the intersection of disciplines. STEAM education develops students ' creative problem-solving skills by using the arts as an instructional approach for experiential and inquiry-based learning. It provides them with numerous opportunities to engage in the creative process and achieve goals in all subject areas *(Dell'Erba, 2019)*.

J. S. Miller, Es Reggiivale, realizing that positive change can only be achieved through the integration of the arts with science, technology, engineering, and mathematics, notes that the implementation of the STEAM approach can enrich and bring to a new level its predecessor – STEM *(Ejiwale, 2013)*. S. Serenko *(2021)* notes that the introduction of STEAM education in the study of music helps to expand the horizons of learning, develop creativity, and stimulate interest in students' learning. STEAM education can make learning music more interesting, effective, and relevant to today's world. Implementing STEAM education can take various forms, including projects, laboratory work, theatrical performances, workshops, and other forms of active learning. Teachers become facilitators, facilitating learning and using knowledge in practical tasks *(Kuzmenko, 2023)*. Compared to traditional education, the STEAM approach is considered more adaptable to the needs of modern society and the economy, as it considers the need to develop creative and technological skills for success in the world. It is designed to form learners who can work effectively in a rapidly changing environment.

The article aims to analyze the potential impact of STEAM education on the outcomes of music teacher training.

2. Research methods

To determine the potential impact of STEAM education on the results of music teacher training, theoretical methods of scientific knowledge were used: analysis of scientific publications and their systematization and generalization, as well as comparison and abstract modeling to identify possible influences within their professional training.

3. Results

STEAM education in the study of music disciplines can be an interesting and productive way to develop student's knowledge and skills. Based on the analysis and systematization of existing practices, we believe that STEAM elements can be included in the study of music (Table 1).

Table 1

Examples of STEAM in the study of music

STEAM Element	Use Case
Music Technology	− Using digital music instruments and software to create and record music.
	− Teaching students how to use audio editing and processing apps.
	− Using virtual instruments and applications for the creative performance of music.
Music Engineering	− Developing and constructing your own musical instruments or devices.
	− The study of acoustic principles and their use in the musical effects' creation.
Art Integration	− Creation of visual art projects that accompany the music performance.
	− Organization of exhibitions of musical and artistic works of students.
Sound Design Projects	− Creating soundtracks for movies, plays, or other events.
	− Learning the basics of sound design and its impact on the perception of visual materials.
Learning the Mathematical Aspects of Music	− Analysis of rhythms, tempos, and meters as mathematical concepts in music.
	− Using mathematical models to create and understand musical structures.
Theatrical performances and musical performances	− Creating musical performances and theatrical performances based on stories, songs, or life situations.
	− Involving students in creating scenography, costumes, and other aspects of the performance.
Collaboration with other subjects	− Organization of joint projects with physics (acoustic phenomena), computer science (programming of musical applications), mathematics (music theory), and other STEAM subjects.
Gaming aspects	− Using slate and games to teach musical terms, sheet music, etc.
	− Creating music bands or projects to create music together.

Music, as the art of sound, has many aspects that can be successfully integrated into STEAM education. Music stimulates students' creativity and emotional development. By experimenting with sounds, they develop their musical style and express their own emotions through the creation of music. In addition, music provides a unique opportunity to learn mathematical and physical concepts. Learning rhythms and tempos allows students to immerse themselves in mathematics by understanding musical structures. The study of the physical aspects of acoustics reveals the mysteries of sound and waves that underlie musical phenomena.

In STEAM education, music is a medium for learning about technology. The digital tools used, such as music creation and editing software, allow students to master modern technologies and develop digital culture skills. Thus, music (or musical art), an integral part of STEAM education, interacts with its other components (science, technology, engineering, art, and mathematics), complementing and enriching learning in these fields. Fig. 1 shows the key aspects of how music interacts with each of the components of STEAM.

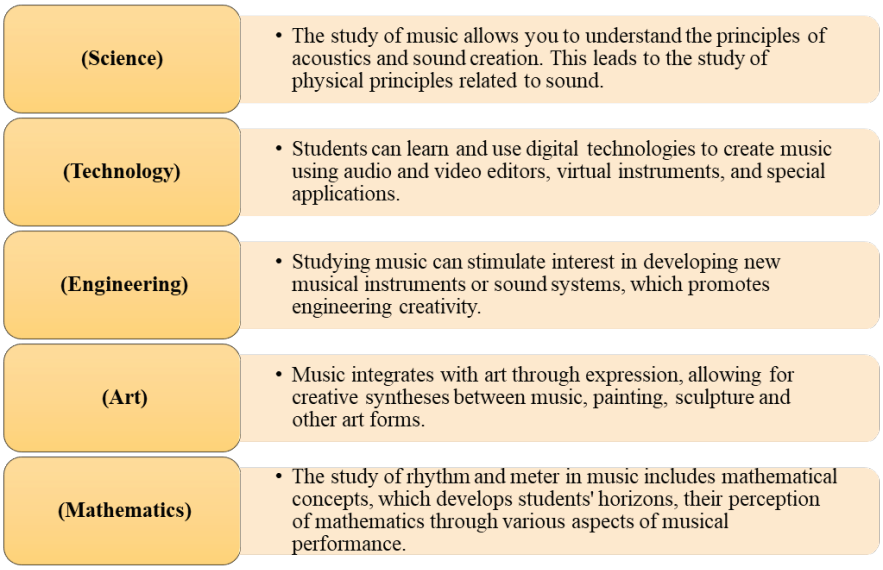

Fig. 1. Key Aspects of Music Interaction with Each of the STEAM Education Components

Considering the subject of our research, we will additionally present the main characteristics of STEAM education that correlate with the components of music teachers' information and digital culture (Fig. 2; *Liu, 2024*).

– Integration of subjects – STEAM goes beyond the traditional segregated study of disciplines, facilitating their joint study in the context of real-world tasks.

– Active learning is using active methods where students are involved in practical projects, research, and creative tasks.

– Problem-based learning – the students solve real-world problems, which allows them to put what they have learned into practice.

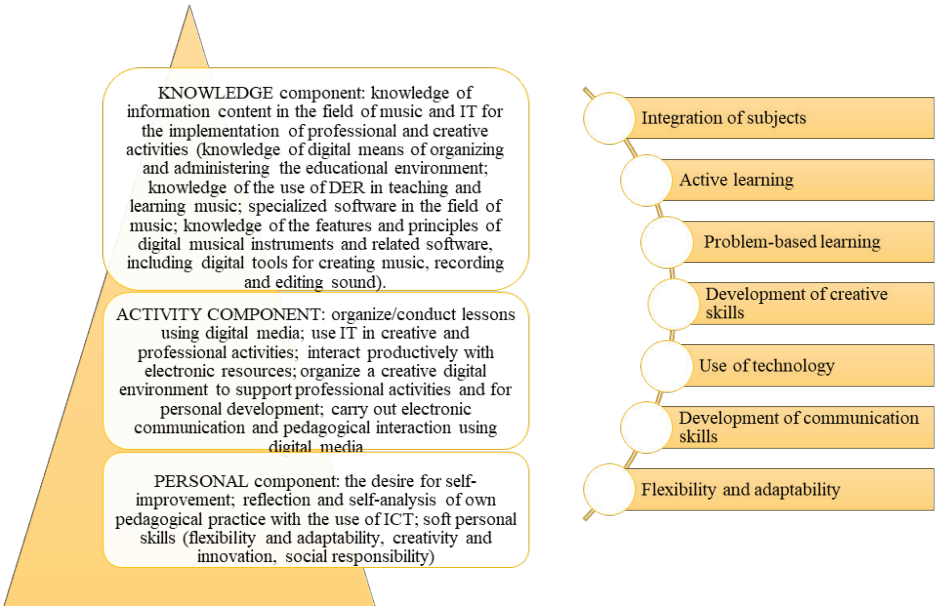

Fig. 2. Components of the Music Teacher's IDC and the Main Characteristics of STEAM Education

– Creative Skills Development – there is a focus on developing creativity, innovative thinking, and ingenuity.

– Use of technology – the widespread use of ICT to support learning and the creative process.

– Development of communication skills – working together, discussing, and presenting projects develop communication skills.

– Flexibility and adaptability – adapting learning to individual students' needs and learning styles.

Based on the analysis results, we say STEAM education holds significant potential for transforming the outcomes of music teacher training. STEAM encourages a more holistic approach to teaching and learning by integrating the arts with science and technology. Music teachers benefit from this approach as it fosters creativity, critical thinking, and problem-solving skills, all essential in today's rapidly evolving educational landscape. STEAM equips future music teachers with the technological proficiency necessary to utilize modern tools and digital platforms, making music education more engaging and relevant to students. The interdisciplinary nature of STEAM encourages collaboration and innovation, enabling teachers to connect music with broader concepts in STEM fields.

4. Discussion

The results obtained expand the possibilities of purposeful creation of links between school and social practice, between the educational process and the whole world from the point of view of the development of children's abilities and the important benefits of STEAM

education (STEM approach in education): accumulation of ideas, exchange of opinions, inclinations, mentality, creation of a single information and educational space with the ability to search and create contacts by skills, organization of gradual learning that unfolds over time, emphasis on the integration of key disciplines.

Researchers, in particular *(Andriievska & Bilousova, 2017)* there are three main ways to implement STEAM education:

− STEAM projects are based on real problems, the solution of which requires integrating knowledge from different fields of study. The results are published online or presented in competitions and contests. This is the most common form of STEAM education in foreign school practice.

− STEAM classes are essentially smaller versions of STEAM projects. A characteristic feature of STEAM classes is that parts of such lessons are strictly structured, and limited in time. At the same time, such lessons are limited by the number of academic disciplines that can be used in solving problems.

− Maker space is a space where students can develop their abilities, show their talents and talents in a particular activity, realize their creative potential, communicate with like-minded people, test their abilities, and test their ideas, without worrying that the next step may turn out to be wrong. In innovative educational practices abroad, maker spaces are characterized as spaces with special equipment (e.g., tools for working with cardboard and wood, sewing tools, 3D printers, and Lego Education sets). It is during the work in the maker space that new project ideas are "born", which are implemented in STEAM projects and STEAM lessons.

According to J. According to Yackman, an American expert in the integration of arts and STEAM education, the acronym STEAM reflects how all the subject topics relate to each other and the real world. The author points out that the letter "A" denotes a broad art, a discipline that goes far beyond one of the branches of art. The letter "A" organizes the relationship between all the humanities disciplines formally classified as different arts, humanities, language sciences, social sciences, disciplines that help to understand which ideas have practical applications and which do not, and all the major arts, each of which stimulates the development of STEM disciplines *(Yakman, 2016)*.

S. Riley defines STEAM as a comprehensive educational approach to learning that uses science, technology, engineering, art, and mathematics as "access points" to guide student research through dialogue and critical thinking skills (Institute for Arts Integration and STEAM: Arts integration and STEAM). V. Andrievska and L. Bilousova *(2017)* believe that the main idea of STEAM education is that educational and cognitive processes are based on an interdisciplinary approach to the study of specific problem situations in real life. In *(Andrievska, 2017)*, STEAM education is interpreted as a creative space for a child's worldview, in which he or she fully realizes his or her needs. Therefore, all activities aimed at the implementation of STEAM education are designed to promote the development of the individual as a creator, and project activities in this regard are one of the most promising. Unlike the organization of the traditional educational process, STEAM projects bring students closer to reality and reduce the gap between theoretical problem-solving and practical implementation of the knowledge gained.

STEAM education creates stable logical connections between disciplines that help students look at the world globally and notice patterns and similarities in different fields of activity. To be a successful specialist, you must combine and develop the skills of an inventor, scientist, manager, psychologist, etc. To solve a specific problem, students focus on intelligence and ingenuity *(Dell'Erba, 2019)*.

The STEAM approach destroys the notion of a "technical" and "humanitarian" mindset. The original goal of STEAM education was to popularize learning in the scientific field. Currently, STEAM curricula are being developed that support humanities research through sciences and mathematics. The development of the educational sector is not limited to digital technologies, as it includes teacher training programs in various fields (not just one subject).

Boychuk V.M., Umanets V.O., and Fu G. also describe the relationship of music with other components of STEAM education *(Boychuk et al., 2021)*. The authors point out that music uses the physical principles of sound; thus, it is related to the natural sciences. Musicians can create, record, and play sound, reflecting its relationship to technology. Music is related to engineering and can be used to make musical instruments and systems. It is also associated with mathematics using mathematical concepts such as harmony, melody, and rhythm. Thus, the authors point out that music bridges the different components of STEAM education, promoting the integration of knowledge and the development of a wide range of skills.

The positive impact of STEAM on the training of music teachers is confirmed by the results of research by scientists L. Aristova, O. Gorozhankina, E. Provorova, Z. Ozera, and R. Demirbatyr, G. Ramsay, C. Aguilar and L. Richerme, J. S. Miller. Dong, K. Choi, A. Milne, A. Calihanna, and others.

L. Aristova, O. Gorozhankina, E. Provorova, R. Lotsman, and D. Levitt provide specific examples of how STEAM education can be useful for the training of music teachers *(Provorova et al., 2023)*:

− STEAM education can help music teachers better understand how music interacts with other areas of knowledge. For example, teachers may study the physics of sound to understand better how musical instruments create sound, or they may study the history of technology to understand how technology has influenced the development of music.

− STEAM education can help music teachers use technology to create more effective and engaging lessons. For example, teachers may use technology to record or make music, or they may use digital technology to create interactive assignments and learning materials.

− STEAM education can help music teachers develop students' critical thinking, creativity, and innovation. For example, teachers can use STEAM projects to help students solve problems, experiment with new ideas, and create original pieces of music.

5. Conclusions

STEAM (Science, Technology, Engineering, Arts, and Mathematics) education has several advantages that make it relevant for the modern training of a future music teacher. Firstly, STEAM promotes the development of critical thinking, creativity, and innovation, which are essential for the successful professional activity of a music teacher. Secondly, STEAM education helps to develop the universal skills necessary for success in various areas of life. Thirdly, STEAM education is based on an interdisciplinary approach, which is needed to solve complex problems of the modern world. Our conclusions are confirmed by the review of scientific papers on the training of future music teachers, which demonstrates the connections and mutual influence of STEAM-oriented professional training on the development of information and digital culture of future music teachers.

We see new opportunities for improving their professional competencies. It allows for adapting teaching methods to modern technological trends, which is especially important

given the rapid development of digital tools and software. Music teachers who employ STEAM approaches can introduce innovative forms of instruction, including interactive platforms for creating, recording, and editing music, thereby increasing student motivation. Also, STEAM fosters the ability to integrate interdisciplinary knowledge, promoting flexible thinking in future music teachers. That helps them more effectively solve educational tasks and organize creative projects. Thus, analyzing the impact of STEAM education enables the development of more effective and relevant training programs for music teachers, enhancing the quality of their teaching and their readiness to meet the challenges of modern education.

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