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INFORMATION-COMMUNICATION TECHNOLOGIES IN THE PERFORMING TRAINING OF FUTURE VIOLINISTS: METHODOLOGICAL ASPECT

This article explores the potential of information and communication technology (ICT) in the context of the performance training of future violinists, in particular with regard to the development of performance skills, competences and creativity. Various aspects of technical skill improvement are considered, including motor coordination, sound production techniques and the role of real-time feedback systems. The results of the study demonstrated the importance of ICT in the development of creativity, social engagement and personalised performance training experiences to ensure that students are able to effectively navigate the complexities of contemporary music performance.

Key words: *information-communication technologies (ICT), violin performance, performing skills, motor coordination, recording techniques, real-time feedback, creative expression, tactile feedback systems, virtual reality in music, multimodal learning environments.*

ІНФОРМАЦІЙНО-КОМУНІКАЦІЙНІ ТЕХНОЛОГІЇ У ВИКОНАВСЬКІЙ ПІДГОТОВЦІ МАЙБУТНІХ СКРИПАЛІВ: МЕТОДИЧНИЙ АСПЕКТ

У статті розглядається потенціал інформаційно-комунікаційних технологій (ІКТ) у контексті виконавської підготовки майбутніх скрипалів, зокрема, щодо розвитку виконавських навичок, компетенцій і творчих якостей. Розглядаються різні аспекти вдосконалення технічних навичок, включно з руховою координацією, технікою звуковидобування та роллю систем зворотного зв'язку в реальному часі. Результати дослідження засвідчили важливість ІКТ для розвитку творчих здібностей, соціальної активності та персоналізованого досвіду виконавської підготовки, що має на меті забезпечення

здібностей ефективно орієнтуватися у складнощах сучасного музичного виконавства.

Ключові слова: *інформаційно-комунікаційні технології (ікт), скрипкове виконавство, виконавська майстерність, моторна координація, техніка звукозапису, зворотній зв'язок у реальному часі, творче самовираження, тактильні системи зворотного зв'язку, віртуальна реальність в музиці, мультимодальні навчальні середовища.*

The integration of information-communication technologies (ICT) into the training of future violinists has shown significant potential in the development of core performance skills, competences and necessary professional-performance qualities. One of the main areas where ICT contributes to the development of violinists is the improvement of technical skills. Digital Audio Workstations (DAWs) and other software tools facilitate performing self-training, allowing students to practice and improve their techniques in a flexible environment. For example, recording and analysing performances using software provides immediate feedback, which is very important for the development of performance skills. This is consistent with the findings that technology can significantly enhance the effectiveness of performance development in music education by offering tools that facilitate creative expression and performance.

The inclusion of ICT in the training of future violinists also contributes to the development of necessary motor skills. Research shows that violin playing requires complex motor coordination and control, especially in relation to bimanual coordination and finger independence (Hiemstra, 2023). Researchers have explored the relationship between motor development and early violin learning, emphasising the complex motor skills required for skilled violin playing. The findings suggest that well-developed bimanual coordination and independent finger movements are vital for young violinists, especially in relation to left and right hand functionality. The introduction of ICT can support the development of these motor skills by providing interactive and engaging training platforms. For example, ICT tools can provide real-time feedback on posture and movement, supporting the development of key movement patterns identified in the study. Digital applications can also track progress in motor skill development, enabling the creation of personalised trajectories of performance development (Hiemstra, 2023).

Thus, ICTs play a crucial role in improving violinists' skills by addressing specific motor tasks. Using interactive learning platforms that simulate the physical aspects of playing, future musicians can practice motor skills in a controlled environment. This approach promotes the development of necessary physical abilities and improves cognitive understanding of the mechanics involved in playing the violin (Hiemstra, 2023).

Another important area where ICT has had an impact is in the development of sound reproduction techniques. A study conducted by A. Blanco et al. (2021) showed that real-time feedback on sound and movement significantly helps beginners in learning the basics of violin playing, especially in reproducing stable and sustained sounds. The study emphasises the vital role of ICT in the development of violinists' skills, especially in relation to bowing technique. The experimental group showed increased stability of sound production when using feedback technologies, indicating that ICT can facilitate the performance of complex musical tasks (Blanco et al., 2021).

Y. Kuo et al. (2020) identified the feasibility of using technology for physical fitness and endurance development of violinists, as well as, addressing physical deficiencies that may hinder proper sound production. The study highlights the significant impact of cervical spine stabilisation exercises in violinists experiencing non-specific neck pain, a common problem associated with asymmetrical posture during playing. Researchers have found that ICT integration can improve adherence to exercise programmes. For example, ICT tools can facilitate remote monitoring and provide instructional videos, which increases exercise adherence and promotes engagement. In addition, mobile applications can offer personalised feedback and progress tracking, effectively addressing individual skill deficits. Thus, ICT implementation not only supports physical rehabilitation but also promotes skill improvement, ensuring violinists have optimal posture and reducing the risk of injury (Kuo et al., 2020).

The combination of auditory and visual feedback systems has been shown to increase the effectiveness of music-performance training by allowing students to adjust their techniques based on immediate feedback. A. Blanco and R. Ramírez (2019) described the potential of ICT in improving the skills of novice violinists using Sound Quality Visual Feedback Systems (SQVFS). Such systems can provide objective metrics to assess students' progress in reproducing consistent sound characteristics including pitch, dynamics and timbre. By analysing EEG activity, the study has identified biomarkers of motor learning, which has proven important for understanding the process of bowing skill formation.

Computerised visual feedback also has the potential to improve intonation skills on the violin. Y. Aksoy's (2023) study emphasises that visual aids, such as 2D keyboard animations and 3D avatars, can facilitate independent practice and promote the development of intonation problem solving skills inherent in playing a stringed instrument with an unstrung string (Aksoy, 2023). In particular, the ability to visualise sound and movement allows violinists to better understand the nuances of intonation and pitch control. The use of a violin equipped with sensors on the fingerboard and audio analysis has posaolly provided two main methods of feedback: audio feedback, which suggests the appropriate pitch following the performer in real time, and visual

feedback, which reflects correct intonation using an optimised algorithm (Pardue & McPherson, 2019).

E. Allingham et al. (2021) investigated how attention concentration during bow use affects sound production and suggested that external attention concentration may improve violinists' motor skills. By examining acoustic, physiological and physical parameters of the bow, the study highlights the importance of psychological methods in musical performance, similar to their recognised role in sport. ICTs such as performance analysis software and virtual reality environments can teach violinists how to maintain optimal concentration (Allingham et al., 2021).

R. Gentner et al. (2010), investigating the encoding of motor skills in musicians, found that the coordination required to play the violin places high demands on the motor cortex, which can be optimised through targeted feedback mechanisms. Their work highlights the complex relationship between motor skills and the musculoskeletal system in musicians, especially violinists. Researchers have suggested that although intensive musical training improves finger dexterity, the quality of motor representations plays a more important role in the development of virtuosity. In this conjecture, the visualisation programmes offered by ICT facilitate the formation of such representations (Gentner et al., 2010).

The integration of haptic feedback systems, as investigated by J. Linden et al. (2011), can also provide haptic guidance, reducing the time required to learn bowed instrument technique. Their study of real-time vibrotactile feedback in violin learning provides insights into how ICT facilitates the contextualisation of feedback, which can be either primary or auxiliary depending on the task. This adaptability allows for individualised strategies for performance development (Linden, et al., 2011).

The emergence of virtual and augmented reality technologies opens up new possibilities for the immersive method in the rehearsal process. These technologies can mimic the performing environment, allowing for simulated conditions that mimic live performances without the accompanying psychological pressure. This method increases the violinist's confidence and stage self-control, qualities crucial for a successful performance (Orman, 2016).

In addition to technical mastery, ICT plays a crucial role in developing the creative abilities of future violinists. The availability of different tools for music writing and improvisation facilitates experimentation with different musical ideas and styles, which enables creative interaction with music. For example, platforms that facilitate collaborative work on pieces allow violinists to explore their creativity in ensemble music-making, enriching their musical experience. This aspect of collaboration is important as it reflects the current musical landscape where cross-genre and interdisciplinary collaboration is becoming increasingly common (Portero & Bravo, 2022).

The use of ICT can significantly improve the social and emotional qualities of violinists. Working with technology can foster a sense of community and belonging. Research shows that music-making through technology can serve as a means of self-expression and social integration, allowing individuals to connect with others who share similar interests. This is relevant for students who do not have access to traditional music education resources, as ICT can democratise music learning and provide opportunities for different groups to participate in music making (Schiavio, et al., 2021).

Thus, integrating ICT into violin learning is a multifaceted approach to developing the basic skills, creativity and emotional engagement of future violinists. The use of technology provides personalisation of the process of music-performance development and enriches the artistic experience of future violinists, preparing them for professional activity based on creativity and innovativeness.

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ACMEOLOGICAL TECHNOLOGIES AS A MEANS OF PERFORMING SELF-IMPROVEMENT OF FUTURE TROMBONISTS

The study examines the application of acmeological technologies for performing self-improvement of future trombonists. The focus is on the systemic regulation and direction of personal and professional development processes with the help of structured techniques aimed at achieving ambitious performance goals and creative self-realisation. The main elements of such technologies are goal-setting, reflective practices and integration of digital resources, which together improve the level of performing skills.

Key words: *Acmeological technologies, future trombonists, performing self-improvement, musicality, goal setting, reflective practices, digital resources, holistic development.*

АКМЕОЛОГІЧНІ ТЕХНОЛОГІЇ ЯК ЗАСІБ САМОВДОСКОНАЛЕННЯ МАЙБУТНІХ ТРОМБОНІСТІВ

У дослідженні розглядається застосування акмеологічних технологій для виконавського самовдосконалення майбутніх тромбоністів. Акцент робиться на системному регулюванні та спрямуванні процесів особистісного та