

# The Role of Information Technology in Piano Education: Attitudes of Professors in Chinese Universities and Students of Peking University

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## Abstract

*The use of computers, specialized software, and online resources has the potential to make piano education more accessible and motivating. This study consisted of two interrelated investigations: a preliminary survey of 150 piano teachers at Peking University (ages 19-56) to obtain information on the development and implementation of a technologically enhanced teaching system, followed by an experimental evaluation. The teachers' survey was conducted to understand potential implementation issues and opportunities. The subsequent experimental study assessed the effectiveness of this system with two groups of students (N = 180): the experimental group (n = 90) used a teacher-informed, technology-based system, while the control group (n = 90) adhered to traditional teaching methods. Results showed significantly higher scores in the experimental group (M = 85.54, SD=10.01) compared to the control group (M = 75.32, SD = 12.21),  $t = 2.234$ ,  $p < 0.001$ , with a moderate effect size (Cohen's  $d = 0.562$ ). The survey revealed that although teachers recognized the potential benefits of integrating technology (43 % noted increased student motivation, and 17 % valued flexible access to materials), they also identified critical implementation challenges, such as difficulties in selecting appropriate software (52 %) and limited individual control in virtual environments (44 %). The results suggest that technologically enhanced piano education (when developed with teacher input) can effectively improve student performance in the context of Peking University. The practical significance of the article lies in demonstrating how*

*modern information technologies can improve piano teaching, highlighting both the advantages and disadvantages of such integration.*

**Key words:** *digital learning resources; information technology; innovative teaching; interactive piano lessons; music pedagogy*

## Introduction

Technology has radically transformed the educational process by facilitating communication between teachers, students, and parents, as well as providing more interesting and interactive lessons that meet the needs of students. Technology also makes the learning materials and resources accessible to students, allowing them to learn at their pace and on an individual basis, but it may require more complex lesson planning and curricula (Heick, 2022; Seitenov et al., 2020). The development of artificial intelligence opens up many opportunities for creating, analyzing, and improving music (Xue & Jia, 2022). Modern telecommunication and information technologies are widely used in music education, including piano teaching; they allow turning individual lessons into more accessible and interactive group classes, thus reducing their cost and increasing accessibility. In particular, augmented reality systems take advantage of mobile capabilities and provide new ways to facilitate piano learning for many people (Cui, 2023). Technology resources in music education include the use of mobile devices, the Internet, interactive whiteboards, and software. All of these provide a variety of digital learning tools for music theory studies, practice tasks, and hands-on activities, as well as the ability to play sheet music and educational games using innovative teaching methods (Klein, 2022).

The development of comprehensive musical skills in piano playing is a long-term process that requires continuous education and improvement and includes identifying problems, improving the acquisition of music theory and playing skills, and using effective methods to develop students' understanding, appeal, and adaptability while playing the piano (Yang, 2021). This process requires an ability assessment system in piano teaching which is a complex model with numerous indicators and attributes, but it reflects the unique strategy and constant changes in the assessment indicators. A comprehensive assessment of piano learning ability helps to take into account a variety of factors, such as social, environmental, and personal ones, which are important for successful learning (Ma, 2022).

## Literature review

The history of music theory and pedagogy has evolved from classical approaches to contemporary innovative teaching methods. A notable example in this context is Spitzer's study, dedicated to the analysis of Beethoven's late style. In his work (Spitzer, 2006), he thoroughly examines the Ninth Symphony, Missa Solemnis, piano sonatas, and string quartets of the composer, which became a bridge between classical and romantic traditions. Spitzer interprets these works through the lens of the musical

and philosophical ideas of Theodor Adorno, skillfully combining music semiotics and critical theory. His comparative analysis includes a juxtaposition of Adorno's ideas with those of thinkers such as Derrida, Benjamin, and Habermas, as well as with the views of contemporary music theorists. The findings suggest that Beethoven's late works not only demonstrate a complex musical structure but also contain a philosophical critique of Enlightenment ideas, shaping a distinct musical language of pre-modernism. Furthermore, an important milestone in the development of music pedagogy was A. B. Marx's treatise *Die Lehre von der musikalischen Komposition*, which is the focus of Spitzer's 1998 study (Spitzer, 1998).

Although Marx is best known for classifying musical forms, particularly the sonata form, his pedagogical approaches warrant separate attention. The treatise, similar to the works of Mattheson, Riepel, and Koch, had not only theoretical but also significant didactic value. The structure of the presentation of material played a key role in its comprehension (while the work sparked critical discussions) due to the "chaotic combination of familiar elements". However, the study demonstrates that the pedagogical aspect of the treatise is inextricably linked to its theoretical content, which refutes the traditional perception of this work as purely analytical. In the contemporary context, the development of music pedagogy has continued through the integration of new technologies. The use of multimedia technology in piano teaching in colleges and universities simplifies learning, thus making it more accessible and intuitive for students (Yang & Jung, 2023). The main advantages are the increase in education quality and the development of individual musical talents. The researchers emphasize the importance of the development and use of such technologies but also point out the existing shortcomings of multimedia applications. Another research explored the possibility of using the Internet technology to automatically evaluate piano playing. The researchers used the methods of comparing artificial systems as well as building a database and models to collect and analyze musical samples (Yu, 2021). It resulted in a practical automatic piano evaluation system demonstrating high accuracy and performance. This research offered a comparison of the automatic evaluation system with the standard manual assessment. The findings showed that the automatic evaluation system has a high recognition rate and speed of operation and indicated the possibility of using this system for effective assessment of piano playing in students. This study also pointed to the potential for the development of such systems and their applicability in education. Such a system can be useful for evaluating the performance of various musical repertoires and providing accurate results for piano students.

The researchers investigated the development of piano education and the growing role of computer multimedia programs in overcoming the respective difficulties (Chen, 2022). The goal was to introduce a neural network algorithm into an interactive piano learning system to overcome the difference between teachers and students, network instability, etc. This paper provided the theoretical basis for the neural network algorithm and described its application for speech recognition and the system structure.

Another study investigated the use of multimedia teaching tools for musical performance in the classes of music teachers in the context of the integration of subject knowledge (He et al., 2022). The study was based on classroom observations and data analysis. It identified differences in the use of multimedia programs between the teachers teaching advanced courses and those teaching regular classes. The findings indicated the superiority of teachers teaching advanced courses in the use of multimedia programs and the improvement of academic effectiveness. This paper provided useful insights for music performance teachers to improve the use of multimedia programs in their classes.

Another research topic was the growing demand for online education in universities and colleges, especially during the COVID-19 pandemic and the general development of Internet technology (Wu, 2023). A significant challenge was the effectiveness of teaching online the musical skills such as playing the piano, which required multisensory learning. The paper defined the functional requirements for an online piano learning system in universities and colleges, developed the overall system architecture, including software and hardware, selected a wireless network communication method, and designed a remote system based on a wireless network. It also compared the advantages and disadvantages of different protocol algorithms to improve the effectiveness of online music learning.

Another striking example of transformation is the experience of Hong Kong, explored by Ho (2004), who analyzed the outcomes of the implementation of the government's 1998 "Information Technologies for Quality Education" strategy. By studying feedback from 29 teachers and 543 students from primary and secondary schools, the researcher discovered that properly integrated information technologies significantly enhance students' motivation and the quality of the learning process. Moreover, an important step in the development of technological innovations was the research by Li (2022a), which presented the use of video and graphic teaching methods to convey the live atmosphere and artistic features of piano performance. The application of artificial intelligence methods, particularly neural networks, for analyzing video and images demonstrated high efficiency and accuracy in classifying characteristics of piano playing. A particularly illustrative example of technological progress in music education is the P.I.A.N.O. system, developed and evaluated by Rogers et al. (2014). This innovative system utilizes interactive projection to accelerate learning by displaying notes directly on the keyboard, eliminating the need for prior study of music notation. The results confirmed that P.I.A.N.O. not only accelerates material acquisition and reduces cognitive load but also significantly improves the overall learning experience and the perception of musical quality compared to traditional methods.

Thus, the evolution in music pedagogy is evident, reflecting the shift from classical theoretical approaches to contemporary technological solutions in piano learning. However, the literature review also reveals several significant gaps, which our research aims to address. Specifically, there has been insufficient investigation into the cultural

context of technology implementation in music education, particularly in Chinese universities, where traditional teaching approaches may significantly influence the acceptance of new technological methods. This creates additional challenges in integrating modern tools into piano teaching. Little attention has been given to how technology can impact the development of students' creative abilities and their motivation to learn.

The aim of our research is to analyze the effectiveness of integrating information technologies into piano teaching, focusing on assessing their impact on student learning outcomes, identifying implementation challenges for teachers, and exploring the cultural aspects of IT integration in piano education at Chinese universities.

Research objectives:

1. Analysis of teachers' experiences and challenges in implementing information technologies for piano education.
2. Evaluation of the practical advantages and limitations of technology-enhanced piano learning from both the teacher's and the student's perspectives.
3. Comparison of the learning outcomes between traditional and advanced technological methods of piano teaching through quantitative analysis.

## **Methodology**

### ***Research design***

The **first stage** was a survey among teachers working at Peking University. The authors used standardized questionnaires with questions about pedagogical experience, attitude to the use of information technologies in education, and readiness to implement intelligent learning systems. The survey was based on the online platform Google Forms. Participants accessed the survey through a link that was distributed by sending it to their corporate mailboxes. This survey was digital and required a computer or a mobile device with Internet access. The form contained multiple choice questions or fields for writing answers. The participants had the opportunity to scroll through the pages, view previous responses, and enter their responses. This approach allowed for convenient and efficient data collection and ensured the preservation and analysis of responses.

The **second stage** was an experimental study at Peking University, which involved two groups: a control group (n = 90) and an experimental group (n = 90). Its main goal was to evaluate the effectiveness of a new system for teaching and evaluating piano playing based on modern information technology among university students.

### ***Sample for experiment***

The experiment involved 180 students of Peking University (63 males and 117 females). The **goal** of the experiment was to evaluate the effectiveness of a developed system for teaching and evaluating piano playing based on modern information technology among students. To achieve this goal, the research design with a control group (n = 90) and an

experimental group (n = 90) was used. The participants were randomly divided into the control group and the experimental group. Both groups were similar in structure and baseline piano skills.

**For the experimental group**, the authors developed and implemented an interactive piano learning system based on advanced information technology and modern teaching methods. This system consisted of the following key components (Table 1).

Table 1  
*Key components of the intelligent system*

Key components of the system	Description
Video tutorials	The students had access to a set of video tutorials that demonstrated various aspects of piano playing including technique and expression.
Interactive exercises	The system provided interactive exercises to practice playing skills such as playing musical scores as well as rhythmic and coordination exercises.
Ability to record and evaluate playing	The students were able to record their playing and receive an objective assessment of performance technique, dynamics, and accuracy.

This interactive piano learning system was designed to improve the teaching quality and allow students to practice and develop their skills in piano playing using innovative information technology.

The **control group** consisted of students who took traditional piano lessons without any intelligent system. To ensure the objectivity of this experiment and comparative analysis, the control group acted as follows:

- Traditional lessons: The control group students took traditional piano lessons in classrooms or studios with piano teachers. They received real-time instruction and demonstrations from instructors.
- Textbooks and sheet music: Students were provided with textbooks and sheet music for learning musical compositions. They studied sheet music, technique, and interpretation on paper and with teachers.
- Evaluation: The skills of the control group students were assessed and tested using traditional methods such as public performance and teachers' evaluations.

The experiment lasted for one semester. At the end of the experiment, the researchers evaluated and compared both groups using practical and theoretical tests and analyzed the performance of musical compositions on the piano. This evaluation also involved specialists in music education.

Based on the obtained results, the authors assessed the effectiveness of the implemented intellectual piano learning system compared to the traditional teaching method. Such an experiment provided an objective assessment of the advantages and disadvantages of using modern information technology in piano learning compared to standard methods. The authors conducted a survey after the experimental study to collect

additional data and impressions from the participants regarding their opinions on each approach [Appendix A].

### ***Survey sample***

The survey aimed to collect and analyze data on the development and implementation of a piano teaching and assessment system based on modern information technology among teachers working at Peking University. The main purpose was to find out their opinion and attitudes to new methods of teaching and evaluation, as well as to determine the possibilities and limitations in the implementation of such a system in the university environment.

The sample consisted of 150 teachers of Peking University (males and females aged 19 to 56 years old). The authors conducted a survey using a standardized questionnaire with questions about experience in teaching music and piano, attitudes toward the use of information technology in education, and readiness to implement intelligent learning systems. The questionnaire was designed to reflect the research objectives as accurately as possible and to obtain the required information [Appendix B].

### ***Statistical analysis***

SPSS statistical software was used to conduct the statistical analysis. Student's t-test was applied to compare the means of two independent samples and to test hypotheses about the equality of means in these samples. Levene's test for the variance homogeneity and the Shapiro-Wilk test for normality were conducted to check the required assumptions. After fulfilling the prerequisites for applying the Student's t-test, the authors were able to calculate the t-test and the level of significance (P-value).

### ***Ethical issues***

All participants in this study gave voluntary consent to participate, were informed in advance about the purpose and all the study conditions, and had the opportunity to refuse participation without any negative consequences. The personal data of the participants were not collected during the study.

## **Results**

According to the survey results, information technologies played a significant role in enhancing students' motivation to learn to play the piano, as indicated by 43 % of the respondents (Figure 1). Interactive exercises, online resources, and progress tracking provided clear incentives for continued learning. In addition, instructors highlighted the advantage of convenient access to learning materials, which allowed students to study at home or at a time that was most convenient for them (17 %).

In total, 16 % of instructors noted the ability to adapt teaching materials according to students' individual needs, which facilitated personalized learning. Twenty-four percent of instructors emphasized the improvement in communication opportunities,

as technologies enabled easier interaction, allowing for prompt responses to students' questions via email, forums, or chat.

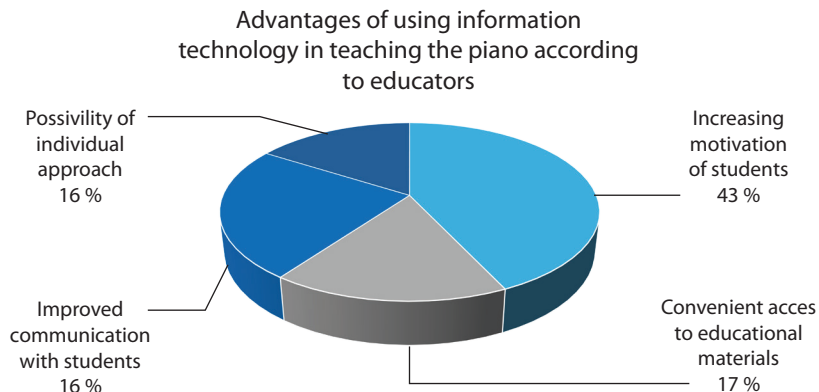


Figure 1. Advantages of using information technology in teaching the piano according to educators

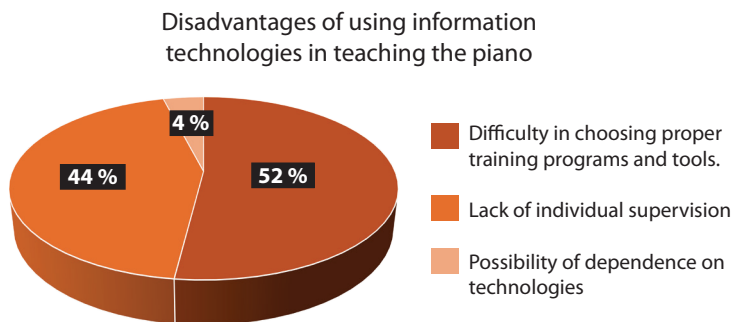


Figure 2. Disadvantages of using information technologies in teaching the piano

However, instructors identified several significant challenges when using information technologies in piano teaching (Figure 2). One of the primary issues is the difficulty in selecting appropriate educational programs and tools (52 %), as the IT market offers many options, and choosing optimal tools can be time-consuming, affecting the effectiveness of learning. The lack of individual student monitoring in a virtual environment (44 %) presents difficulties due to the inability to physically observe students, potentially leading to losing control over the learning process. Students with varying levels of motivation and self-discipline require greater effort from instructors to ensure the effectiveness of their learning. Furthermore, some instructors express concerns about the possibility of students becoming overly dependent on technology (4 %), which could limit their ability to play without computers and software, negatively affecting the development of practical musical skills.

The following feedback from instructors illustrates the challenges they face when using information technologies in piano teaching:

Respondent 1:

“Choosing the optimal software takes a lot of time, and frankly, this reduces the effectiveness of the learning process. Many programs do not meet the needs of my students or are too complex for their level. Instead of simply starting the lessons, I often waste time searching for better options.”

Respondent 2:

“When working with students online, you cannot directly observe their technique or work. Each student has a different level of self-discipline, and without constant monitoring, it is harder to assess their progress.”

Respondent 3:

“Sometimes I feel that students start focusing more on the computer programs than on the actual process of playing. They rely more on the software to evaluate their playing, which can limit their real musical abilities. I fear that if students do not have access to technology, they may not be able to play without the aid of a computer.”

Respondent 4:

“When they encounter new programs, many of them have difficulty mastering these tools, especially at the early stages of learning. I try to help them, but it takes much more time than I had planned. I often have to assist with technical issues so that students can focus on the music rather than on how to use the programs.”

Next, we will examine the results of the experiment with the students.

Table 2  
Survey results of students on the use of the intelligent piano learning system

Category	Indicator	Percentage of students (%)
Assessment of the system's interface	Very convenient and intuitive	65
Improvement of piano playing skills	Significant improvement in skills	67
	Noticeable improvement in skills	30
Assessment of the quality of video lessons and interactive exercises	No significant improvement	3
	High quality	80
Difficulties in using the system	Opportunities for improvement	20
	No difficulties	75
Assessment of the ability to record and evaluate performance	Had difficulties but overcame them independently	20
	Had difficulties and needed help	5
System improvement	Very useful and convenient	60
	Opportunities for improvement	30
Motivation for learning the piano	Not useful and not convenient	10
	More interactivity in video lessons	40
Willingness to recommend the system	More options for system settings	25
System advantages	Improvement in sound and image quality	20

Category	Indicator	Percentage of students (%)
Participation in additional activities	More exercises and tasks for learning	15
	Increased motivation	65
Key advantages of the system	Did not change their motivation	20
Category	Undecided	15
Assessment of the system's interface	Willing to recommend	70
Improvement of piano playing skills	User-friendliness	45
	Improved skills	30
Assessment of the quality of video lessons and interactive exercises	Participated	40
	Convenience and accessibility	50
Difficulties in using the system	Improved learning and progress tracking	30

The analysis of the results in Table 2 indicates an overall positive evaluation of the intelligent piano learning system. The majority of students (65 %) found the system's interface user-friendly and intuitive, and 70 % reported that the system improved their piano skills, with 67 % noting significant improvement. The quality of video lessons and interactive exercises was also positively assessed, although 20 % of students desired further enhancements. The system was considered useful by 60 % of students, who rated the recording and playback evaluation feature as very convenient; however, 10 % did not find it useful. Additionally, 40 % suggested that increased interactivity and more customization options would be beneficial. Most students reported improvements in their skills (55 %) and were willing to recommend the system to others (70 %), indicating its effectiveness. Thus, these findings suggest that the interactive piano learning system received high ratings from students, with the majority noting improvements in their skills and the system's ease of use. However, there are areas for enhancement, particularly regarding interactivity, system customization, and content quality.

Summing up, most students considered the system positive and useful for their studies, thus confirming the success of the development and implementation of the piano teaching and assessment system based on modern information technology (Table 2).

Table 3

*Comparison of performance levels between the experimental and the control group using a t-test for independent samples*

	Sample size	M	SD	t	P-value	Cohen's d
Control Group	90	75.32	12.21	2.234	0.000	0.562
Experimental Group	90	85.54	10.01			

A comparison of skill levels between two groups using a t-test showed that the experimental group that studied using the piano teaching and assessment system demonstrated significantly higher results than the control group that studied using traditional methods. The size of the effect, according to Cohen's d (0.562), indicates a moderate level of influence. Thus, this result confirmed a significant difference between the results of the two groups. The experimental group, which was exposed to a new system of piano teaching and assessment based on modern information technology,

showed significantly improved performance compared to the control group. There are reasons to believe that the developed system improved the quality of teaching and assessment of piano playing among students in higher educational institutions.

Additionally, cultural factors (mentality, upbringing, and educational environment) significantly influence the perception and use of information technology in piano education at Chinese universities. The traditional approach to education in China, which emphasizes technical mastery and discipline, may lead to some resistance toward new methods that require a more personalized approach.

For instance, in Chinese culture, great importance is placed on respect for the authority of teachers, which may affect the perception of technological innovations as less serious or informal. However, the findings of the study indicate that interactive exercises and online resources significantly enhance students' motivation and the accessibility of educational materials, aligning them with the needs of modern education.

## **Discussion**

Due to the intensive development of information technology, advanced computer technologies and information solutions find applications in music (Lv, 2023). Artificial intelligence (AI), the result of the active development of information technology, is becoming a key factor that complements music education (Li, 2022b). The combination of intelligent technology and face-to-face learning with artificial intelligence helps to solve the problem of lacking individual approaches in traditional teaching methods and increases students' interest in learning (Yu et al., 2023). Innovations in higher music education are considered an important mechanism for the introduction of modern information and communication technology to improve the educational process (Yin, 2023). These innovations are aimed at increasing interactivity and convenience for students during classroom lessons to make learning more effective and attractive; this approach to higher music education takes into account the potential of modern technology to change the way of learning and improve the quality of music education (Yu, 2021). For example, the use of augmented reality (AR) in teaching the piano is an innovative approach to the development of music education. Traditional computer tools and hardware are actively used in learning music, and AR can introduce a new level of interactivity (Chen, 2023). Cloud technology and networked platforms can also bring innovation to piano learning. Time and place often limit traditional music performance practices, but a cloud platform can help overcome these limitations. It allows for creating a network piano class using digital tools and Internet resources, which makes learning more accessible and effective for students (Tu & Peng, 2020). The development of online resources for music education in China has been successful in recent years. Still, there are challenges, such as the limited number of regional online resources and inefficient search (Yan, 2022). That is why the development of an interactive piano learning system is a complex process that includes advanced methods and modern technologies (Liu & Huang, 2021).

The results of the current study confirm the importance and effectiveness of the developed system of teaching and evaluating piano playing based on modern information technology. The analysis indicated that the experimental group, which used a new information technology-based piano teaching and assessment system, showed a significant performance improvement compared to the control group. Therefore, this system contributed to the improvement of the quality of piano teaching and assessment among students in higher education institutions.

Similarly, one study investigated the use of virtual reality (VR) to teach the piano and the use of specialized hardware and software (Feng, 2023). It showed a high accuracy of user gesture recognition and emphasized the possibilities of using this technology in music education. A second study by Chinese authors investigated the use of the Internet of Things and multimedia technologies to improve the quality of piano learning and used an artificial fish school algorithm to improve the learning process (Wang & Bai, 2022). It offered a new approach to intellectual learning in music education. The third study examined the impact of modern online technology on music education and the respective teacher's role (Yao & Li, 2023). It emphasized the importance of a balanced approach that combined the use of modern technology and the teacher's participation in the educational process. The findings indicated the need to develop musical skills and individual abilities of students through the use of applications and programs. The comparison of these studies with the current research showed some common and different aspects:

1. Use of technology. All three studies involved the use of information technology to improve piano learning. The current research was also based on modern information technology, such as a teaching and assessment system developed based on modern software.

2. Motivation of students. All three studies indicated a positive effect of technology on students' motivation. The current findings also indicated an increased motivation as students were interested in the new teaching and assessment system.

3. Quality of education. Two out of three studies showed improvements in the quality of learning using technology. However, the current findings indicated a significant intergroup difference, where the experimental group that used the new teaching and assessment system showed improved performance compared to the control group.

4. Advantages and difficulties. All studies noted the advantages of using technology, such as convenient access to educational materials and the ability to provide an individual approach. Also, all three studies pointed to difficulties related to technical aspects and providing support for users.

Overall, the current research added to existing knowledge, thus confirming the positive impact of modern information technology on piano learning and providing evidence of significant improvement in student performance while using a new teaching and assessment system.

### **Research limitations**

This study applied a quasi-experimental design, which limits the possibilities of analyzing the obtained results. In addition, limitations may be related to the specifics of the implementation of educational programs in various higher education institutions. Also, limitations may be related to the specifics of the software used as components in the piano learning and assessment system; the results of a similar study may differ due to the specifics of the software used.

### **Conclusion**

The comparison of the mean values of performance levels in the experimental and the control group showed a statistically significant difference between the groups with a moderate effect size (0.562). The findings confirm the effectiveness of the developed system in improving the quality of teaching and assessment of piano playing among students in higher educational institutions. The general conclusion from the analysis showed that the introduction of modern information technology in music education had a significant positive effect on learning to play the piano. Information technology can:

1. Increase students' motivation and stimulate their active participation in studies.
2. Provide convenient access to educational materials, which makes learning more flexible and accessible.
3. Provide an individual approach to learning for the effective development of skills.

The development and implementation of a piano teaching and assessment system based on modern information technology holds significant potential for enhancing learning and developing musical skills. The results of this study will assist teachers and educational institutions understand the benefits and possibilities of using information technology in music education. The contribution of this study lies in identifying key elements that promote and hinder the effectiveness of interactive technologies in the organization and assessment of music education, as well as evaluating their overall effectiveness. This provides valuable insights for the design and implementation of similar tools in the educational process. **Prospects for further research include** a higher focus on the development and implementation of innovative information technology in piano music education. It is important to research optimal strategies for using information technology and develop pedagogical approaches for the best implementation of new methods in music education. Further research could also investigate the impact of information technology on other aspects of music education and music creativity.

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## **Appendices**

### **Appendix A**

1. How do you rate the convenience and interface of the interactive piano learning system?
2. Has the system helped you improve your piano skills?
3. How do you rate the quality of video tutorials and interactive exercises available in the system?
4. Have you experienced an improvement in your piano playing level after using this system?
5. Did you have any difficulties using the system and how did you overcome them?
6. How do you rate the ability to record and rate your performance in this system?
7. Have you participated in a comparative experiment where one group used an intelligent system and the other used a traditional teaching method? What were the results?
8. If you were asked to suggest improvements or changes to this system, what would you suggest?
9. Have you experienced an increase in your motivation to learn the piano with this system?
10. If you could recommend this system to other students, would you? What advantages would you emphasize?
11. Have you participated in additional open classes, seminars, or competitions that were related to this system?
12. What do you think are the advantages of using modern information technology in music education?

### **Appendix B**

1. How do you rate the importance of using modern information technology in teaching the piano?
2. What advantages do you see in the use of information technology in teaching the piano?
3. Do you already use information technology when teaching the piano? Which exactly?
4. What disadvantages do you see in the application of information technology in teaching the piano?
5. Have you participated in the implementation of an IT-based piano teaching and assessment system? If so, what were the results?
6. What difficulties do you or your students encounter in the process of using information technology to teach the piano?
7. What opportunities do you see for further improvement of the system of teaching and evaluation of piano playing based on information technology?

8. How do you rate the readiness of other teachers to use information technology in piano lessons?
9. Does the university or college where you work have plans to further develop information technology in the teaching of music, particularly piano?
10. What recommendations would you make to improve the implementation of information technology in piano teaching?

# Uloga informacijske tehnologije u nastavi klavira: stavovi profesora s kineskih sveučilišta i studenata sa Sveučilišta u Pekingu

## Sažetak

Upotreba računala, specijaliziranoga softvera i izvora dostupnih online može učiniti nastavu klavira dostupnijom i motivirajućom. Ovo se istraživanje sastojalo od dva međusobno povezana dijela: preliminarnoga upitnika provedenoga na uzorku od 150 nastavnika klavira sa Sveučilišta u Pekingu (u dobi između 19 i 56 godina) kako bi se dobile informacije o razvoju i implementaciji obrazovnoga sustava u kojemu se primjenjuje tehnologija, a nakon toga je provedena eksperimentalna evaluacija. Proveden je upitnik za nastavnike s ciljem utvrđivanja potencijalnih izazova i prilika. U eksperimentalnoj studiji koja je uslijedila procjenjivala se učinkovitost takvoga sustava na dvjema skupinama učenika ( $N = 180$ ): u eksperimentalnoj skupini ( $n = 90$ ) korišten je sustav u kojemu su se nastavnici oslanjali na rezultate istraživanja i koristili tehnologiju, dok su se u kontrolnoj skupini ( $n = 90$ ) primjenjivale tradicionalne nastavne metode. Rezultati su pokazali značajno bolje rezultate u eksperimentalnoj skupini ( $M = 85,54$ ,  $SD = 10,01$ ) u usporedbi s kontrolnom skupinom ( $M = 75,32$ ,  $SD = 12,21$ ),  $t = 2,234$ ,  $p < 0,001$ , s umjerenom veličinom učinka (Cohenov  $d = 0,562$ ). Istraživanje je pokazalo da, iako su nastavnici prepoznali potencijalne dobrobiti integriranja tehnologije u nastavni proces (43 % nastavnika primijetilo je povećanu motivaciju učenika, a 17 % ih je smatralo da je fleksibilan pristup materijalima jako koristan), također su prepoznali i ključne izazove u procesu implementacije, poput poteškoća pri odabiru odgovarajućega softvera (52 %) i ograničene individualne kontrole u virtualnom okružju (44 %). Rezultati upućuju na to da nastava klavira koja se provodi pomoću tehnologije (kada se provodi uz nastavnikove upute) može uvelike poboljšati rezultate studenata u kontekstu Sveučilišta u Pekingu. Ovaj rad ima praktičnu važnost jer pokazuje kako moderna informacijska tehnologija može unaprijediti nastavu klavira, naglašavajući i prednosti i nedostatke te integracije.

**Ključne riječi:** digitalni materijali za učenje; glazbena pedagogija; informacijska tehnologija; inovativne nastavne metode; interaktivna nastava klavira

## Uvod

Tehnologija je značajno transformirala obrazovni proces tako što je olakšala komunikaciju između nastavnika, učenika i roditelja, a isto tako je omogućila zanimljiviju i interaktivniju nastavu koja odgovara potrebama učenika. Tehnologija ujedno omogućava učenicima lagan pristup materijalima i izvorima za učenje, što im pomaže da uče svojim individualnim tempom. No, ona zahtijeva složenije planiranje nastave i kurikula (Heick, 2022; Seitenov i sur., 2020). Razvoj umjetne inteligencije otvara mnoge mogućnosti za stvaranje, analizu i razvoj glazbe (Xue i Jia, 2022). Moderne telekomunikacijske i informacijske tehnologije uvelike se koriste u nastavi glazbe, uključujući i nastavu klavira. One omogućavaju transformaciju individualnih nastavnih sati u nastavu koja je interaktivna i dostupna cijeloj skupini, što snižava troškove i olakšava pristup. Preciznije rečeno, sustavi proširene stvarnosti koriste mobilne opcije i stvaraju nove načine učenja klavira koji su dostupni mnogima (Cui, 2023). Tehnologije koje se koriste u nastavi glazbe obuhvaćaju upotrebu mobilnih uređaja, interneta, interaktivnih bijelih ploča te računalnih programa. Sve one pružaju raznovrsne digitalne alate za učenje o teoriji glazbe, praktične zadatke i aktivnosti, mogućnosti sviranja prema notama i obrazovne igrice primjenom inovativnih nastavnih metoda (Klein, 2022).

Razvoj sveobuhvatnih glazbenih vještina u sviranju klavira dugotrajan je proces koji zahtijeva stalno usavršavanje i razvoj, a uključuje prepoznavanje problema, napredak u poznavanju glazbene teorije i vještina sviranja te korištenje učinkovitih metoda kako bi se kod učenika potaknulo razumijevanje i razvila kvaliteta i prilagodljivost pri sviranju klavira (Yang, 2021). Cijeli taj proces zahtijeva sustav procjene sposobnosti u nastavi klavira, a to je kompleksan model s brojnim indikatorima i atributima. No, on odražava i jedinstvenu strategiju i stalne promjene u indikatorima procjene. Opsežna procjena sposobnosti za učenje klavira obuhvaća raznovrsne čimbenike, kao što su društveni i osobni čimbenici te okolina, što je sve važno za uspješno učenje (Ma, 2022).

## Pregled literature

Povijest teorije i pedagogije glazbe razvila se iz klasičnih pristupa suvremenim inovativnim nastavnim metodama. U tom kontekstu trebamo kao primjer istaknuti Spitzerovu studiju, koja je posvećena analizi kasnoga Beethovenova stila. U svojem radu Spitzer (Spitzer, 2006) detaljno analizira Devetu simfoniju, Missu Solemnis, sonate za klavir te gudačke kvartete toga kompozitora, koje su sve postale most između klasične tradicije i romantizma. Spitzer ta djela interpretira kroz prizmu glazbenih i filozofskih ideja Theodora Adorna, vješto kombinirajući glazbenu semiotiku i kritičku teoriju. Njegova komparativna analiza uključuje usporedbu Adornovih ideja s idejama mislilaca poput Derride, Benjamina i Habermasa, kao i sa stajalištima suvremenih teoretičara glazbe. Rezultati pokazuju da Beethovenova kasna djela ne samo da pokazuju složenu glazbenu strukturu već sadrže i filozofsku kritiku prosvjetiteljskih ideja, oblikujući poseban glazbeni jezik predromantizma. Nadalje, važna prekretnica u razvoju glazbene

pedagogije bila je rasprava A. B. Marxa naslovljena *Die Lehre von der musikalischen Komposition*, što je u fokusu Spitzerova istraživanja iz 1998. godine (Spitzer, 1998).

Iako je Marx najviše poznat po tome što je klasificirao glazbene oblike, pogotovo sonatu, njegovi pedagoški pristupi zahtijevaju posebnu pažnju. Rasprava, slična onima koje su napisali Mattheson, Riepel i Koch, nije imala samo teorijsku, već i značajnu didaktičku vrijednost. Struktura prezentacije materijala ima ključnu ulogu u načinu na koji će se on razumjeti (dok je djelo izazvalo kritičke diskusije) zbog „kaotične kombinacije poznatih elemenata”. Međutim, studija je pokazala da je pedagoški aspekt rasprave duboko utkan u njegov teorijski sadržaj, čime se odbacuje tradicionalna percepcija da je ovo djelo čisto analitičke prirode. U suvremenom kontekstu, razvoj glazbene pedagogije nastavio se putem integracije novih tehnologija. Upotreba multimedijske tehnologije u nastavi klavira na koledžu i na sveučilištu olakšava proces učenja te ga tako čini lakše dostupnim i intuitivnim (Yang i Jung, 2023). Glavne prednosti su poboljšanje kvalitete obrazovanja i razvoj individualnih glazbenih talenata. Istraživači naglašavaju važnost razvoja i upotrebe takvih tehnologija, no upozoravaju i na postojeće nedostatke primjene multimedije. U drugom istraživanju ispitana je mogućnost korištenja internetske tehnologije za automatsko ocjenjivanje sviranja klavira. Istraživači su koristili metode usporedbe sustava umjetne inteligencije te izradu baze podataka i modela za skupljanje i analizu glazbenih uzoraka (Yu, 2021). To je rezultiralo praktičnim sustavom za automatsku evaluaciju sviranja klavira, a sustav se pokazao jako točnim i uspješnim. U ovome se istraživanju prikazuje usporedba sustava za automatsku evaluaciju sa standardnim načinom ocjenjivanja. Rezultati pokazuju da sustav za automatsku evaluaciju ima visoku stopu prepoznavanja i veliku brzinu rada, a uočena je i mogućnost korištenja toga sustava za učinkovitu procjenu sviranja klavira provedenu među učenicima. Ovo je istraživanje također pokazalo i potencijal za razvoj takvih sustava i njihovu primjenjivost u obrazovanju. On bi mogao biti koristan za evaluaciju izvedbe raznovrsnih glazbenih repertoara i pružanja točnih rezultata za studente klavira.

Stručnjaci su analizirali i razvoj nastave klavira i sve veću ulogu multimedijalnih računalnih programa u prevladavanju pojedinih poteškoća (Chen, 2022). Cilj je bio uvesti algoritam neuronske mreže u interaktivni sustav za učenje sviranja klavira kako bi se prevladale razlike između nastavnika i učenika, problemi nastali zbog nestabilne mrežne veze itd. Ovaj rad pruža teorijsku osnovu za algoritam neuronske mreže i opisuje njegovu primjenu u prepoznavanju govora i strukture sustava.

U drugome je istraživanju analizirana upotreba multimedijjskih nastavnih alata za glazbenu izvedbu tijekom nastave glazbe u kontekstu integracije znanja o predmetu (He i sur., 2022). Istraživanje je temeljeno na opažanjima u razredu i na analizi podataka. Prepoznate su razlike u upotrebi multimedijjskih računalnih programa između nastavnika koji su izvodili nastavu u naprednijim skupinama i onih koji su izvodili nastavu u redovnim skupinama. Rezultati upućuju na superiornost nastavnika koji su izvodili nastavu u naprednim skupinama u korištenju multimedijjskih računalnih programa i poboljšanje u akademskim postignućima. Ovo istraživanje prikazuje

korisne primjere za nastavnike glazbe koji im mogu pomoći u boljem korištenju multimedijske programe u svojoj nastavi.

Druga tema istraživanja bila je sve veća potražnja za *online* oblikom obrazovanja na sveučilištima, fakultetima i visokoškolskim ustanovama, posebno tijekom pandemije COVID-19 i razvoja internetske tehnologije općenito (Wu, 2023). Veliki je izazov bila učinkovitost *online* poučavanja o glazbenim vještinama kao što je sviranje klavira, što zahtijeva multisenzorno učenje. U radu se definiraju funkcionalni zahtjevi za *online* sustav za učenje klavira na sveučilištima i koledžima, a izrađena je ukupna struktura sustava, uključujući i softver i hardver, odabrana je metoda bežične mrežne komunikacije te je dizajniran sustav za učenje na daljinu koji se oslanja na bežičnu mrežu. Također se uspoređuju prednosti i nedostaci različitih algoritama protokola kako bi se poboljšala uspješnost učenja o glazbi u *online* okružju.

Još jedan istaknuti primjer transformacije nastave jest onaj iz Hong Konga, koji je istraživao Ho (2004). On je analizirao ishode implementacije vladine strategije „Informacijske tehnologije za kvalitetno obrazovanje” iz 1998. godine. Proučavajući povratne informacije 29 nastavnika i 543 učenika iz osnovnih i srednjih škola, uočio je da dobro integrirane informacijske tehnologije mogu znatno povećati motivaciju učenika i kvalitetu procesa učenja. Nadalje, važan korak u razvoju tehnoloških inovacija predstavlja istraživanje koje je proveo Li (2022a). On je prikazao nastavne metode u kojima se koriste videozapisi i grafika kako bi se prenijela živahna atmosfera i umjetnička obilježja sviranja klavira. Primjena metoda u kojima se koristi umjetna inteligencija, pogotovo neuronske mreže, za analizu videozapisa i slika pokazala je veliku učinkovitost i točnost u klasificiranju karakteristika sviranja klavira. Odlična je ilustracija tehnološkoga napretka u glazbenom obrazovanju sustav P.I.A.N.O., koji su izradili i evaluirali Rogers i sur. (2014). Ovaj inovativni sustav koristi interaktivnu projekciju kako bi ubrzao učenje tako što prikazuje note izravno na tipkovnici, što eliminira potrebu prethodnoga poznavanja notnoga sustava. Rezultati su potvrdili da P.I.A.N.O. ne samo da ubrzava usvajanje sadržaja i smanjuje kognitivno opterećenje, nego i znatno poboljšava cjelokupno iskustvo učenja i percepciju glazbene kvalitete, u usporedbi s tradicionalnim metodama.

Stoga se može reći da je evolucija u glazbenoj pedagogiji očita te održava prijelaz s klasičnih, teorijskih pristupa na suvremena tehnološka rješenja u učenju klavira. Međutim, pregled literature također pokazuje nekoliko važnih propusta, kojima se u našem istraživanju bavimo. Preciznije rečeno, do sada nije dovoljno ispitan kulturološki kontekst uvođenja tehnologije u glazbeno obrazovanje, pogotovo na kineskim sveučilištima gdje tradicionalni nastavni pristupi značajno utječu na prihvaćanje novih metoda koje koriste tehnologiju. To stvara dodatne izazove u integraciji modernih alata u poučavanje sviranja klavira. Malo je pažnje poklonjeno tome kako tehnologija može utjecati na razvoj kreativnih sposobnosti učenika i na njihovu motivaciju za učenje.

Cilj je našega istraživanja analizirati učinkovitost integracije informacijskih tehnologija u nastavu klavira, s naglaskom na procjeni njihovoga utjecaja na ishode

učenja studenata, utvrđivanju izazova na koje nastavnici nailaze tijekom provedbe te na ispitivanju kulturoloških aspekata integracije informacijske tehnologije u nastavu klavira na kineskim sveučilištima.

Ciljevi istraživanja:

1. Analiza nastavničkih iskustava i izazova na koje nailaze tijekom uvođenja informacijske tehnologije u nastavu klavira.
2. Evaluacija glavnih prednosti i ograničenja učenja klavira pomoću tehnologije, iz perspektive nastavnika i perspektive studenata.
3. Usporedba ishoda učenja postignutih pomoću tradicionalnih metoda i pomoću napredne tehnologije u nastavi klavira, provedena kvantitativnom analizom.

## **Metodologija**

### ***Nacrtno istraživanje***

**Prva faza** istraživanja sastojala se od upitnika za nastavnike koji su zaposleni na Sveučilištu u Pekingu. Autori su koristili standardizirane upitnike o pedagoškom iskustvu, stavovima o upotrebi informacijske tehnologije u nastavi te spremnosti za uvođenje inteligentnih sustava za učenje. Upitnik je izrađen u obliku Googleovog obrasca. Sudionici su upitniku pristupili preko poveznice koja im je poslana na službene e-adrese. Upitnik je proveden u digitalnom obliku i za ispunjavanje je bilo potrebno računalo ili mobilni uređaj s pristupom internetu. Upitnik se sastojao od pitanja višestrukoga odabira ili pitanja s poljima u koja su se upisivali odgovori. Sudionici su mogli pregledati stranice s pitanjima, vratiti se na prethodne odgovore te unijeti svoje odgovore. Ovaj pristup omogućio je praktično i učinkovito prikupljanje podataka, kao i čuvanje i analizu odgovora.

**Druga faza** istraživanja bila je eksperimentalna studija provedena na Sveučilištu u Pekingu, a obuhvatila je dvije skupine: kontrolnu skupinu ( $n = 90$ ) i eksperimentalnu skupinu ( $n = 90$ ). Glavni joj je cilj bio procijeniti učinkovitost novoga sustava za poučavanje i evaluaciju sviranja klavira temeljenoga na modernoj informacijskoj tehnologiji među studentima.

### ***Uzorak istraživanja***

Eksperiment je uključio 180 studenata sa Sveučilišta u Pekingu (63 muškog i 117 ženskog spola). Cilj istraživanja bio je procijeniti učinkovitost izrađenoga sustava za nastavu i ocjenjivanje sviranja klavira, temeljenoga na modernoj informacijskoj tehnologiji na studentskoj populaciji. Kako bi se taj cilj ostvario, provedeno je istraživanje s kontrolnom ( $n = 90$ ) i s eksperimentalnom skupinom ( $n = 90$ ). Sudionici su bili nasumično podijeljeni u kontrolnu i eksperimentalnu skupinu. Obje su skupine imale sličnu strukturu i osnovne vještine sviranja klavira.

**Za eksperimentalnu skupinu** autori su izradili i primijenili interaktivni sustav za učenje sviranja klavira, koji se zasniva na korištenju napredne informacijske tehnologije i modernih nastavnih metoda. Sustav se sastojao od sljedećih ključnih komponenti (Tablica 1).

## Tablica 1

Ovaj interaktivni sustav za učenje sviranja klavira izrađen je kako bi se poboljšala kvaliteta poučavanja i kako bi se studentima pomoglo da uvijekbavaju i razvijaju svoje vještine sviranja klavira koristeći inovativnu informacijsku tehnologiju.

**Kontrolna skupina** sastojala se od studenata koji su pohađali sate sviranja klavira organizirane na tradicionalni način, bez inteligentnoga sustava za učenje. S ciljem osiguranja objektivnosti eksperimenta i komparativne analize, nastavni proces u kontrolnoj skupini izgledalo je ovako:

– Tradicionalni nastavni sati: studenti u kontrolnoj skupini pohađali su nastavne sate klavira organizirane na tradicionalni način, u učionicama ili studiju s nastavnicima klavira. Njihova se nastava odvijala u stvarnom vremenu, a nastavnici su im demonstrirali sviranje.

– Udžbenici i note: studenti su koristili udžbenike i note za učenje glazbenih kompozicija. Proučavali su note, tehniku i interpretaciju na papiru i s nastavnicima.

– Evaluacija: Vještine studenata iz kontrolne skupine ocjenjivane su pomoću tradicionalnih metoda kao što su javna izvedba i ocjene nastavnika.

Eksperiment je trajao jedan semestar. Na kraju eksperimenta istraživači su ocijenili i usporedili obje skupine koristeći praktične i teorijske testove te su analizirali izvedbu glazbenih kompozicija na klaviru. Ova je evaluacija uključila stručnjake u području nastave glazbe.

Na temelju dobivenih rezultata autori su procijenili učinkovitost primjene inteligentnoga sustava za učenje sviranja klavira u usporedbi s tradicionalnim načinom poučavanja. Eksperiment je omogućio objektivnu procjenu prednosti i nedostataka korištenja moderne informacijske tehnologije u nastavi klavira, u usporedbi sa standardnim načinom provedbe nastave. Autori su nakon eksperimentalnoga istraživanja proveli upitnik kako bi dobili dodatne informacije i saznali dojmove sudionika o obama nastavnim pristupima [Prilog A].

## **Uzorak istraživanja**

Svrha upitnika bila je od nastavnika zaposlenih na Sveučilišta u Pekingu prikupiti i analizirati podatke o razvoju i primjeni sustava za učenje i ocjenjivanje sviranja klavira koji se zasniva na korištenju moderne informacijske tehnologije. Glavni je cilj bio saznati njihova mišljenja i stavove o novim metodama poučavanja i ocjenjivanja, kao i utvrditi mogućnosti i ograničenja primjene takvoga sustava na sveučilišnoj razini.

Uzorak se sastojao od 150 nastavnika zaposlenih na Sveučilištu u Pekingu (muškoga i ženskoga spola, dobi u rasponu od 19 do 56 godina). Autori su proveli upitnik koristeći standardizirani oblik upitnika s pitanjima o iskustvu u poučavanju glazbe i nastavi klavira, stavovima o korištenju informacijske tehnologije u obrazovanju te spremnosti za korištenje inteligentnih sustava za učenje. Upitnik je konstruiran tako da odražava ciljeve istraživanja što je točnije moguće te da se dobiju potrebni podatci [Prilog B].

## **Statistička analiza**

Za provedbu statističke analize korišten je statistički računalni programski paket SPSS. Proveden je t-test za studente kako bi se usporedile srednje vrijednosti dvaju nezavisnih uzoraka i kako bi se testirale hipoteze o jednakosti srednjih vrijednosti u uzorcima. Provedeni su Levenov test homogenosti varijance i Shapiro-Wilkov test normalnosti kako bi se provjerile potrebne pretpostavke. Nakon što su ispunjeni preduvjeti za primjenu t-testa za studente, autori su mogli izračunati rezultate t-testa i razinu značajnosti (P vrijednost).

## **Etički aspekti**

Svi sudionici u istraživanju dali su svoj dobrovoljni pristanak za sudjelovanje. Obaviješteni su unaprijed o cilju i uvjetima istraživanja te su imali priliku odbiti sudjelovanje bez ikakvih negativnih posljedica. Osobni podatci o sudionicima nisu prikupljeni tijekom istraživanja.

## **Rezultati**

Prema rezultatima upitnika, informacijske tehnologije imale su važan utjecaj na povećanu motivaciju studenata za učenje klavira, kako je istaknulo 43 % ispitanika (Slika 1). Interaktivni zadatci, *online* izvori i praćenje napretka bili su odličan poticaj za trajno učenje. Osim toga, nastavnici su istaknuli prednost praktičnoga pristupa materijalima za učenje, što je studentima pomoglo pri učenju kod kuće ili u vrijeme koje im je najviše odgovaralo (17 %).

### Slika 1

Ukupno je 16 % nastavnika uočilo mogućnost prilagodbe nastavnih materijala individualnim potrebama studenata, što je olakšalo personalizirano učenje. 24 % nastavnika istaknulo je napredak u prilikama za komunikaciju jer je informacijska tehnologija olakšala interakciju i omogućila brze odgovore na pitanja studenata putem e-pošte, foruma ili *chata*.

### Slika 2

Međutim, nastavnici su prepoznali nekoliko značajnih izazova pri korištenju informacijske tehnologije u nastavi klavira (Slika 2). Jedan od najvećih jest problem odabira odgovarajućega obrazovnog programa i alata (52 %) jer tržište nudi puno opcija, a odabir najboljih alata zahtijeva puno vremena i utječe na uspješnost u učenju. Nedostatak je i nemogućnost fizičkoga, individualnog praćenja studenata u virtualnom okruženju (44 %), što bi moglo dovesti do gubitka kontrole nad procesom učenja. Studentima s različitom razinom motivacije i samodiscipline potreban je veći angažman nastavnika kako bi bili uspješni u učenju. Nadalje, neki su nastavnici izrazili zabrinutost da će studenti postati previše ovisni o tehnologiji (4 %), što bi moglo ograničiti njihovu sposobnost sviranja bez računala i računalnih programa, a to bi imalo negativan utjecaj na razvoj praktičnih glazbenih vještina.

U nastavku slijede povratne informacije nastavnika koje ilustriraju izazove s kojima su se susreli prilikom korištenja informacijske tehnologije u nastavi klavira:

Sudionik br. 1:

„Odabir optimalnoga računalnog programa zahtijeva puno vremena. Iskreno govoreći, to smanjuje učinkovitost procesa učenja. Mnogi programi ili ne odgovaraju potrebama mojih studenata ili su previše složeni za njihovu razinu. Umjesto da jednostavno započnem nastavni sat, često gubim vrijeme tražeći bolje opcije.”

Sudionik br. 2:

„Kada radite sa studentima *online*, ne možete izravno promatrati njihovu tehniku ili njihov rad. Svaki student ima različitu razinu samodiscipline pa je bez stalnoga nadgledanja teško procijeniti njihov napredak.”

Sudionik br. 3:

„Ponekad mi se čini da se studenti više fokusiraju na računalni program nego na sam proces sviranja. Više se oslanjaju na to da će softver ocijeniti njihovo sviranje, što bi moglo ograničiti njihove stvarne glazbene sposobnosti. Bojim se da ako studenti nemaju pristup tehnologiji, neće moći svirati bez pomoći računala.”

Sudionik br. 4:

„Mnogi studenti imaju poteškoće u svladavanju novih digitalnih alata i programa, posebno u ranim fazama učenja. Pokušavam im pomoći, ali mi za to treba puno više vremena nego što sam planirao. Često moram pomagati riješiti tehničke poteškoće kako bi se studenti mogli usredotočiti na glazbu umjesto na korištenje programa.”

Dalje ćemo analizirati rezultate eksperimenta provedenoga sa studentima.

Tablica 2

Analiza rezultata iz Tablice 2 pokazuje opću pozitivnu evaluaciju inteligentnoga sustava za učenje sviranja klavira. Većina studenata (65 %) smatra da je sučelje sustava intuitivno i lako za korištenje. 70 % ih je navelo da je sustav unaprijedio njihove vještine sviranja klavira, a 67 % ih je uočilo značajan napredak. Kvaliteta videolekcija i interaktivni zadatci također su pozitivno ocijenjeni, iako 20 % studenata smatra da ih je potrebno još doraditi. 60 % studenata smatra da je sustav koristan i da je mogućnost snimanja i preslušavanja onoga što su odsvirali jako praktična, dok ih 10 % smatra da sustav nije koristan. Nadalje, 40 % ih smatra da bi korisno bilo uvesti veću interaktivnost i opcije koje omogućavaju bolju prilagodbu korisniku. Većina studenata (55 %) je uočila napredak u svojim vještinama sviranja te su voljni preporučiti sustav drugima (70 %), što pokazuje njegovu učinkovitost. Dakle, ovi rezultati pokazuju da je interaktivni sustav za sviranje klavira od studenata dobio visoke ocjene i da je većina studenata uočila napredak u razvoju vlastitih vještina, kao i lakoću korištenja sustava. Međutim, postoje još područja koja je potrebno doraditi – uglavnom ona koja se tiču interaktivnosti, prilagodbe korisniku te kvalitete sadržaja.

Da zaključimo, većina studenata smatra da je sustav pozitivan i koristan u njihovom studiju, što potvrđuje uspjeh razvoja i primjene sustava za poučavanje i evaluaciju sviranja klavira temeljenoga na modernoj informacijskoj tehnologiji (Tablica 2).

### Tablica 3

Usporedba razine razvijenosti vještina između dviju skupina provedena pomoću t-testa pokazala je da eksperimentalna skupina, koja je učila svirati klavir koristeći sustav za učenje i sviranje klavira postigla znatno bolje rezultate od kontrolne skupine, koja je učila pomoću tradicionalnih metoda. Veličina učinka, prema Cohenovoj vrijednosti  $d(0,562)$ , pokazuje umjerenu razinu učinka. Tako je ovaj rezultat potvrdio značajnu razliku između rezultata dviju skupina. Eksperimentalna skupina, koja je koristila novi sustav za poučavanje i evaluaciju sviranja klavira temeljenoga na modernoj informacijskoj tehnologiji, pokazala je znatno bolju izvedbu u usporedbi s kontrolnom skupinom. Postoje razlozi zbog kojih se može smatrati da je korišteni sustav poboljšao kvalitetu nastave i evaluacije sviranja klavira među studenata u institucijama visokoga obrazovanja.

Uz to, kulturološki čimbenici (mentalitet, odgoj i odgojno-obrazovno okružje) značajno utječu na percepciju i upotrebu informacijske tehnologije u nastavi klavira na kineskim sveučilištima. Tradicionalni pristup obrazovanju u Kini, koji naglašava disciplinu i ovladavanje tehničkim vještinama, može probuditi otpor prema novim metodama koje zahtijevaju personalizirani pristup.

Na primjer, u kineskoj se kulturi veliki naglasak stavlja na poštivanje autoriteta nastavnika, što može utjecati na percepciju o tehnološkim inovacijama kao manje ozbiljnim ili neformalnim. Međutim, rezultati istraživanja pokazuju da interaktivni zadatci i *online* izvori značajno povećavaju razinu motivacije studenata i pristup obrazovnim materijalima te ih istovremeno prilagođavaju potrebama modernoga obrazovanja.

## Rasprava

Zbog intenzivnoga razvoja informacijske tehnologije napredne računalne tehnologije i informatička rješenja nalaze svoju primjenu u području glazbe (Lv, 2023). Umjetna inteligencija (UI), kao rezultat aktivnoga razvoja informacijske tehnologije, postaje ključan čimbenik koji je nadopuna glazbenom obrazovanju (Li, 2022b). Kombinacija inteligentne tehnologije i učenja licem u lice pomoću umjetne inteligencije pomaže riješiti problem nedostatka individualnoga pristupa u tradicionalnim nastavnim metodama te povećava interes studenata za učenje (Yu i sur., 2023). Inovacije u visokoškolskom obrazovanju smatraju se važnim mehanizmom za uvođenje moderne informacijske i komunikacijske tehnologije s ciljem poboljšanja obrazovnoga procesa (Yin, 2023). Te su inovacije usmjerene na povećanu interaktivnost i praktičnost tijekom nastave u učionicama, da bi se proces učenja učinio što učinkovitijim i privlačnijim. Takav pristup glazbenom obrazovanju na razini visokoga školstva uzima u obzir potencijal

koji moderna tehnologija ima u svrhu promjene načina učenja i za unaprjeđenje kvalitete glazbenoga obrazovanja (Yu, 2021). Na primjer, upotreba proširene stvarnosti u nastavi klavira inovativan je pristup u razvoju glazbenoga obrazovanja. Tradicionalni računalni alati i hardver aktivno se koriste u učenju glazbe, a proširena stvarnost može uvesti novu razinu interaktivnosti (Chen, 2023). Tehnologija čuvanja podataka u oblaku i umrežene platforme također donose inovacije u učenju sviranja klavira. Vrijeme i mjesto često ograničavaju tradicionalni način izvođenja glazbenih djela, no platforma u oblaku može pomoći prevladati ta ograničenja. Ona omogućava kreiranje nastavnoga sata sviranja klavira pomoću digitalnih alata i internetskih izvora, što čini učenje pristupačnijim i učinkovitijim za studente (Tu i Peng, 2020). Razvoj *online* izvora za nastavu glazbe u Kini u posljednjih je nekoliko godina jako uspješan. Ipak, postoje izazovi poput ograničenoga broja regionalnih *online* izvora i neučinkovitoga načina pretraživanja (Yan, 2022). Zbog toga je razvoj interaktivnoga sustava za učenje sviranja klavira jako složen proces koji uključuje napredne metode i moderne tehnologije (Liu i Huang, 2021).

Rezultati ovoga istraživanja potvrđuju važnost i učinkovitost razvijenoga sustava poučavanja i evaluacije sviranja klavira temeljenoga na modernoj informacijskoj tehnologiji. Analiza je pokazala da je eksperimentalna skupina, koja je koristila novi IT sustav za poučavanje i evaluaciju nastave klavira pokazala značajno poboljšanje u usporedbi s kontrolnom skupinom. Stoga se može reći da je sustav pomogao unaprijediti kvalitetu nastave i evaluacije sviranja klavira među studentima u institucijama visokoga obrazovanja.

Slično tome, u jednom se istraživanju ispitivala upotreba virtualne stvarnosti u nastavi klavira i upotreba specijaliziranih programa i digitalnih uređaja (Feng, 2023). Pokazalo se da tehnologija virtualne stvarnosti ima veliku preciznost u prepoznavanju pokreta korisnika i istaknute su mogućnosti korištenja takve tehnologije u glazbenom obrazovanju. U drugom istraživanju koje su proveli kineski stručnjaci proučavana je upotreba interneta i multimedijske tehnologije s ciljem razvoja kvalitete učenja sviranja klavira, a korišten je i algoritam umjetnoga jata riba kako bi se poboljšao proces učenja (Wang i Bai, 2022). Istraživanje je omogućilo novi pristup inteligentnom učenju u glazbenom obrazovanju. U trećem je istraživanju ispitivan utjecaj moderne *online* tehnologije na glazbeno obrazovanje i uloga nastavnika u njemu (Yao i Li, 2023). Naglašena je važnost uravnoteženoga pristupa koji kombinira primjenu moderne tehnologije i sudjelovanje nastavnika u obrazovnom procesu. Rezultati su pokazali potrebu za razvojem glazbenih vještina i individualnih sposobnosti studenata upotrebom računalnih aplikacija i programa. Usporedba ovih istraživanja s našim istraživanjem pokazala je neke zajedničke, kao i neke različite aspekte:

1. Upotreba tehnologije. Sva tri istraživanja bave se upotrebom informacijske tehnologije s ciljem unaprjeđenja učenja sviranja klavira. Naše istraživanje također se bavi proučavanjem informacijske tehnologije, kao što je sustav za poučavanje i evaluaciju sviranja klavira temeljen na modernom računalnom programu.

2. Motivacija studenata. Sva tri istraživanja pokazala su pozitivan utjecaj tehnologije na motivaciju studenata. Naši rezultati također pokazuju povećanu motivaciju jer su studenti bili zainteresirani za novi sustav poučavanja i evaluacije.

3. Kvaliteta obrazovanja. Dva od tri istraživanja pokazala su poboljšanje u kvaliteti učenja primjenom tehnologije. Međutim, rezultati našega istraživanja pokazali su razliku između skupina, pri čemu je eksperimentalna skupina, u kojoj se koristio novi sustav poučavanja i evaluacije, imala bolje rezultate u izvedbi nego kontrolna skupina.

4. Prednosti i poteškoće. U svim su istraživanjima uočene prednosti korištenja tehnologije, kao što je praktičan pristup obrazovnim materijalima i mogućnost individualnoga pristupa. Isto tako, sva su tri istraživanja istaknula poteškoće povezane s tehničkim aspektima i pružanjem podrške korisnicima.

Općenito gledajući, ovo istraživanje dalo je dodatne spoznaje već postojećem znanju i tako potvrdilo pozitivan utjecaj moderne informacijske tehnologije na učenje sviranja klavira i dokazalo da postoji značajno poboljšanje u izvedbi studenata kada koriste novi sustav poučavanja i evaluacije.

### **Ograničenja istraživanja**

U ovom je istraživanju primijenjen kvaziekperimentalni nacrt koji ograničava mogućnosti analiziranja dobivenih rezultata. Osim toga, ograničenja mogu biti povezana i s posebnostima primjene obrazovnih programa u različitim institucijama visokoga obrazovanja. Isto tako, ograničenja mogu biti povezana i s posebnostima softvera koji je korišten u raznim komponentama sustava za poučavanje i evaluaciju sviranja klavira. Rezultati sličnoga istraživanja mogu se razlikovati zbog specifičnosti korištenoga softvera.

### **Zaključak**

Usporedba srednjih vrijednosti izvedbe u eksperimentalnoj i u kontrolnoj skupini pokazala je statistički značajnu razliku između skupina, s umjerenom veličinom učinka (0,562). Rezultati pokazuju učinkovitost razvijenoga sustava u unaprjeđenju kvalitete poučavanja i evaluacije sviranja klavira studenata u institucijama visokoga obrazovanja. Opći je zaključak analize pokazao da uvođenje moderne informacijske tehnologije u glazbeno obrazovanje ima pozitivan utjecaj na učenje sviranja klavira. Informacijska tehnologija može:

1. povećati motivaciju studenata i stimulirati ih na aktivno sudjelovanje u nastavnom procesu
2. pružiti praktičan pristup obrazovnim materijalima, što učenje čini fleksibilnijim i dostupnijim
3. omogućiti individualni pristup učenju s ciljem učinkovitoga razvoja vještina.

Izrada i primjena sustava za poučavanje i evaluaciju sviranja klavira temeljenoga na modernoj informacijskoj tehnologiji ima značajan potencijal za unaprjeđenje učenja

i razvoj glazbenih vještina. Rezultati ovoga istraživanja pomoći će nastavnicima i obrazovnim institucijama bolje razumjeti prednosti i mogućnosti korištenja informacijske tehnologije u glazbenom obrazovanju. Doprinos ovoga istraživanja leži u prepoznavanju ključnih elemenata koji promiču i ometaju učinkovitost interaktivne tehnologije u organizaciji i evaluaciji nastave glazbe, kao i u procjeni njegove ukupne učinkovitosti. Ono pruža vrijedne smjernice za izradu i primjenu sličnih alata u obrazovnom procesu. **Preporuke za buduća istraživanja** uključuju veću usredotočenost na izradu i primjenu inovativne informacijske tehnologije u nastavi klavira. Važno je istražiti optimalne strategije za korištenje informacijske tehnologije i razviti pedagoške pristupe za najbolju implementaciju novih metoda u glazbenom obrazovanju. Daljnja bi istraživanja također mogla ispitati utjecaj informacijske tehnologije na druge aspekte glazbenoga obrazovanja i glazbenu kreativnost.

## Prilozi

### Prilog A

1. Kako biste ocijenili praktičnost i sučelje interaktivnoga sustava za učenje klavira?
2. Je li vam sustav pomogao unaprijediti vlastite vještine sviranja klavira?
3. Kako biste ocijenili kvalitetu videouputa i interaktivnih zadataka dostupnih u sustavu?
4. Jeste li osjetili da su se vaše vještine sviranja poboljšale nakon korištenja ovoga sustava?
5. Jeste li pri korištenju sustava naišli na neke poteškoće i kako ste ih riješili?
6. Kako biste ocijenili mogućnost snimanja i ocjenjivanja vašega sviranja u ovom sustavu?
7. Jeste li sudjelovali u komparativnom eksperimentu u kojemu je jedna skupina koristila inteligentni sustav, a druga tradicionalne nastavne metode? Kakvi su bili rezultati?
8. Da vas se pita o prijedlozima za poboljšanje ili promjene ovoga sustava, što biste predložili?
9. Jeste li osjetili veću motivaciju za učenje sviranja klavira tijekom korištenja ovoga sustava?
10. Biste li sustav preporučili drugim studentima? Koje biste prednosti naglasili?
11. Jeste li sudjelovali u dodatnim otvorenim satima, seminarima ili natjecanjima koja su povezana s ovim sustavom?
12. Što mislite da su prednosti korištenja moderne informacijske tehnologije u glazbenom obrazovanju?

## **Prilog B**

1. Kako biste ocijenili važnost korištenja moderne informacijske tehnologije u nastavi klavira?
2. Koje ste prednosti upotrebe informacijske tehnologije u nastavi klavira uočili?
3. Koristite li već informacijsku tehnologiju u svojoj nastavi klavira? Koju tehnologiju koristite?
4. Koje nedostatke primjene informacijske tehnologije u nastavi klavira uočavate?
5. Jeste li sudjelovali u provedbi sustava za poučavanje i evaluaciju sviranja klavira pomoću informacijske tehnologije? Ako jeste, kakvi su bili rezultati?
6. Na koje ste poteškoće vi ili vaši studenti naišli tijekom primjene informacijske tehnologije u nastavi klavira?
7. Koje prijedloge imate za daljnji razvoj sustava za poučavanje i evaluaciju sviranja klavira temeljenoga na modernoj informacijskoj tehnologiji?
8. Kako biste ocijenili spremnost drugih nastavnika za primjenu informacijske tehnologije u nastavi klavira?
9. Ima li sveučilište ili fakultet na kojemu radite ikakve planove za daljnji razvoj informacijske tehnologije za nastavu glazbe, tj. nastavu klavira?
10. Što biste preporučili za poboljšanje primjene informacijske tehnologije u nastavi klavira?