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THE USE OF VIRTUAL PLATFORMS IN TEACHING TO PLAY BASS GUITAR

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SUMMARY. The aim of this article is an empirical study of the effectiveness of learning to play the bass guitar using virtual platforms. The empirical study employed such methods as the non-parametric Student's t-test, the parametric Levene's test, SWOT analysis and the interview method, the SPSS Statistics 26 package. The results showed a statistically significant improvement in the academic performance of students in the experimental group (EG) after using digital teaching methods, with an increase in average scores when playing the bass guitar by 6.25 points. Intragroup comparisons showed statistically significant improvements (p-value = .000) in the studied subject in the EG. The conclusions emphasize the importance of using digital learning methods to improve academic performance, offering valuable empirical data for the development of educational practices and the basis for further research in this area. Research prospects are based on the need to develop interactive and multimedia resources in the context of studying different forms of art, which contribute to improving the understanding and involvement of students.

Keywords: musical education, bass guitar, virtual platform, academic performance, online learning

Introduction

Digital technologies are actively used in modern education in different countries, which is explained not only by the rapid digitalization process, but also by the need to develop new educational approaches[2]. Music education

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[2] Attah, Tom, et al. "Teaching Music Theory in UK Higher Education Today: Contexts and Commentaries." In *Music Education Research*, Taylor & Francis, 26(1), 2024, pp. 71-81. https://doi.org/10.1080/14613808.2024.2306650

is no exception, where the technologies has been increasingly used to a greater extent since the pandemic, when offline learning became impossible[3,4]. For example, online platforms and virtual reality technologies offer new opportunities for learning to play musical instruments[5,6]. Recognizing the role of digital technologies in the 21st century, researchers have raised questions about the effectiveness of such tools, including in music education[7,8]. Interdisciplinary teaching methods can, however, complement this context, because the essence of such programmes is to combine knowledge and skills from different fields to achieve a more comprehensive and in-depth understanding of the subject[9].

Analysis of the effectiveness of learning through online platforms and virtual reality is considered so important because modern technologies offer unique opportunities for universities and schools[10,11]. Online platforms and virtual reality environments can adapt educational programmes to individual learner preferences by using the potential of a deeply interactive and personalized learning experience[12,13]. Such innovations can give students

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3 Hasenhütl, Gert. "Manual Drawing in Transformation: A Brief Assessment of "Design-by-Drawing" and Potentials of a Body Technique in Times of Digitalization." In *Journal of Aesthetic Education*, University of Illinois Press, 54(2), 2020, pp. 56–74. https://doi.org/10.5406/jaesteduc.54.2.0056

4 O'Neill, Edward R. "A Common Arts Instructional Method and the Logic of Design." In *Journal of Aesthetic Education*, University of Illinois Press, 58(1), 2024, pp. 108–124. https://doi.org/10.5406/15437809.58.1.06

5 Gubbins, Edmond. "Teacher Habitus as/at the Nexus of Practice: Musical Futures and Irish Primary Schools." In *Music Education Research*, Routledge, 25(5), 2023, pp. 562–576. https://doi.org/10.1080/14613808.2023.2277200

6 Gao, Hongjiao, and Li, Fan. "The Application of Virtual Reality Technology in the Teaching of Clarinet Music Art under the Mobile Wireless Network Learning Environment." In *Entertainment Computing*, Elsevier, 49, 2024, 100619. https://doi.org/10.1016/j.entcom.2023.100619

7 Kassing, Gayle, & Jay, Danielle M. *Dance teaching methods and curriculum design: comprehensive K-12 dance education*. Champaign: Human Kinetics Publishers, 2020.

8 Rahimi, Ramy A., and Oh, Grace S. "Rethinking the Role of Educators in the 21st Century: Navigating Globalization, Technology, and Pandemics." In *Journal of Marketing Analytics*, Palgrave Macmillan, 2024, pp. 1-16.

9 Vess, Deborah, and Linkon, Sherry. "Navigating the Interdisciplinary Archipelago: The Scholarship of Interdisciplinary Teaching and Learning." In *Disciplinary styles in the scholarship of teaching and learning*. Eds. Mary Taylor Huber, and Sherwyn P. Morreale. New York: Routledge, 2023, pp. 87-106.

10 Di Natale, Anna F., et al. "Immersive Virtual Reality in K-12 and Higher Education: A 10-Year Systematic Review of Empirical Research." In *British Journal of Educational Technology*, BERA, 51(6), 2020, pp. 2006-2033.

11 Mystakidis, Stylianos, Berki, Eleni, and Valtanen, Juri P. "Deep and Meaningful E-Learning with Social Virtual Reality Environments in Higher Education: A Systematic Literature Review." In *Applied Sciences*, MDPI, 11(5), 2021, 2412. https://doi.org/10.3390/app11052412

12 Childs, Elizabeth, et al. "An Overview of Enhancing Distance Learning through Emerging Augmented and Virtual Reality Technologies." In *IEEE Transactions on Visualization and Computer Graphics, IEEE,* 30(8), 2023, pp. 4480-4496

13 Liao, Ruoyuan. "Virtual Reality Technology in Art Education System." In Design Studies and Intelligence Engineering. Eds. Jain, L.C., et al. Hangzhou: IOS Press, 2024, pp. 58-69

access to a variety of educational resources, engage them in new ways, and overcome limitations imposed during traditional classes[14]. The motivation for studying the effectiveness of such teaching methods arises from scanty empirical research and the need to understand how well the digital tools under consideration can complement or replace established approaches. The global challenges such as the recent pandemic emphasized the need to develop and improve distance learning technologies[15]. Besides, the effectiveness of digitalization demonstrates the possibility of introducing virtual and augmented reality environments that offer new forms of interaction with interdisciplinary educational content[16].

The aim of the article is to empirically study the effectiveness of teaching bass guitar using virtual platforms. The aim involved the fulfilment of the following research objectives:

1. Analyse intragroup indicators of academic performance in the bass guitar course, determining the level of significance when comparing pre-test and post-test indicators.

2. Compare pre-test and post-test indicators of academic performance of the CG and EG when playing the bass guitar.

3. Identify the strengths, weaknesses, opportunities, and threats of teaching to play bass guitar using virtual platforms through SWOT analysis.

Literature review

Many researchers from different countries explore the specifics of the effective use of modern technologies in teaching, in particular music. Spanish researchers J. Martin-Gutierrez et al.[17] studied the features of using augmented reality in acoustic guitar teaching. The experiment was conducted at the University of Monterrey (Mexico) among students who had never played guitar before and those who had already had such experience, in order to test in practice whether augmented reality is effective in learning to play a musical instrument. The researchers developed an educational programme in which they proposed using a special application with a 3D model of an

[14] Almusaed, Amjad, et al. “Enhancing Student Engagement: Harnessing “AIED”’s Power in Hybrid Education — A Review Analysis.” In *Education Sciences*, MDPI, 13(7), 2023, 632.

[15] Zarei, Soraya, and Mohammadi, Shahriar. “Challenges of Higher Education Related to E-Learning in Developing Countries during COVID-19 Spread: A Review of the Perspectives of Students, Instructors, Policymakers, and ICT Experts.” In *Environmental Science and Pollution Research*, Springer, 29(57), 2022, pp. 85562-85568. https://doi.org/10.1007/s11356-021-14647-2

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[17] Martin-Gutierrez, Jorge, et al. “Augmented Reality to Facilitate Learning of the Acoustic Guitar.” In *Applied Sciences*, MDPI, 10(7), 2020, 2425. https://doi.org/10.3390/app10072425

acoustic guitar and a hand. This gives students the opportunity to learn to play guitar independently without the teacher's help, repeating after the hand from the application.

In Italy, a study was conducted on the possibilities of using UbiMus technology in teaching guitar[18]. After studying the latest developments in educational technology, Turchet and Barthet propose a smart guitar system that enables collaborative learning promoting positive emotional and creative interactions between students.

Norwegian researchers S. Havre et al. conducted an experiment using the music video game Rocksmith to teach electric and bass guitar[19]. The experiment involved students and music teachers to determine the role of video games in the development of professional competencies. Over a year, the authors of the study monitored the features of learning with the help of Rocksmith, the development of musical skills, and also collected feedback from the experiment participants.

In Denmark, a study was conducted using mobile virtual reality in primary school music education[20]. The experiment involved students aged 10 years, who were offered training using the VR4EDU virtual reality-based mobile application. The study conducted at a Chinese university was based on a comparison of music learning in two groups: an experimental group that learned through virtual reality and a control group that had traditional online learning[21].

The researchers in Canada examined the effectiveness of mixed reality in teaching how to play musical instruments[22]. The participants in the experiment learned to play the electronic musical instrument — theremin — without physically touching its surface in an immersive educational environment.

A study conducted in Taiwan was based on the use of a virtual guitar

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based on a 3D Kinect device in music education[23]. Kinect functionality involves using natural gestures to produce synthetic sounds similar to the sounds of real musical instruments. During the experiment, the researchers developed a finger tracking algorithm that can be used when playing a virtual guitar.

A case study conducted in Belgium and Serbia examined the use of augmented reality in teaching cellists using a 2D and 3D teacher model[24].

The experiment using the mixed reality application Passthrough in piano teaching was conducted in Spain[25]. The researchers developed a colour rendering application for teaching pianists and compared its effectiveness with another application with similar functionality — Synthesia.

In Luxembourg, the use of interactive technologies, in particular virtual reality, in teaching the violin and drum set was studied based on a teacher survey[26].

The analysis of studies by the researchers from different countries gives grounds to conclude that there is active research into the use of virtual reality technology in teaching how to play various musical instruments. However, the issue of the effectiveness of virtual platforms in bass guitar teaching has not been sufficiently studied, which indicates the relevance and necessity of this study.

Methods and materials

Research design

The respondents' academic grades for the first half of the year in the bass guitar course were used as the pre-test values. The study itself began in October 2023, when students were selected and assigned to the CG and EG, while ensuring internal homogeneity of the sample. Next, the CG continued their classical lessons on the subject under study without experiencing any changes. At the same time, digital learning methods were integrated into the EG programme to provide bass guitar training through

[23] Hakim, Noorkholis L., et al. "Virtual Guitar: Using Real-Time Finger Tracking for Musical Instruments." In *International Journal of Computational Science and Engineering,* Inderscience, 18(4), 2019, pp. 438-450. https://doi.org/10.1504/IJCSE.2019.099081

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virtual platforms. At the same time, the total number of training hours in the CG and EG was the same, only the content of the courses changed. More detailed information about the intervention is presented in Table 1.

Table 1

Activities	*Description*	*Integration of digital methods*
Tasks with the interaction elements	Creating interactive exercises on virtual platforms for learning to play the bass guitar with the addition of gaming components	Virtual platforms are an environment for completing educational tasks, interacting, sharing knowledge and receiving feedback
Lessons on virtual platforms	Delivering classes online in virtual classrooms where technology helps students to learn the bass guitar	Using technology to recreate the effect of physically being in space and deepening the learning process
Studying the subject	Implementation and demonstration of performances in a virtual environment, giving students the opportunity to study skills in a complex, using virtual platforms	The use of virtual platforms for rehearsals and performances in order to practice and demonstrate acquired skills
Group projects	Implementation of team projects in which students work together on assignments covering bass playing	The use of cloud technology services provides collaboration and access to video, audio, and other multimedia educational resources

Digital methods for bass guitar teaching through virtual platforms

The empirical study consisted of three stages. The first stage involved the analysis of intragroup indicators of academic performance in the bass guitar course among the CG and EG students. It was the basis for determining the level of significance by comparing pre-test and post-test indicators.

The second stage provided for calculations of a non-parametric t-test to compare the pre-test and post-test indicators of academic performance of the CG and EG when playing the bass guitar.

At the third stage, by analysing interviews conducted with the EG students, the strengths and weaknesses, opportunities and threats that learning to play the bass guitar through virtual platforms poses were described in the form of a SWOT analysis.

Data collection

The analysis of students' academic grades when playing the bass guitar was used as the main quantitative method. Students' grades for the course were given according to a 100-point system, where grading system A corresponds to 90-100 points, B - 80-89, C - 70-79, D - 60-69, and F - less than 60 points. These data were requested with permission from all study

participants. The qualitative analysis was based on feedback from students in the influence group regarding their experiences using online platforms for learning to play the bass guitar, which helped to identify the advantages and disadvantages of these methods according to the principle of SWOT analysis.

Participants

The participants were students from the Institute of Arts named after A.G. Rubinstein. Students from this particular institute were chosen to conduct the experiment, as they already had the necessary level of knowledge in the technique of playing the bass guitar, which allowed them to immediately begin learning using virtual platforms without wasting time learning the basics. The criteria for selecting the sample were the year of study, knowledge of the technique of playing the bass guitar and age. The total number of subjects involved was 300 people who voluntarily agreed to take part in this research project (Table 2). This quantity that makes the sample representative and the results valid.

Table 2

Group	Total	Men	Women	Average age	SD
CG	150	67	83	19.65	0.36
EG	150	63	87	19.47	0.42

Research participant data

Source: tabled by the author based on the collected data about the experiment participants

The participants were randomly assigned to the CG and EG, testing the internal homogeneity of their scores on academic performance in the bass guitar course. The average age of all study participants was 19.56 years (SD=0.39). All of them voluntarily took part in the study and agreed to the use of their data, subject to anonymity and confidentiality.

The study used the Moodle platform, the Kahoot! platform for gamification of learning, and the Alibaba Cloud service for collaboration. Zoom and YouTube were used as online platforms, and Oculus Rift was used as a VR platform, which opened up the opportunity to study bass guitar in a specific virtual reality. At the end of the academic year, in May 2024, the students received their course grades, which were taken for analysis as post-test results. Also, 15-minute interviews were conducted with the EG students, which became the basis for a SWOT analysis. The interviews were conducted by professional psychological interviewers who posed questions to the EG students via Zoom. The students had to answer the questions briefly without thinking much. The responses were recorded with the students' permission for further SWOT analysis.

Data analysis

The SPSS Statistics 26 software package was used to analyse grades in the academic subject under study. Student's t-test was calculated to assess differences before and after the experiment within a group (paired), as well as to compare values between two groups (unpaired). Additionally, interviews with the EG members provided the basis for a SWOT analysis, demonstrating the strengths, weaknesses, opportunities, and threats of using virtual platforms in a bass guitar course.

Results

The first research objective was to analyse intragroup indicators of academic performance in the bass guitar course among the CG and EG students, determining the level of significance when comparing pre-test and post-test indicators. Descriptive analytical statistics for the CG and EG are presented in Table 3.

Table 3

Group		pre-assessment of playing bass guitar	post-assessment of playing bass guitar
CG	Mean	74.65	74.87
	N	150	150
	Standard deviation	2.970	3.015
	Standard error of the mean	.242	.246
	Variance	8.821	9.091
	Excess	-1.019	-1.054
	Asymmetry	.139	.087
EG	Mean	74.92	81.17
	N	150	150
	Standard deviation	3.112	1.403
	Standard error of the mean	.254	.115
	Variance	9.685	1.970
	Excess	-1.120	-1.239
	Asymmetry	.029	-.166

Descriptive analytical statistics of the academic performance of the CG and EG students who play bass guitar

Source: tabled by the author based on the collected data about the experiment participants

In the CG, means underwent slight fluctuations, while in the EG, an increase in means for playing bass guitar was recorded by 6.25 points. The mean in the CG before learning to play bass guitar using virtual platforms is 74.76 points, and after training - 74.87. As we can see, the means in the CG,

which was taught using traditional methods, did not change significantly. In turn, in the EG, which learned to play bass guitar using virtual platforms, the mean increased from 74.92 to 81.17, which indicates the effectiveness of virtual methods compared to traditional ones.

The Student's t-test was used to calculate the statistical significance of intragroup differences in the academic performance of the CG and EG students for playing bass guitar.

Table 4 shows the calculation of the statistical significance of intra-group differences in academic performance, which indicates a significant improvement in the academic performance of the EG students (p-value = .000) for playing bass guitar, indicating the effectiveness of the implemented digital teaching methods. However, in the control group the differences were not statistically significant.

Table 4

	Paired differences					t	Degrees of freedom	value (double -sided)
	Mean	Mean square deviation	Root mean square error	95% confidence interval for the difference				
				Lower	Higher			
Paired samples test for the CG								
bass guitar	-.227	4.198	.343	-.904	.451	-.661	149	.509
Paired samples test for the EG								
bass guitar	-6.253	3.514	.287	-6.820	-5.686	-21.792	149	**.000**

Calculation of the statistical significance of intragroup differences in the academic performance of the Cg and EG students for playing bass guitar

Source: tabled by the author based on the collected data about the experiment participants

The second objective of the study was to compare the pre-test and post-test academic performance scores of the Cg and EG for playing bass guitar using a nonparametric unpaired t-test. The information is presented in Table 5.

Table 5

		Levene's test		t-test for equality of means						
		F	value	t	Degrees of freedom	Value (two st.)	Average difference	RMS difference error	95% confidence interval for the difference	
									Lower	Higher
pre-assessment of playing bass guitar	EV	.567	.452	-.778	298	.437	-.273	.351	-.965	.418
	NEV			-.778	297.352	.437	-.273	.351	-.965	.418
post-assessment of playing bass guitar	EV	81.767	.000	-23.200	298	.000	-6.300	.272	-6.834	-5.766
	NEV			-23.200	210.671	.000	-6.300	.272	-6.835	-5.765

Calculation of the statistical significance of intergroup differences in the academic performance of the EG and CG students for playing bass guitar

Note: EV – equal variances are assumed; NEV – equal variances are not assumed

Source: tabled by the author based on the collected data about the experiment participants

The Levene's test formula for equality of variances was used to calculate the statistical significance of intergroup differences in the academic performance of the Cg and EG students for playing bass guitar. At the pre-test, the Levene's test did not reveal a statistically significant difference in the range of scores between the groups, indicating that the level of knowledge of participants in both groups was at the same starting positions in terms of academic performance in playing bass guitar. The results of the post-assessments showed significant differences in performance between the CG and EG, the t-test revealed statistically confirmed differences in the results of the post-assessments for bass guitar ($t = -23.200$, $p < .001$), indicating a significant increase in academic performance in the EG compared to the CG after the introduction of virtual platforms.

The third objective of the study was to describe the strengths, weaknesses, opportunities and threats that the integration of virtual platforms in teaching bass guitar poses in the form of a SWOT analysis by analysing interviews conducted with the EG students. The data is presented in Figure

1. Some quotes from the interviews are provided below to further understand the participants' impressions of the experience of integrating virtual platforms into bass guitar training.

Figure 1

S	W	O	T
Expanding access to learning materials	Obstacles related to technology and the need for specific equipment	Opening new horizons for classical learning	Lagging behind educational institutions in mastering technology
Convenience and effectiveness in leraning materials	Difficulties in integrating online platforms and VR systems at the initial stages	Introduction of advanced technological solutions into educational activities	Significant financial costs for implementation
Increasing student activity and participation in the learning process	Potential difficulties maintaining personal motivation	Studying subjects that combine different forms and areas of knowledge	Difficulties in ensuring stability of educational teaching standards
Option to customize the educational process to suit individual needs	The danger of moving away from the traditional system that is necessary	Opportunities for global exchange of knowledge and experience	Possible digital addiction to gadgets and digital devices

SWOT Analysis to Identify the Strengths, Weaknesses, Opportunities, and Threats of Integrating Virtual Platforms into Bass Guitar Teaching

Among the strengths of the experiment, the respondents noted wide access to educational materials, convenience and effectiveness in mastering them, increased activity and involvement, as well as some personalization. Here's what one participant said: *"Using virtual platforms has transformed the way I experience learning. I noticed that now I had unlimited access to educational resources, which made it much easier to learn new information on playing bass guitar. The interactivity oriented to my passions and needs has increased my interest and drive to learn the bass guitar."* At the same time, weaknesses included obstacles to the need for expensive equipment, difficulties in the initial stages, students' self-motivation and fear of moving away from traditional learning. One of the participants shared her observations: *"When integrating virtual platforms, the main obstacles for me were the difficulties when I did not understand how things worked and how to use them. Sometimes it was difficult for me to stay motivated without direct contact*

with teachers and classmates, even though we met during traditional classes. The rejection of the usual educational structure, despite its obsolescence and anti-immersion, introduced additional difficulties into learning, increasing the feeling of instability, especially at the beginning." Regarding opportunities, the respondents noted the prospects for introducing advanced technological solutions, interdisciplinary approaches and global exchange of experience and knowledge through virtual platforms. One of the quotes was: *"The use of digital methods can open up never-before-seen possibilities in learning, giving us the chance to immerse ourselves in multimedia learning that blurs the boundaries between different art forms. It can also contribute to international dialogue in the educational space."* Threats, as noted by participants, may be hidden in the different levels of technical training of different educational institutions, the need for significant financial influences, organizational difficulties and the growth of digital dependence. One quote clearly illustrates this: *"Making university technology up to date can be challenging for unprepared systems, with high costs associated with introducing advanced technologies. I am also concerned about the increasing dependence on digital devices, so the integration of technology into learning must be thoughtful and careful."*

So, the results showed a statistically significant improvement in the academic performance of the EG students after using virtual platforms in learning, with an increase in average grades for playing bass guitar.

Discussion

One article[27] notes growing scientific productivity and increased international collaboration in the application of virtual platforms in higher education, which emphasizes the general trend towards the integration of new technologies into the educational process and is consistent with the results of this research, demonstrating improved academic performance of students after the introduction of digital educational methods. Another study[28] shows how combining art education with virtual reality can improve students' learning and enhance their intrinsic motivation. The paper notes that "the application of VR technology in art teaching can avoid the disadvantages of traditional teaching, improve the quality and efficiency of art education, and promote the development of education". These findings are reflected in our

[27] González-Zamar, Mariana D., and Abad-Segura, Emilio. "Implications of Virtual Reality in Arts Education: Research Analysis in the Context of Higher Education." In *Education Sciences*, MDPI, 10(9), 2020, 225. https://doi.org/10.3390/educsci10090225

[28] Liu, Pei. "Application and Teaching Exploration of Virtual Reality Technology in Art Appreciation." In *International Journal of Learning and Teaching*, 3(7), 2021

study, confirming the effectiveness of using virtual platforms to stimulate active participation and deep understanding of learning material.

Similarly, another paper[29] discusses breakthrough methods of teaching music arts using virtual technologies, which helps to create more effective conditions for students' self-learning. This also resonates with our findings, confirming the value of virtual technology as a tool for developing learning skills and improving the quality of music education.

Our research is also supported by data presented in another paper[30], which illustrates the potential of creating personalized virtual spaces for students, enriching the educational process with new opportunities for immersion and interaction. Additionally, another article[31] focuses on the significance of using social virtual reality environments to achieve deeper and better educational experiences. These results are consistent with our study's findings on the impact of virtual platforms on the growth of students' academic performance, emphasizing the importance of merging technological innovation with music education.

The study[32] raises the issue of a lack of social interaction and reduced student engagement in distance learning, which is reflected in the weaknesses and threats of using online learning and virtual platforms identified by our research. Despite this, the authors suggest that attention should be paid to how augmented and virtual reality (AR/VR) technologies can help to overcome these challenges, bringing forward new directions for future research, similar to the current one that opens the way for studying virtual reality in the educational field. Another study[33] focuses on the application of interactive learning in the arts, confirming the findings of this study on the value of digital learning methods. Both works show how the use of modern technology can improve understanding of educational materials and ultimately improve educational achievement. However, another

[29] Gao, Hongjiao, and Li, Fan. "The Application of Virtual Reality Technology in the Teaching of Clarinet Music Art under the Mobile Wireless Network Learning Environment." In *Entertainment Computing*, Elsevier, 49, 2024, 100619. https://doi.org/10.1016/j.entcom.2023.100619

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[31] Mystakidis, Stylianos, Berki, Eleni, and Valtanen, Juri P. "Deep and Meaningful E-Learning with Social Virtual Reality Environments in Higher Education: A Systematic Literature Review." In *Applied Sciences*, MDPI, 11(5), 2021, 2412. https://doi.org/10.3390/app11052412

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[33] Chen, Si, Gu, Yu, and Wang, Yubo. "The Impact of Digital Technology on the Reform of Art Teaching in the Wireless Network Environment." In *Wireless Communications & Mobile Computing*, Wiley, 2022, https://doi.org/10.1155/2022/1386737

research[34] demonstrates how virtual reality experiences enhance immersion and positively impact students' learning experiences. These findings are reflected in our study, emphasizing the significant impact of virtual platforms on students' academic performance as well as engagement, as measured by interviews.

Similar results are reported in another study[35] on the use of virtual reality to improve students' art appreciation. The findings indicated that its use improved academic performance, learning motivation, self-efficacy, critical thinking, and performance. This has something in common with the results of our study, confirming the potential of digital technologies to enrich music education and improve students' analytical skills. Finally, another paper[36] examines the role of digital STEAM applications in music education to enhance creativity and interest in learning, which complements our findings by highlighting the importance of using virtual technologies to enhance educational opportunities and enrich the learning experience.

The article[37] discusses the structure of a first-class erhu course, focusing on reforms of blended online and offline learning. The author emphasizes the importance of innovation in teaching methods and the need to improve assessment systems, which has something in common in this study's findings of significant improvements in academic performance due to the introduction of innovative educational approaches. Another study[38] focusing on the creation of an online piano teaching programme confirms the positive impact of digital educational methods mentioned in this study. The high interest and readiness of teachers for online learning, as well as the recognition of the effectiveness and accessibility of digital technologies for teaching music, are consistent with the observed improvement in academic performance, emphasizing the importance of digitalization in the educational process.

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Another work[39] on online dance training, identifies both the prospects and shortcomings of this approach, in particular the need to improve the quality control system, which complements the conclusions of our study, pointing to the critical importance of quality methods for implementing such integrations. However, an analysis of the impact of multimedia and virtual technologies on education described in[40] (Liu et al., 2021) confirms the effectiveness of integrated technologies in improving students' cognitive abilities, indicating the positive impact of digital learning methods on academic performance.

Conclusions

The relevance of the results obtained is confirmed by the valuable contribution to the field of knowledge under study, the expansion of theoretical and practical foundations in understanding the impact of digitalization on the educational process. The results showed a statistically significant improvement in the academic performance of the EG students after using virtual platforms in learning, with an increase in average grades in playing bass guitar by 6.25 points. Intragroup comparisons showed statistically significant improvements (p-value = .000) in the studied subject in the EG. A nonparametric t-test revealed significant differences in performance between the CG and EG at post-assessments, confirming the effectiveness of virtual platforms in teaching bass guitar. Analysis of interviews with the EG students gave grounds to describe the strengths, weaknesses, opportunities and threats of the experiment, providing a deeper understanding of its effects. The practical value of the results is the empirical confirmation of the effectiveness of virtual platforms in learning in the context of increasing academic performance in playing bass guitar. At the same time, the academic value is confirmed by a valuable contribution to the field of knowledge under study, expanding the theoretical and practical foundations in understanding the impact of digitalization on the educational process. The findings may motivate educational institutions to integrate online platforms and virtual reality into their curricula, or reconsider existing traditional pedagogical strategies.

Limitations

The study is based on an analysis of academic performance, which may not cover all the intricacies of bass guitar playing, which carries some

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limitations. The study involved students from only one institute, which narrows the area and limits the extrapolation of the obtained data.

Recommendations

It is recommended to develop interactive and multimedia resources for learning various art forms to enhance student understanding and engagement. It is also important to examine the disadvantages and potential threats associated with the use of digital methods of teaching bass guitar through virtual platforms and propose appropriate measures to minimize these risks.

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