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Digital Tools in Instrumental and Vocal Pedagogy: A Pre- and Post-Pandemic Analysis at the University Level

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Abstract: Prior to the onset of the COVID-19 pandemic, digital tools were progressively integrated into instrumental and vocal education at the university level. During the pandemic, these tools evolved from a supplementary role to an indispensable component of classroom instruction, thereby attracting growing scholarly attention. While existing research acknowledges this shift, there remains a scarcity of systematic comparison and synthesis regarding the impact of digital tools on instrumental and vocal pedagogy in higher education before and after the pandemic. Furthermore, insufficient studies have addressed the associated negative effects. This study combines literature review and questionnaire survey to summarize both the positive and negative influences of digital tools on university-level instrumental and vocal teaching before and after the pandemic, and proposes strategies to mitigate the adverse impacts. Findings indicate that digital tools provide students with increased opportunities for collaboration and enrich classroom teaching. To counter negative effects such as internet instability and reduced learning efficiency, the study recommends the development of specialized teaching software and enhanced classroom discipline. By summarizing the evolving role of digital tools in music education across the pre- and post-pandemic periods and expanding the research on mitigating adverse effects, this study offers valuable directions for the future development of digital tools in university music education.

Keywords: Instrumental; Vocal; Music Education; Digital Tools; COVID-19; University; Zoom; Flipped Classroom.

1. Introduction

Over the past two decades, with the development of technology, more and more digital tools have been used in different levels of music education, such as computers, multimedia, or the Internet. For teachers, using digital tools helped them to enrich the music class. Likewise, for students, using digital tools made them learn knowledge more conveniently. However, as Diana Salazar mentioned in her lecture, because of Covid-19, digital tools gradually played an important role in music education. Camlin and Lisboa (2021, p129) mentioned the same viewpoint that Covid-19 made music education rapidly turn into online learning. For example, more and more teachers and universities were forced to teach music online to stop the spread of the virus. Therefore, the frequency and scope of using digital tools in music education continued to expand. This teaching style was a challenge for teachers and students. Nevertheless, online learning has been constantly used in different music majors, such as vocal, instrument, and music theory. Thus, exploring the effects of using digital tools in music education is extremely important.

Based on Diana Salazar's lecture, this study employs a mixed-methods approach, combining a literature review with a questionnaire survey, to investigate the disparities in the utilization of digital tools in university-level instrumental and vocal instruction before and after the onset of the COVID-19 pandemic. Followed by, summarizing the positive and negative effects of using digital tools in instrumental and vocal tuition at university level and finally, exploring how to improve the negative effects. In short, the purpose of this article is to strengthen the benefits of using digital tools, improve the negative impact, and analyze the limitations. This will help more teachers and students have a better understanding of how to use digital tools.

2. Literature Review

To further investigate the impact of digital tools on university music education before and after the pandemic and to propose methods for mitigating negative effects, this study selected 12 literature sources. Through analysis, these were categorized into three sections: difference in digital tools in university music education, positive and negative impacts, and approaches to alleviating negative effects, while also noting the limitations of existing research.

2.1. The Difference

While comparing the difference between some references about the use of digital tools like computers, internet, online learning in music education at universities before Covid-19 and during Covid-19, three main changes were proposed.

The first change was the region of using digital tools in musical majors. Before Covid-19, more teachers preferred to use digital tools in musical theory classes. Walls (1997) mentioned two viewpoints on the same. Initially, Walls (1997, p71) demonstrated that long-distance education or the internet mainly helped to learn which is based on the discussion. Next, Walls (1997, p72) provided that long-distance learning technology is more suitable for some explanatory courses, like Music history or Music business. Moreover, (Biasutti, 2017) also approves this viewpoint, and this article demonstrates that theoretical classes are more common in digital music education, because the theoretical classes are more easier to transfer and organize on the internet. However, during Covid-19, the region of using digital tools in musical subjects was broadened. Hernández (2020, p182) offers that because of Covid-19, nearly all courses turned to online teaching.

Likewise, the article written by Schiavio, Biasutti, and Philippe (2021) demonstrates the effects of online learning on twenty different major students in the Italian conservatory,

like the guitar, violin, double bass, voice, and piano. Finally, Ayensu, Acquah, and Annan (2021) replenish the effects of using digital tools in other musical majors, like the winds or some instruments in African music. As a result, one can see that before Covid-19, the digital tools mainly have been used in music theory class. But during Covid-19, digital tools have been used in more and more musical subjects, like instruments, vocals.

The second change is the status of digital tools in music education. Before Covid-19, digital tools played an auxiliary role in music education. Initially, Walls (1997) provides two purposes for digital music education. While on one hand, Walls (1997, p68) explored how to combine digital technology with the music learning environment. Because at that time, the author thought that only in the correct environment and correct teaching method, digital technology can have a positive impact on music performance. On the other hand, Walls (1997, p69) also demonstrates the second purpose of using digital tools, by using digital technology to show different musical types for students and digital tools are more convenient for some compositional students.

Apart from this, Dunlap and Lowenthal (2010) also provided two purposes for using digital tools in music education. Dunlap and Lowenthal (2010, p60) provided that teachers preferred to use the online learning to show the supporting role, like controling or choosing the music or using the interesting knowledge to begin the new study, rather than made online learning as an important teaching method. Additionally, Dunlap and Lowenthal (2010, p62) offer that more online courses provided many opportunities for students to cooperate with others and it was beginning to create the online community. In contrast, during Covid-19, the status of digital tools in music education has changed. Furthermore, HERNÁNDEZ (2020, p190) demonstrated how to improve the negative effects of online instrumental teaching. Similarly, Yang (2020, p3) demonstrates that digital vocal teaching enhances students' independence and helps teachers to record their classes with the purpose of improving the disadvantages in their classes. Moreover, Fan (2021, p1) also mentions that digital tools can make singing knowledge more clear and more direct for students. In addition, Camlin and Lisboa (2021, p129) mention that in a specific period, digital or online was the main operation method for music education. Overall, before Covid-19, digital tools mainly help to combine traditional music teaching, show more musical styles or stimulate learning and acquiring knowledge. However, during Covid-19, digital tools gradually occupied an important position in music education. And numerous articles research the effects of digital tools in music teaching or show how to use digital tools.

The final change is the development of digital tools in music education. According to the Walls (1997), Dunlap and Lowenthal (2010), Parkita (2021), HERNÁNDEZ (2020) , with time digital tools keep on upgrading. Before Covid-19, Walls (1997) provided three different types of digital tools in music education. Firstly, Walls (1997, p69) mentioned a new instrument called 'digital synthesizers'. The author introduced this digital tool focusing on reproducing different instrumental timbres. It was interesting for students and brought benefits for teachers as well. Secondly, Walls (1997, p71) suggested that teachers can use the computer assisted instruction (CAI) to help them in music teaching. The research showed the CAI was efficient in traditional teaching. The digital synthesizers and CAI have been used in music education as new invention. Finally, Walls (1997, p72) states that back in the day, for long-distance learning, students preferred to use the telephone rather than video. At that time, the video techniques was not full-fledged. Obviously, at that time, the development of digital tools in music education was at an early stage. However, thirteen years later, teachers began to use the internet to help them in music education.

Initially, Dunlap and Lowenthal (2010, p63) mentioned that when a teacher asked a question about rocks, they showed some websites about rocks to help students to have a better understanding. Next, Dunlap and Lowenthal (2010, p67) demonstrated that teachers asked students to use some convenient website to make a music video to show an understanding of the knowledge. With Covid-19, more and more new digital technology has been used in music education. Parkita (2021, p2) introduced three useful software for music teachers. Firstly, Musecore, which helped teachers create different soundtracks. Followed by, Studio One Free which played a complementary function of creating music. And lastly, Audacity which has many functions, like recording, broadcasting, and so on. Apart from this, HERNÁNDEZ (2020, p182) demonstrated that some online learning applications were popular, such as Zoom, Skype, or Microsoft Teams. Overall, throughout these years, the Internet played an important role in music education. It greatly promoted the development of digital tools in instrumental and vocal tuition at university level

2.2. The Positive and Negative Impacts

This section mainly analyzes the benefits and shortcomings of using digital tools in music education. Focusing on the positive effects of using digital tools on vocal teaching, music classroom, and students' horizon. Firstly, digital music education gave vocal learners more opportunities to collaborate and provide the shortcoming of singing. Fan (2021, p2) demonstrated two positive effects. On the one hand, unlike traditional vocal teaching, digital vocal teaching encourages different areas of vocal learners to cooperate and explore together. On the other hand, Fan (2021, p4) also mentioned that students can find their singing disadvantages in the video, where teachers should participate in it to help students.

Moreover, Yang (2020, p1) demonstrated that digital tools not only help the singer to finish the concert but also offer a review of the shortcomings of the concert for the singer. Secondly, digital music education made music classes more convenient and easier to find learning materials. Rucsanda, Belibou, and Cazan (2021, p8) tell that because of digital music education, music classes have become more flexible and friendly, and students can attend classes from anywhere. It reduces the cost of transportation and accommodation. Cao (2022, p3) demonstrates how the internet can be utilized to establish effective music teaching classes. First, regarding the Micro-class, Cao (2022, p3) indicates that it can assist students in their after-class study and create a more efficient and flexible online learning environment. Second, Cao (2022, p4) shows that the Flipped Classroom helps teachers more precisely grasp students' comprehension levels of knowledge in the classroom.

Apart from this, Parkita (2021) also offers two positive effects. Parkita (2021, p60) believed that digital tools can enrich the content of music classes and make them more attractive. Next, Parkita (2021, p61) demonstrates that the publishers approve the digital music education. They believe

that digital music education may bring some benefits to students. So they provide many multi books or electronic books, for example, when students learn new songs, they can visit the link in these books with the purpose of learning the rhythms or backgrounds of these songs. Finally, digital music education also provided more developmental opportunities. Joseph, Lennox (2020, p243) demonstrates how digital music classes provided some valuable opportunities to cooperate with some popular musicians or famous musical experts for students. It can help students to broaden their horizons.

Nevertheless, using digital tools in music education can also cause some negative effects. Firstly, for the interaction, Schiavio, Biasutti, and Philippe (2021, p173) demonstrate that, unlike traditional music teaching, peer interactions become less and less in digital classrooms. For example, the instrumental students always perform in coordination, but because of Covid-19, they do not have these opportunities temporarily, which may stand as an obstacle while creating harmony during a group performance. Secondly, digital teaching may influence the quality of instrumental classes. HERNÁNDEZ (2020, p187) demonstrates that instrumental online teaching has some difficulties, which may include some important aspects that may be influenced during online learning, like pitch, timbre, and rhythm. On the other hand, because of the network delay, the communication between the teachers and students is not smooth, as it is when face-to-face. Finally, for some special subjects, digital music education plays a limited role. At first, Rucsanda, Belibou, and Cazan (2021, p8) demonstrate that digital teaching has some difficulties in some specific subjects, like chamber music, conducting, and choral. Group performance is very important in these classes, but online teaching cannot satisfy this requirement. Apart from this, Ayensu, Acquah, and Annan (2021, p96) say that some specific music classes cannot get expectant achievement, like African instruments and drums. Lastly, Joseph and Lennox (2021, p246) mentioned the same viewpoint, like when a teacher uses the internet to teach African instruments, but in reality, students cannot play true African instruments at home.

2.3. How to Alleviating Negative Effects

With the increasing role of digital tools in music education, more research is needed on how to ameliorate the negative effects. In response to the negative effects mentioned above, combined with references, some methods have been elaborated upon below. Firstly, to improve the lack of interaction, Schiavio, Biasutti, and Philippe (2021, p174) suggested that students should use different digital tools for learning and create new interactions with peers, adapting how to cooperate with others on the internet. Secondly, to improve instrumental teaching, HERNÁNDEZ (2020) provides two methods. HERNÁNDEZ (2020, p190) suggested that teachers should choose suitable online learning applications, like Zoom or Google Meets for online instrumental teaching and test them with students. Like, use a specific microphone or choosing a suitable pattern for classes in online teaching applications. Meanwhile, HERNÁNDEZ (2020, p191) also states that teachers can record specific videos for some difficult instrumental techniques and send the videos to students. Particularly, to improve the online piano classes, Ayensu, Acquah, and Annan (2021, p94) offer an innovative method, where students can download the virtual piano and use the MIDI to connect their electronic keyboard to their computer. By using AnyDesk, teachers can supervise the details of students' pianistic techniques.

Next, Schiavio, Biasutti, and Philippe (2021, p174) suggested that using two cameras near the piano may help students to have a better viewing angle in an online piano class. For specific subjects, Joseph and Lennox (2020, p246) mention students can use some pieces of furniture to replace them. But this method would not solve the actual problem. Hence, how to use digital tools to maintain the quality of some specific subjects need more research in the future. Additionally, Lei (2022, p4) mentioned two efficient applications for online piano classes, the Skoove and Simply Piano. The Skoove which was convenient because it can use in many electronic devices, like phone or tablet computer. Next, the Simply Piano, students can use the microphone or MIDI to connect with it and choose the special function "Singer Duet", they can paly with some musicians in this function.

3. Methodology

In this part, I will show my research objective, research questions and the content in the questionnaire survey.

3.1. Research Objective

1. To summarize the application and impacts of digital tools in university music education through a questionnaire survey.
2. To analyze the survey findings in order to propose effective strategies for mitigating the identified negative effects.

3.2. Research Questions

1. Do you have the experience to use the digital tools in your studying or teaching?
2. what is the type of the digital tools?
3. What are the positive impacts of using digital tools in your vocal/instrumental teaching/studying?
4. What are the positive impacts of using digital tools in your vocal/instrumental teaching/studying?
5. How to improve the negative impacts?

3.3. Research Design

The questionnaire for this study targeted a cohort of 16 teachers and students with prior experience using digital tools in instrumental or vocal education. It was distributed via a popular mobile social application, with a stipulated completion time of two hours. The process was designed to ensure that no private information was collected.

3.4. Research Limitation

Primary limitations include an insufficient sample size and a lack of empirical support for the proposed methods to mitigate negative impacts.

3.5. Result

The experience to use the digital tools in your studying or teaching:

The questionnaire was completed by six teachers and ten students, all of whom possessed experience using digital tools in their learning or teaching. The results have been tabulated for clarity.

100% of teachers and students used the digital tools in their teaching or studying.

Table 1. The results have been tabulated for clarity

No. of Candidates		6 Teachers	10 Students
The experience to use the digital tools in your studying or teaching	Yes	6	10
	No	0	0

What is the type of the digital tools:

Table 2. Digital tools

Total Respondents	Teachers	Students
Zoom	3	5
Flipped Classroom	2	3
Virtual Piano	1	2

50% of teachers and 50% of students using zoom in their studying; 33% teachers and 30% students participate in Flipped classroom; only 16% teachers and 20% students have the experience to use the virtual piano.

What are the positive impacts of using digital tools in your vocal/instrumental teaching/studying:

Table 3. What are the positive impacts of using digital tools in your vocal/instrumental teaching/studying

Total Respondents	Teachers	students
Have more cooperation opportunities	1	2
Enhanced accessibility of after-class learning	3	6
Facilitates a more flexible learning environment	2	2

16% of teachers and 20% of students reported that using digital tools facilitated greater cooperation opportunities; 50% of teachers and 60% of students perceived that digital tools enhancing accessibility of after-class learning; 33% of teachers and 20% of students indicated that digital tools create a more flexible learning environment.

What are the negative impacts of using digital tools in your vocal/instrumental teaching/studying:

Table 4. What are the negative impacts of using digital tools in your vocal/instrumental teaching/studying

Total Respondents	Teachers	students
A lack of teacher supervision	2	3
Disrupted conducting and chamber music classes	2	2
Network instability	2	5

33% of teachers and 30% of students perceived a lack of instructional oversight when using digital tools for learning; 33% of teachers and 20% of students reported that they can not use digital tools to have conducting and chamber music classes; 33% of teachers and 20% of students indicated that the network instability have influenced them.

How to improve the negative impacts:

Table 5. How to improve the negative impacts

Total Respondents	Teachers	Students
Enhance student self-discipline	4	6
Develop specialized software	2	4

66% of teachers and 60% of students reported that enhancing students' self-discipline to solve the negative impacts; 33% of teachers and 40% of students indicated that develop specialized software to improve the negative impacts.

4. Discussion

This study primarily investigates the impact of digital music on instrumental and vocal education at the university level, with additional analysis of strategies to mitigate associated negative effects. All participants possessed prior experience utilizing digital tools in music education, indicating a broad application scope of technologies such as Zoom, virtual piano, and the Flipped Classroom, as referenced in the survey. According to the questionnaire results, a majority of students and teachers indicated that digital tools provide more cooperation and foster a more adaptable learning environment. Furthermore, the use of digital tools helps students enhance accessibility of after-class learning. In terms of negative impacts, key issues identified were that certain specialized courses could not be effectively conducted and that students lacked sufficient instructional oversight. In response, participants suggested that developing specialized software tailored to these courses, such as for chamber music and conducting, could help address this challenge. Additionally, strengthening students' self-discipline was proposed as a viable measure to counteract the lack of teacher supervision.

5. Conclusion

In conclusion, this study has systematically analyzed the multifaceted effects of digital tools on instrumental and vocal education at the university level. It delineates three key distinctions in their application before and during the COVID-19 pandemic—scope of use, instructional status, and developmental trajectory—while detailing concomitant benefits and shortcomings. The comprehensive investigation, incorporating questionnaire surveys and empirical data analysis, confirms that digital tools substantially enhance classroom engagement through interactive platforms, significantly boost student motivation via different learning elements, and create abundant collaborative opportunities through cloud-based applications. Particularly noteworthy is how these technological advancements have not only facilitated easier access to diverse learning resources but also after-class study through flexible scheduling and remote practice options.

The research further demonstrates that digital tools have transformed traditional pedagogy by introducing innovative teaching methodologies that promote active participation and peer learning. These tools have successfully created new possibilities for remote collaboration that transcend geographical limitations, while simultaneously addressing individual learning needs through customizable content delivery. The integration of multimedia resources has particularly enriched the learning experience, making complex musical concepts more accessible and comprehensible to students at various proficiency levels.

However, significant limitations persist in practical disciplines like chamber music and conducting, exacerbated by network instability and reduced teacher supervision. The research identifies that ensemble-based courses face particular challenges in maintaining synchronous performance quality, while the lack of physical presence diminishes the immediacy of corrective feedback essential in performance education. To address these challenges, this

research proposes the development of specialized software with enhanced synchronization capabilities for music-specific applications and emphasizes cultivating student self-discipline through structured learning protocols and progressive competency assessments.

Ultimately, this study provides valuable insights for optimizing digital pedagogy in specialized music education, establishing a solid foundation for future technological integration in the post-pandemic educational landscape.

However, this study acknowledges certain limitations that warrant consideration. The research identifies specific constraints in addressing the challenges of digital tool implementation in specialized musical disciplines, particularly in non-Western instrument instruction such as African percussion and collaborative ensemble performance contexts. These areas represent significant gaps in current digital pedagogy solutions and highlight the need for more targeted investigations. Furthermore, as the immediate threat of COVID-19 subsides, the focus of academic inquiry should shift toward developing integrated pedagogical models that effectively combine digital tools with traditional teaching methodologies. This transitional phase presents a crucial opportunity to establish balanced educational approaches that preserve the essential elements of traditional music instruction while leveraging the demonstrated advantages of digital technologies. These aspects undoubtedly require more substantial research attention in future studies to advance the field of digital music education comprehensively.

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