Ear Training Applications in Music Education: Exploring Utilization, Effectiveness, and Adoption Factors in France

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Abstract: This study investigates the utilization of ear training applications in the context of music education in France. Ear training is a crucial skill for musicians that involves the ability to identify and reproduce musical sounds. Mobile applications are increasingly being used to support and enhance this skill. The study examines the prevalence of ear training applications among music students and instructors, their perceived effectiveness, and the factors that influence their adoption and use. It also explores the potential benefits and drawbacks of integrating ear training apps into music education curricula. The data was collected through a survey of 125 students, as well as interviews with eight teachers and four developers. Results show that ear training apps have potential benefits for music education in France, but are currently underutilized. While students are willing to use them, teachers face challenges in finding apps that align with their pedagogical methods and provide high-quality musical examples. Improved integration of ear training tools could be achieved by focusing on music perception, memory, and metacognitive learning skills.

1 INTRODUCTION

In music, ear training refers to the process of developing and refining one's ability to recognize and identify musical sounds, such as pitches, intervals, chords, and rhythms, solely by listening to them. This skill is essential for musicians of all levels and is frequently taught in music schools and conservatories.

In this context, one of the most prevalent methods for training musical hearing is "dictation," which refers to the process of listening to a piece of music and then transcribing it by writing down the notes, rhythms, and other musical elements that make up the piece.

Computer technology, especially Computer-Assisted Instruction (CAI), has been used for ear training and dictation since the late 1960s(Peters, 1992). Within a decade, many universities in the USA had adopted these tools, and a few commercial options were available for domestic use. At the professional level, the music industry, regardless of culture, was eager to use technology, which impacted every aspect from recording to distribution.

Even though technology continues to drive trends in the music industry, its pace in music education has been slower(Spieker and Koren, 2021). Nonetheless, the COVID-19 pandemic and subsequent lockdowns have affected the use of technology in the music and ear training classroom. Therefore, this study analyzes the current use of technology for musical ear training, focusing on the French higher education system, students, and teachers.

2 EAR TRAINING APPS IN HIGHER EDUCATION INSTITUTIONS

Integration of ear training CAIs in higher education has been analyzed since the first programs in the 1960s (Stevens, 1991; Peters, 1992). The adoption of technology for higher music education has occurred at different rates among countries. For example, in the USA (Spangler, 1999), the UK (Upitis, 1983), and Australia (Stevens, 2018), the use of CAIs in univer-

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sities and conservatories has been well-documented and analyzed. However, the adoption of technology in other countries has had an irregular pace.

In 2020, Buonviri and Paney (Buonviri and Paney, 2020) conducted a study about the use of technology in aural skills for Advanced Placement Music Theory in the USA. They focused their survey on high school teachers who pointed out that while technology can offer additional practice opportunities and personalized learning experiences for students, these advantages may be reduced by limitations such as a lack of access to technology and constraints of software programs. 91% of respondents incorporated technology into their classrooms, primarily using websites during class.

In Turkey, Demirtaş (Demirtaş, 2021) conducted a survey about university music students' attitudes towards technology after the 2020-2021 academic year, during which the use of digital technologies predominated due to the pandemic. The researchers found that attitude scores decreased after a year of e-learning in all student populations.

In France, the authors Marie-Aline Bayon (Bayon, 2017) and Pascal Terrien (Terrien and Deveney, 2018) have analyzed the broader topic of technology and music education at all levels of instruction and its evolution in recent years. Terrien found that despite the challenges, teachers perceived the period of distance learning as stimulating and satisfying due to pedagogical innovations and closer relationships with their students and colleagues. He concluded that the integration of new technologies in teaching is not without difficulty, and the use of digital tools should be supported and involve stakeholders to affect teachers' perceptions of learning, methods of collaboration, and assessment. Bayon, on the other hand, has reflected on the concept of a music school that integrates technology at all levels of instruction. The school uses software for ear training, score editing, creation, and recording. Bayon advocates for the integration of digital technologies in all music instruction levels.

Recent studies (De Berny et al., 2021; Biasutti et al., 2022) have shown that the COVID-19 pandemic has accelerated the integration of technology in education, specifically highlighting the benefits of blended learning (Guppy et al., 2022). During the pandemic, teachers focused on promoting student success and adopted approaches such as cooperative learning and individualized teaching. The overall findings of these studies indicate that online music learning could be successful when teachers adapted their content and developed personalized materials.

3 SORBONNE UNIVERSITY'S STUDENT'S SURVEY

3.1 Background

In April 2021, a questionnaire was sent to undergraduate and graduate students at the Sorbonne University Musicology Department to inquire about the use of digital tools for auditory and musical learning. The objective of the survey was to understand the conditions of using digital technology as an additional tool for aural training at Sorbonne University. The questionnaire aimed to explore students' interests and difficulties experienced in aural training, awareness of the existence of digital learning tools, as well as the most and least appreciated aspects of these tools, among others.

3.2 Population

The number of responses to the questionnaire was 125, giving us a confidence level of 95% and a margin of error of 8.1% (see Table 1). It should be noted that the questionnaire was only sent once to the students' email addresses. Women (71%) participated more than men (29%) in the survey.

Most students (56%) were between 19 and 23 years old at the time of the survey. The most represented instruments among the students were the piano (27.2%), voice (12.8%), violin (14.4%), cello (8.8%), and flute (7.2%). The majority of students (49.6%) had between 13 and 16 years of musical practice. Sixty percent of students had one to three hours of daily instrumental practice, and 48% had one to three hours of group music practice. Additionally, 74.4% of the students had studied in a specialized teaching establishment (such as a Conservatoire au Rayonnement Régional, Pôle Supérieur d'Enseignement, or CNSMDP), with 54.9% preparing or having prepared a conservatory diploma. In France, most practical subjects are taught in conservatories while universities deliver Musicology (mostly theory oriented) degrees. Furthermore, 79.2% of students had five years or more of ear training and music reading (solfège).

Table 1: Percentage of students surveyed by year.

% students	N. students	1st year	2nd year	3rd year	Master 1st	Master 2nd
Total	839	33%	19.6%	17.6%	16.4%	13.2%
Survey	125	32.2%	20.8%	24%	11.2%	12.8%

3.3 Results

According to the survey results, 73% of students reported experiencing difficulties in ear training. The main causes of these difficulties were perception,

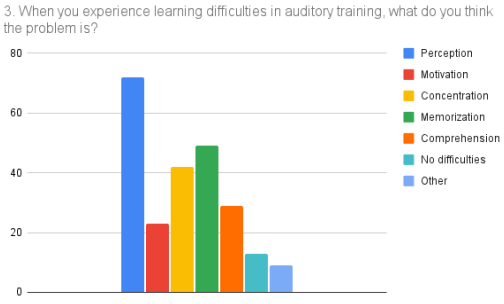

Figure 1: Learning problems felt by students.

memorization, and concentration (Figure 1). Although 50% of students reported being aware of the existence of applications for aural and musical learning, especially those that specialize in developing the musical ear, only 59.7% of students reported receiving encouragement from their teachers to use learning applications. Furthermore, 56.5% of students reported discussing learning applications with their classmates. The majority of students (70.4%) used learning applications on a smartphone. Nearly half (48%) of students had used the applications for less than a year, and 50% of students used the applications "from time to time," while 14.8% used them on a daily basis. Of the students who used ear training applications, 81.4% reported that they were at most or moderately motivated to study ear training, and 88.9% reported being able to progress or moderately progress thanks to these tools.

In terms of the most appreciated elements in the applications, 55.6% of students found the learning method to be the most favorable, followed by feedback on the answer. In contrast, the quality of the sounds (37%) and visual design (31.5%) were the least appreciated elements. The most common reason for using the applications was "to improve my school results," followed by "to improve my musical knowledge." The main purpose of using the application was to develop the musical ear, followed by learning harmony (called in France "Music Writing").

It is worth noting that the analyses of the survey remain descriptive. The results did not provide significant evidence to identify correlations among the responses to predict behavior between variables. As a result, a new survey is being developed to further explore the needs of students in relation to the Sorbonne University's ear training class. Nonetheless, it is evident that the students find motivation and support in the ear training apps. They struggle primarily with perception, memorization, and concentration problems. The feedback and learning methods in the apps are the most appealing elements to them, while sound quality and visual design are the least favored.

3.3.1 Favourite Applications

The most used applications were:

- Complete Ear Trainer
- Perfect Ear
- EarMaster Pro

These applications have strong gamification features, give immediate feedback on the response and use drill type exercises for ear training. The gamification aspects are score, time, ranking and statistics. They offer exercises for intervals, chords, chord inversions, scales, melodic dictations, chord progressions. EarMaster Pro allows to sing or play the answer, while on the other two the response is through buttons. Additionally, EarMaster Pro has attracted the interest of researchers, as evidenced by multiple studies (Liu, 2014; Wang, 2015).

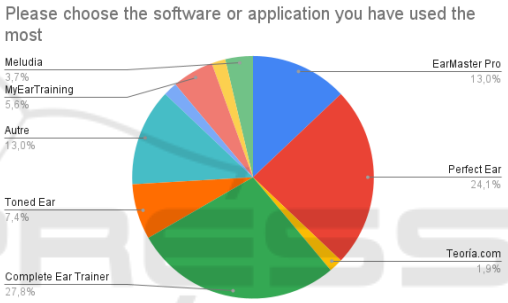

Figure 2: Preferred applications.

Students declared having used and being familiar with at least eighteen ear training applications (Figure 2). This data and the fact that at least 43% of students mentioned having discussed with their colleagues about music learning apps shows that students are interested, and look for music education tools.

The preferred applications, Complete Ear Trainer and Perfect Ear are mobile phone applications, while Ear Master Pro is a desktop application. In these applications the learning method was the main appreciated feature, and the sound quality the least appreciated, except in the case of EarMaster Pro where there are some responses that point to the opposite.

The data in the current survey remains descriptive. However, a more in-depth survey has been developed and is currently being conducted at Sorbonne University and other universities in France, with the goal of conducting a broader analysis.

4 INTERVIEWS

4.1 Teachers

The active pedagogies, as described by Jacques-Dalcroze, Willems, Orff, Kodaly, among others, have had a significant impact on the teaching of solfège in modern-day conservatories and universities in France (Large, 2017). These pedagogical approaches typically rely on the musical experience of the student as the primary means of learning (Protásio, 2022). The active participation of the student in musical expression and personal reflection is central to these methods. In 1977, influenced by this philosophy, the French Ministry of Culture modified the approach to teaching solfège from one that used abstract and segmented musical elements to one that encouraged the use of real musical examples (Large, 2017). This change in approach is an essential element to consider in understanding the reluctance to adopt most available digital tools in formal music education.

In this study, we interviewed four conservatory teachers, including two from Paris, one from Marseille, and one from Tours, regarding their use of digital tools in the ear training class. One of them teaches future ear training conservatory teachers. Two of the teachers cited the technical nature of the drills and examples as the primary reason for not using ear training apps. According to all four conservatory teachers, the use of intervals, chords, or cadences in an uncontextualized manner creates an artificial and unnatural environment. Another point cited against the use of apps was that the musical sounds tended to be poor in comparison to recordings of real instruments. Additionally, the teachers emphasized the importance of the human interaction of teacher feedback as a key element in the progression of ear training, which they did not consider positive to be automated. Although one teacher acknowledged the potential for social interaction with a community of learners, he was against the use of gamification features, stating that the motivation to study should be intrinsic to the musical activities.

One conservatory teacher suggested that digital tools could be beneficial if drills were presented in relation to the historical evolution of musical contexts, highlighting how musical elements interact in different ways, are played on different instruments, and depend on the aesthetics of a particular style or period. Another teacher expressed a desire for a tool that could develop the student's attention to a particular voice in a polyphony, where the student would have to write the missing voice after listening to a recording.

We also interviewed four university teachers at Sorbonne University. In this university, the ear training and music analysis teachers have created a curriculum that follows the content covered in the music history class. In this way, they ensure an enhanced immersion of students in specific styles. However, they encounter the problem of a wide spectrum of levels in aural skills, especially in the first year. They have to constantly try different methods to help students who are starting their musicology bachelors without a strong ear training and music theory background. These teachers are motivated to try digital tools to support their work, but they cite similar conditions to those stated by conservatory teachers regarding contextualization, the use of the voice or instruments, and the quality of sounds.

Two advocates of digital technologies for music education in France, Amandine Fressier and Marie-Aline Bayon, were also interviewed. Despite having different approaches, they share the objective of using technology as a means of creative expression to enhance the understanding of musical elements. Fressier advocates for the use of open software, primarily for musical notation and recording. In contrast, Bayon partners with platforms such as EarMaster Pro or Soundtrap through her school, promoting the integration of technology into a blended learning format for music education. They are both prominent advocates for the inclusion of digital technologies in music education. According to both of them, the lack of technology integration is due to inadequate instruction on these tools by teachers, budgetary constraints from their institutions, and insufficient time to adapt the tools to their usual teaching methods.

In summary The conservatory teachers cited poor quality sound, lack of musical context, and the importance of human interaction and feedback as barriers to the adoption of ear training apps, while one suggested that such tools would be beneficial if presented in relation to the historical evolution of musical contexts. The university teachers faced the challenge of teaching a wide spectrum of levels in aural skills, but were also motivated to try digital tools to support their work. Finally, two advocates for digital technologies in music education emphasized the importance of adequate instruction, budgetary constraints, and insufficient time as reasons for the lack of technology integration in music education.

4.2 Developers

Various ear training software programs have been developed, including Meludia, EarMaster Pro, Complete Ear Trainer, and the ear training research project

BbMAT (Duret et al., 2021). These programs utilize different platforms, including web, desktop, and mobile apps. While BbMAT is free to use, the others are available on subscription.

One of the most widely used programs is EarMaster Pro, which allows users to sing or play the answer due to its pitch recognition feature, and includes scores of classical music and jazz for lesson planning based on a real repertoire. However, the use of computer-generated sounds is an issue that the EarMaster team is working to address, as it limits the program's ability to provide a variety of instrument samples. Meanwhile, Meludia takes a different approach by focusing on "fundamental musical archetypes," and Complete Ear Trainer is based on the David Lucas Burge's "Perfect Pitch Ear Training SuperCourse" (Burge, 1981), which includes ear training drills on intervals, chords, scales, and dictation. Both programs are considering the inclusion of real repertoire in the future. BbMAT, on the other hand, is specifically designed to train different aspects of ear training, such as the identification of textures, timbres, and emotional meanings in music, and has been developed for use by cochlear implant users. Meludia has also been used in studies for cochlear implant users and incorporates timbral aspects in its training path (Boyer and Stohl, 2022).

In interviews with the developers, it was noted that budgetary constraints can limit sound quality and the use of real musical examples, as well as the inclusion of requests from different schools and teachers. Despite these challenges, developers continue to strive for improvements and innovations in ear training software programs.

5 DISCUSSION

The survey and the interviews with teachers and developers have allowed us to clarify the current state of integration of digital technologies in the ear training classroom, especially at the university level.

Although the survey did not show correlations, it made clear that issues of perception, memory, and attention are present. According to the literature, these aspects are trainable, and could be addressed by specialized strategies (Blix, 2014). It is important to note that students present these issues even though most of them are not novice ear training/music theory students. Therefore, a dedicated focus on attention (Kraus and Chandrasekaran, 2010), memory (Mishra, 2004), and imagery (Zatorre and Halpern, 2005) can improve the way students identify, conceptualize, and use musical elements.

The interviews with the teachers revealed that they would be willing to try digital tools in their ear training classes. In addition, they have ideas for software that would be aligned with their methods. However, problems like budget for these kinds of tools in conservatories, instruction on how to use and customize the tools, and inappropriate pedagogical approaches prevent larger integration. Some institutions have managed to include these tools as part of their training; however, according to experts on digital integration in education (Bayon, Terrien, and Fressier), there is still great potential in technology to tackle learning problems.

In Sorbonne University (and probably in other universities), poor basic knowledge of ear training/music theory can quickly become a handicap for students in many subjects. The university is opening doors to students who have not spent their previous years in music schools, conservatories, or who do not come from families where music is practiced. Also, different musical backgrounds (international students) and interests (electronic music production and performance, influence of sound design) can result in different levels of expertise regarding traditional ways to measure music literacy (such as dictation and sight-reading). Therefore, we argue that a way to provide more inclusive education would be to offer tools that narrow the knowledge gap in these specific areas and evaluate different aspects of musicianship (Chenette, 2019).

The offer from apps could improve this landscape by adding suggestions for learning by cognitive psychology and pedagogy (Karpinski, 2000; Butler and Lochstampfor, 1993). Instead of focusing only on drills, it would be beneficial if they include contextualized exercises and use their capabilities to further interaction with musical content. The use of metacognitive strategies (Blix, 2014) and singing (Fine et al., 2006) can greatly benefit struggling students (Wash, 2019). They would also appeal more to teachers and institutions if they could provide deeper levels of customization (provided that they can guarantee teacher training). We agree with the study of Cheng and Leong (Cheng and Leong, 2017) in which they advocate for a better dialogue between software developers and ear training teachers. We believe that better ICT instruction for teachers and the search for feedback by developers can have a positive impact on the outcomes for all involved actors.

6 CONCLUSIONS

Ear training apps are available in abundance on the market, but unfortunately, they have not been adequately utilized in formal music education in France. However, students are willing to use these apps to supplement their instruction, and many of them have seen considerable benefits. Ear training and solfège teachers, particularly those from younger generations, are enthusiastic about incorporating digital tools to enhance their lessons. However, in some cases, teachers face the challenge of selecting from numerous apps that do not fully align with their pedagogical approaches. The obstacles hindering the use of these apps include inadequate musical examples, poor sound quality, incomplete musical nuances, and high costs for students. Some developers are working to address these concerns and meet the needs of educators. We assert that the integration of ear training tools can be improved by providing real musical examples and focusing on training music perception, memory, and metacognitive learning skills.

7 DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [DAMB], upon request.

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