Music reading and music notation software: a multiple-case study

Leitura musical e software de notação musical: um estudo de caso múltiplo

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ABSTRACT: A multiple-case study was conducted within the context of the subject "Musical Practices and Fundamentals" of the Degree of Primary Education at the University of Seville. Five volunteers were subjected to an oral test in which they had to study four music sheets of two different difficulty levels, using two different means. The main objective of this study was to understand the differences between the perceptions of the participants toward the use of these two different means. The results show that the software had greater acceptance for those participants who had lower knowledge and skills regarding the musical content of the music sheets used in this study. Based on the results, it is understood that the introduction of this type of means could pose an improvement in the performance of the students, thereby reducing the differences in previous musical knowledge and skills, which, in turn, could enrich the methodology of the subject.

KEYWORDS: Music reading; Music notation software; Technological acceptance; Multiple-case study; College students.

RESUMO: Foi realizado um estudo de casos múltiplos no contexto da disciplina de Fundamentos e Práticas Musicais da Licenciatura de Educação Primária da Universidade de Sevilha. Cinco voluntários foram submetidos a uma prova oral em que tiveram que estudar quatro escores de dois níveis de dificuldade diferentes, auxiliados por dois meios distintos. O objetivo principal foi compreender como as percepções dos participantes sobre o uso desses dois meios diferentes difeririam. Os resultados mostraram que o editor foi mais aceito quando os participantes tinham menos conhecimento e habilidades sobre o conteúdo musical das partituras. En base a los resultados, se entiende que la introducción de este tipo de medios podría suponer una mejora en el rendimiento de los alumnos, consiguiendo salvar las diferencias en cuanto conocimientos y habilidades musicales previas y, asimismo, podría suponer un enriquecimiento en la metodología de a assinatura.

PALAVRAS-CHAVE: Leitura musical; Software de notação musical; Aceitação tecnológica; Estudo de caso múltiplo; Estudantes universitarios.

1. Introduction and literature review

The present study aimed to address a problem framed within the University of Seville in the Degree of Primary Education, in the specialty of Musical Education, specifically in the subject of "Musical Practices and Fundamentals". One of the main objectives of said subject is that the students learn to sight-sing written musical code. The literature about musical reading is scarce; however, the few studies conducted in this regard seem to indicate that this is a special type of musical perception (Sloboda, 2004). According to the mentioned author, musical reading can be understood as a set of necessary processes and conditions that enable the perception and interpretation of the encoded musical language. Decoding musical texts is a very complex skill. In the first stages of the learning of this skill, the aforementioned processes do not take place automatically or instantly (McPherson & Gabrielsson 2002). Depending on the type of output derived from musical reading, the latter can be either silent or sonorous. In silent music reading, the coding/decoding processes take place internally, whereas, in sonorous music reading, the response can be either vocal or instrumental. Both responses require motor processes and orders that enable musical performance (Merchán Sánchez-Jara 2016). In the musical reading processes aimed at singing performance, it is fundamental to be able to associate the musical symbols with their sonorous correspondence, that is, with the identification and recovery of different sonorous heights and relations (Shön & Besson 2002). Usually, the lectures of the subject "Musical Practices and Fundamentals" are attended by very different students, ranging from those with music studies to those with no music knowledge, including other students who have some notions about music, and others who have learned to play an instrument by themselves. In general lines, most of the students do not have the knowledge and skills required to read and sing a music sheet. To face this difficulty, a musical instrument is used as a means to guide them in the melodic intonation or singing performance of the music sheet. It is frequently observed that the learning process becomes slow and tedious due to the double difficulty of having to play in the instrument the proposed exercise with the aim of knowing how it must sound, and simultaneously practicing, with one's voice, the sonorous model provided by the means. This causes some frustration and discouragement among the students with lower expertise level. Hasegawa *et al*. (2004) demonstrated that the mental processes generated from the visual information of the music sheet were qualitatively different between expert and non-expert pianists. The former associated the music code with motor sequences and sonorous images. Therefore, the reading and performance of musical notes pose a series of motor skills, which are accompanied by visual-auditory-motor transformation processes.

Technology, due to its special characteristics, seems to be a useful and effective tool to reinforce the practice of this type of skill. Different studies have highlighted the effectiveness of technology to improve and develop musical reading (Chan *et al*. 2006; Davis 2001; Goodwin 1991; Lemons 1985; Ozeas 1991; Parker 1979). In these studies, although different technologies were used, they all shared the following common characteristics: they enabled individualized practice for the students and offered a double visual-sonorous stimulus that seemed to facilitate the association and memorization of the musical symbol-sound relationship. Music notation software are computer programs that allow creating and editing music sheets. These are similar to word processors, although the characters are musical notation symbols. Another characteristic of these means is that they allow listening to the output of each of the notes that the user introduces in the editor, as well as perceiving the sound of longer fragments. These editors are also found as apps for mobile devices, such as Smartphones and Tablets. One of the main advantages of their use is that they allow the user to access them anytime, anywhere (Palazón-Herrera, 2014). Different studies have

analyzed the impact of the use of music notation software on the development of music reading (Galera *et al*. 2013; Jeremic *et al*., 2020; Prasso 1997). All these studies show that this type of means had a positive impact on the development of music reading.

Despite the positive aspects offered by technology, it must be adapted to the learning contexts. The perception of the students toward technology during learning is important in the educational contexts. This attitude of the students has been considered key for the acceptance of certain technological means. The aim of the present study was to explore the possibility of incorporating a music notation software within the context of the subject "Musical Practices and Fundamentals", in order to obtain data that help us to determine the type of means that can be used and how to introduce it, following the guidelines of Hernández and Navarro (2017). The perceptions toward the use of technology for learning have been mainly analyzed within the framework of the models of technological acceptance for learning. These models are based on psychosocial theories, which state that intention is what best predicts behavior (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh *et al*., 2003). According to these models, the different factors that influence intention include: a outcome expectations, which indicate the extent to which the user believes that the use of technology will help her/him during the proposed task; b) effort expectancy, which is associated with the degree of difficulty of using a certain technology; and c) usefulness, which refers to the positive aspect of using the means for a certain task. However, these models do not consider the task itself as a component within the acceptance and use of technology. Other models, such as Task-Technology Fit (TFF) (Goodhue & Thompson, 1995), do consider the suitability between the nature of the task, the characteristics of the technology and the individual characteristics of the user to determine the obtained results. The TFF model shows that the interaction that takes place during the use of a technology between the characteristics of the task, of the technology and of the individual has a direct impact on the performance results. Mulet *et al*. (2019), in their systematic review on the use of technology in the educational scope, determined that most of the studies based on the acceptance models used a quantitative approach. They concluded that, even though qualitative studies do not offer generalizable results, they can provide a more detailed, sensitive and contextualized understanding of the perceptions and conditions that affect these perceptions of the students toward the use of technology. It is important to explore how, why and in what conditions it is possible to combine technology, tasks and individual characteristics to improve the learning outcomes (Nicholson *et al.,* 2008).

2. Research aims and questions

The aim of this study was to explore the perceptions of a group of volunteering students of the subject "Musical Practices and Fundamentals" of the Degree of Primary Education at the University of Seville, who participated in a small oral test in which they had to study four music sheets of two difficulty levels, using two support means: a music notation software and their usual instrument.

The research questions addressed were:

- How do the students use the two means when studying music sheets of different difficulty level?
- What is the perception of the participants toward the difficulty of use and the usefulness of the two means?
- Which of the two means do they prefer?

- Are there differences in the valuations of the users about the strategy of use, usefulness and preference as a function of the type of means they used and the difficulty of the music sheets?

3. Method

To address the questions and objectives of the study, a phenomenographic approach was used. This research method allows identifying the qualitatively different ways in which individuals perceive, experience and/or conceive a certain phenomenon (Marton, 1995). The research methodology applied was multiple-case study, which allows the researcher to explore the differences within cases and between cases (Baxter & Jack, 2008).

3.1. Participants

The sample was constituted by five volunteers aged 18-21 years who were registered in the subject "Musical Practices and Fundamentals" of the Degree of Primary Education within the specialty of Musical Education at the University of Seville. A purposeful sampling was carried out, with the aim of obtaining a sample of five students who represented the variety that exists in the group-class of the mentioned subject in terms of the level of previous music studies and gender.

3.2. Music notation software

The program used as support for music sheet reading was *MuseScore*, which is a free and easy-to-use app that works in the main operational systems of the market, and it can be installed in mobile devices. Different studies have shown that it is useful for learning to read music, as it allows simultaneously perceiving the notation and its sonorous correspondence (Buenaño Logroño, 2016; Larasati *et. al.*, 2021; Watson, 2018).

3.3. Oral test

The participants were subjected to an oral test, in which they had to study four music sheets of two different levels of difficulty, using two different support means: the habitual instrument they used to study and the MuseScore music notation software. The level-1 music sheets corresponded to a difficulty level that was considered easy within the program of the subject, whereas the level-2 music sheets corresponded to a more difficult level. Figure 1 presents examples of both levels. This test was also recorded to analyze the singing performance of the music sheets, as well as the strategies used during the study.

3.4. Interview

The data were gathered through an interview, which included different questions related to: the musical experience of the participants; their perception toward the subject; the strategy used during the use of the instrument and of the music notation software during the study of the music sheets of different difficulty levels in the oral test; the difficulty they experienced when using the different means to study the different music sheets in the oral test; the usefulness of each of the means; and the preference for one means or the other when studying the different music sheets.

Figure 1 – Level I and Level II examples music scores

3.5. Procedure

The volunteers were contacted to establish a date and time for the individual realization of the oral test. In this test, they had to study four different music sheets of two different difficulty levels, using both their habitual instrument and the music notation software. Prior to the oral test, all participants were introduced to the use of the music notation software using said test, where they learned basic aspects about its use. During the test, we recorded the time that the participants needed to study the different music sheets before being ready to read them vocally. Moreover, this singing performance was recorded to evaluate its quality according to three criteria: rhythmic accuracy, melodic accuracy and number of mistakes. Once the test was completed, a different date was set to interview each of the participants individually.

3.6. Data analysis

To analyze the results of the oral test, we designed a protocol that measured the time required to study the music sheets, the number of mistakes made, and the rhythmic and melodic deviation of the participants" interpretation with respect to the theoretical model using a phonetic analysis program (Boersma & Weenink, 2021), which allowed labelling and fragmenting the audio files into different intervals corresponding to the different notes and silences. The data obtained from the interviews and video recordings were analyzed using a system of categories and codes, thereby facilitating their understanding and organization (Miles & Huberman, 1994).

3.7. Ethical aspects

All the information gathered during the study was treated respecting the confidentiality and anonymity of the participants. Pseudonyms were used to refer to each of the cases. All participants signed an informed consent form.

4. Results

María: "When I use the piano and I encounter a difficulty in a passage, I play it quickly and that's it. With MuseScore I would have to stop and write it, and so it would be more complex".

María is an 18-year-old woman. She started her music studies when she was very young, and she was studying in the conservatory when the present research was carried out. She had studied clarinet for 12 years. The contents of the class were easy for her, as she already worked on them in the conservatory when she was 9 and 10 years old. Although her main instrument was the clarinet, she used the piano to help her study sight-reading. She had taken piano lessons for several years. She also had previous knowledge before the training session about the use of music sheet editing programs. María completed all the phases of the oral test. In both levels, she spent less time studying with the instrument than with the editor; however, this difference was proportionally lower with the level-2 music sheets. The vocal music reading quality was practically the same using both means, for both level-1 and level-2 music sheets. In the level-1 music sheets, she did not need any support means to know how the music sheet would sound; she only used her instrument to get the pitch for tuning: "Well, I don't need it […] I don't need to use the keyboard […] it's very basic, they're notes do, mi, sol, do. Since it is so basic, I don't need it; I intonate it without using the instrument. I would simply play C or A to have a reference sound and then that's it".

In the level-2 music sheet she used her instrument to verify certain intervals or passages. For the level-2 music sheet, it was not difficult for her to use the editor, although she considered that it was not necessary: "I didn't find it difficult to use the editor, although I didn't think it was necessary to use it. I could write it in MuseScore, yes. I did write it and listened to it, but I didn't need to listen to it to know how to sing it later".

The means that she found the most useful was her instrument, as it was quicker and more direct for her: "[…] if there's a passage I don't get, I just use my instrument for that passage, which is quicker".

Regarding the editor, she thought that the main drawback was the time spent using it. In the two music sheet levels, she would have preferred using her instrument over the score-writer software.

Oliver: "[…] here, I was a bit lost […] I'm telling you, fitting the 6/8, the alterations […] and paying attention to my intonation, making sure that my intonation matches that of the piano, while ensuring that my hand goes to the exact note I have to intonate […]".

Oliver is a 20-year-old man. He completed the conservatory elemental grade at 14 years and, after two years, he decided to change the specialty and take the test to enter the conservatory intermediate grade with the trombone. He has prepared for this test for four years. The contents of the subject were easy for him, as he stated that they were practically the same as those he had worked on all these years at the conservatory. In the oral test, he used the keyboard as the habitual instrument to help him study the vocal reading of the music sheets, despite the fact that he had never taken piano lessons. Before the training sessions, he had no knowledge on the use of music notation software. Oliver went through the different phases of the oral test. The time spent in level 1 was shorter using the score-writer; however, the opposite occurred in level 2. In general, and for all music sheets, the vocal music reading quality was greater when the editor was used. The difficulty he experienced in the use of the instrument for level 1 and level 2 was different. While in level-1 music sheets he only used the instrument for support in certain passages, in level 2, with the increase of difficulty of the musical contents, the use of the instrument was not entirely fluid. On the other hand, he did

not find it difficult to use the score-writer in any of the two levels, and the use he made of it was the same. The means he found most useful was the music notation software: "When I use the score-writer, I only have to make sure that my intonation matches the correct intonation […] I just listen to it, save its sound in my mind, and then reproduce it".

In addition to the ease to focus on his own intonation, Oliver considered the accuracy of the model generated by the program as an advantage. He found the instrument useful when the music sheets were easy, as he made a fluid use of it and, by using it continuously, he related the written notes to the keys. However, when the musical contents were more complex, the instrument did not offer a correct model that guided his interpretation. In the level-1 music sheets, he did not prefer any of the two means. On the other hand, for the level-2 music sheets, he preferred the score-writer over the instrument, as it allowed him to be more focused on the quality of his sight-reading, and he also found it easier to use.

Violeta:

> As I see it, if I always use the score-writer, hmm […] in the future it will be very difficult to study the music sheet by myself… then, when I have to learn it on my own in an exam, and I don't have the base to get the melody out by myself because I studied with the program [long pause] and […], well, no […] no […], it doesn't really train people.

Violeta is a 20-year-old woman. While in primary school, the music teacher encouraged her mother to enrol her in a music school to learn to play the piano. She spent six years in the music school, and when she entered high school, she quit music, as she did not have enough time for it. Since she left the music school, she barely played the piano, and that was five years before the present study. During the time she spent in music school, she learned musical language. The contents of the subject were not excessively difficult for her. However, she found difficulties in sight-reading, especially in the rhythmic element. The instrument she used to help her study in the test was the keyboard. Before being included in the present study, she did not have any knowledge on music notation software. Violeta performed the vocal reading of all the music sheets corresponding to level 1 and level 2 in the oral test. In level 1, the time spent with the instrument was slightly shorter than that spent using the notation software. On the other hand, the time spent in level 2 was drastically shorter with the program than with the instrument. The vocal music reading quality was similar when both means were used for the music sheets of both levels. In level 1, Violeta played the entire music sheet with the keyboard while she sang it. She stated that it was not difficult for her to use the instrument: "[…] it was not difficult for me to use the instrument […] the notes are easy […] hmm […] also, it wasn't fast, it was a slow rhythm […] there are crotchets and minims and, I don't know […] I didn't find it difficult."

The way in which she used the instrument in level 2 was different: "[…] I started playing the whole thing, but I realized I couldn't do it, so I took it by beats looking at the rhythm more carefully."

Using the instrument in level 2 was more difficult for her, due to the greater complexity of the musical contents, especially the rhythmic elements. She used the notation software similarly in both levels: "Firstly, I copied it, and then I listened to it many times and sang it at the same time as the score-writer until I got the melody."

In both cases, it was not difficult for her to use it. Both means were useful to her, although she justified the usefulness of each means differently. Regarding the instrument, she believed that, when she used to study the scores, not only did it provide a sonorous model of the music sheet, but it also forced her to use strategies to independently face the vocal music reading of the music-sheet, which she believed that the score-writer could not do. According to Violeta, the main advantage of the program was its quickness, since it allowed her to focus on memorizing the sonorous model and rehearsing it. In level 1, she preferred to use the instrument, as she found it faster, and then in level 2 she preferred to use the notation software, stating the same reason.

Zeus: "[…] I found the score-writer to be easier to use. You just click on it, write it there, click play, go back as many times as you wish, and simply use those notes as reference to memorize […]"

Zeus is a 21-year-old man. He started learning to play the bass and the guitar when he was 14 years old with his friends by imitation and by ear. He did not learn to read music, although he started researching on his own about aspects of musical theory. The subject was quite difficult for him, especially musical reading and, more specifically, the rhythmic element. The instrument he used to help him study the vocal music reading of the music sheets was the guitar. Before starting with the training session, he already had some experience in the use of music notation software. Zeus completed all the parts of the oral test. In all cases, he spent less time studying with the program than with the instrument. The vocal music reading quality was greater when he used the editor as the support means. In level 1, he used the guitar to know the tune of the notes he was going to sing, although he did not interpret the music sheet in the guitar; he only used it to know how to tune the notes that were written. He worked in this way by fragments, and then he used the guitar to do the harmonic base. In this level, he did not find it difficult to use the guitar, as he was familiarized with it, and the music sheet was not difficult for him: "[…] when playing the instrument, I have no problem. I do play. In fact, I'm currently doing this in my free time. But […] when it comes to sight-reading, if there aren't big changes in the rhythm, if it's about crotchets and minims, it's fine."

In level 2, despite the fact that he used the guitar in a similar manner, it was more difficult for him, as he was not accustomed to accompanying during the singing reading of music sheets of certain complexity:

> But here… especially because of the changes in rhythm, which already have some spark, it has a natural sign here and… the silences, which require more concentration and more…. skill at reading and playing at the same time… I found it so difficult, because of the key signature.

The way in which he used the score-writer in the music sheets of both level 1 and level 2 was the same. He stated that it was not difficult for him to use the program. The means he found most useful was the notation software. He also highlighted the capacity of the program to generate a correct sonorous model and its ease of use. Regarding the instrument, he pointed out the automatism generated when associating the written notes with the position of these in the instrument and, therefore, their sonorous association: "You're not only singing… making music with your voice; you're also making music with your hands. So, for example, if I'm going to play a G, I already know how it sounds, because I've played a G many times."

In the level-1 music sheet, he preferred using the instrument, as it was easy for him to sight-read music sheets at that level, and he found it more comfortable and easier to use the guitar. However, in level 2, he preferred using the notation software, as it was faster and allowed him to focus on the sonorous model.

Estela: "I'd always choose the program. It's easier… because I can't play the instrument properly, and the score-writer is the only thing that allows me to know how this music sheet sounds."

Estela is a 19-year-old woman. She is a music enthusiast and stated that she is always listening to music, every time of the day, every day. However, she did not have any contact with the world of music outside compulsory education. She found this subject to be difficult, claiming that the level was very high and that the contents advanced very quickly. The instrument she usually employed to help her study was the keyboard, despite the fact that she had very little knowledge on its use. Before the training session, she did not have any contact with music notation software. Estela could not sing any of the level-1 or level-2 music sheets when she used the instrument as a means of support. However, she was able to do it when she used the notation software. In the level-1 music sheet, she used the instrument by memorizing the notes by fragments, and then she located them in the keyboard and played them, in order to know how they sounded. When she had memorised the tuning of a fragment, she moved on to the next fragment. Using the instrument was very difficult for her. The main difficulty lied in the fact that she did not know how to identify the written notes with the corresponding keys, and she had to count the keys. The process took her so much time that she quit before memorising the intonation of the music sheet. In the level-2 music sheets, when she had to use the instrument, she did not even try to read them: "[…]in the first level, I just couldn't do it well with the keyboard… and I told myself: "this is just impossible for me" … if it was hard for me with the crotchets, which are supposed to be easier, imagine with the quavers, which are shorter."

She used the notation software to study the level-1 and level-2 music sheets by copying the notes and then listening to the reproduction of the music sheet in the program. She stated that it was not difficult to use it, which she found to be the most useful means. The main advantage was the confidence it gave her, since the sonorous model generated by the notation software accurately corresponded to the music sheet:

> The score-writer reads the notes as they are, with the tempo and everything… it can't fail… well, I can fail if I get nervous […] the score-writer will tell me everything correctly. If I fail, it'll be me, not because the program made a mistake.

In both levels, she preferred using the notation software: "I would always choose the score-writer. It's easier […] because I can't play the instrument properly, and the score-writer is the only thing that allows me to know how that music sheet sounds."

Next, table 1 summarizes the different cases and the dimensions studied for each case, in order to provide a panoramic and comparative view of the set of participants.

Tab. 1 – Different cases and analyzed dimensions

Participants	Musical expertise[1]	Means/time[2]	Means/accuracy[3]	Use of means[4]	Difficulty[5]	Usefulness[6]	Choice[7]
María	12 years clarinet conservatory studies	Instrument	Same for both means	Same for both means and levels	Easy for both means	Instrument: quickness	Always Instrument.
Oliver	4 years conservatory studies and 4 years preparing trombone conservatory admission	Instrument in level I. Notation software notation software in level II.	Notation software	Different for level I and II with instrument. Same for both levels with notation software.	Easy for level I and difficult for level II for instrument. Easy for both levels for notation software.	Instrument: quickness and automatic responses. Notation software: vocal performance and correct sonorous model.	Level I: both Level II: notation software.
Violeta	6 years attending to piano classes in a Music School	Instrument in level I. Notation software in level II.	Same for both means	Different for level I and II with instrument. Same for both levels with notation software.	Easy for level I and difficult for level II for instrument. Easy for both levels for notation software.	Instrument: develop self-learning. Notation software: correct sonorous model.	Level I: instrument. Level II: notation software.
Zeus	7 years playing guitar by himself	Notation software	Notation software	Same for both levels with instrument. Same for both levels with notation software.	Easy for level I and difficult for level II for instrument. Easy for both levels for notation software.	Instrument: quickness and automatic responses. Notation software: correct sonorous model and easy to use.	Level I: instrument. Level II: notation software.
Estela	Music classes at compulsory education.	Notation software	Notation software	Instrument: Useless. Notation software: same for both levels.	Instr.: very difficult. Notation software: easy for both levels.	Instrument: Useless. Notation software: correct sonorous model.	Always notation software

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[1] Musical experience prior to Bachelor Studies.

[2] Means with which the participants spent less time during the study of the different music sheets.

[3] Means which obtained better results during music sheet sight-reading.

[4] Difference in the usage strategy applied for both means in the different music sheet levels.

[5] Perceived difficulty of use of the means during the study of the different music sheet levels.

[6] Advantages of the means.

[7] Favorite means for support during the study of the different music sheet levels.

5. Discussion and conclusion

In view of the results, we can assert that the way in which the participants used the instrument was different. This difference seems to be related to the degree of musical expertise and the difficulty of the music sheets. Thus, there were two opposite cases: María and Estela. While María barely needed to use any means to know how the music sheets sounded, due to her extensive musical background, Estela, who had very little musical knowledge, could not use the instrument as a means to help her vocal reading. Between these two cases, we found Oliver, Violeta and Zeus. Oliver and Violeta used the instrument qualitatively differently to study the level-1 music sheets compared to the level-2 music sheets. It seems that, in order for the instrument to be used as an efficient means of support to singing reading, it is necessary to have basic technical-musical knowledge that allows associating the visual information of the music sheet with motor sequences and sonorous images (Brodsky *et al.* 2008; Hasegawa *et al.* 2004). In any case, it is understood that the efficient use of the instrument could be associated with a certain level of musical expertise and with the complexity of the musical content (Sloboda 1974; 1977).

Regarding the music notation software, it appears that the way in which the participants used it was not related to their previous musical knowledge or to the difficulty of the music sheets they had to read. In this sense, we can infer that these means adapt more efficiently, thereby reducing the differences regarding musical expertise and task difficulty (Jeremic *et al.* 2020). Moreover, this idea is confirmed by the fact that the vocal music reading quality observed, for all cases, was similar or higher when the music notation software was used as a means of support.

The difficulty in the use of the instrument, as well as in the strategy of use, varied as a function of the musical expertise and the difficulty level of the music sheets. The results seem to indicate that, when the user has enough technical and musical knowledge to address a certain music sheet, the difficulty to use the instrument is not high. This was observed in the case of María for both difficulty levels and for the rest of the cases, except for Estela, for the level-1 music sheets. However, when there was a lack of instrumental technical skills or the musical contents were complex for the student or a combination of both aspects, the use of the instrument became difficult. Nevertheless, this variability in the perception toward the difficulty of use did not apply to the music notation software. As was observed, all students perceived that the music notation software was easy to use, even for those who did not have prior to the training session previous experience with this type of software, as was the case for Oliver, María and Estela. This indicates that, in addition to their capacity to show the sound-symbol correspondence in a straightforward manner, music notation software is easy to use and, therefore, can improve the user's performance (Larasati & Sukmayadi 2021; Lituma 2015; Palazón-Herrera 2014; Watson 2018).

One of the positive aspects of the music notation software, highlighted by most of the participants, was its capacity to provide a correct sonorous model that guided the sight-reading of the music sheet. This was a determining factor during the study, since, based on the sonorous image of the music sheet, the participants used the vocal resources and skills required to adapt the intonation to such image. The results of the oral test show that the vocal music reading quality in three of the five cases Oliver, Zeus and Estela was higher using the music notation software. In the other two cases María and Violeta, the vocal music reading quality was similar to that obtained using the instrument. This suggests that the perceptions of the participants toward the correction of this sonorous model were coherent with the results obtained in their singing performance, and it seems that their perceptions were not influenced by their previous musical knowledge

or by the difficulty of the music sheets. One of the positive aspects highlighted for the instrument was quickness, which is directly associated with the way in which the instrument was used during the study. According to María and Oliver, who used the instrument only in certain passages in which they had doubts, the instrument required less time to use when studying the music sheets compared to the music notation software. Another positive aspect identified for the instrument was the capacity to generate automatisms during its use, which developed the symbol-instrumental position-sound relationship (Drost *et al*., 2005; Bangert *et al*., 2001; Shulz *et al.,* 2003). This last positive aspect was mentioned by those students who had some experience with the instrument Violeta and Oliver. After playing an instrument for many years, they may have realized that they can imagine the sound of the corresponding fret or key without playing them. In the case of Estela, no positive aspect was observed when considering the instrument as a means of support to music reading. Therefore, we can assert that the perceived usefulness of the instrument for the five cases analyzed seems to be mediated by the way of using it, which, in turn, is influenced by the degree of difficulty of the music sheets.

The preference for one or another means also seems to be different in each participant and when addressing different levels of difficulty in the music sheets. In the two opposites we found María and Estela. María always preferred the instrument as a means of support. With it, she saved time when studying the music sheets, and the quality of her vocal music reading did not decrease. On the other hand, Estela always preferred the music notation software, as it allowed her to study the music sheets that she could not study with the instrument, and it also increased her vocal music reading quality. Between these two cases we found Oliver, Violeta and Zeus. Violeta and Zeus preferred the instrument as a support means to study the level-1 music sheets, whereas Oliver had no preference for any means. This variability in terms of preference was homogenized in level 2. In this level, the three mentioned participants preferred the music notation software, with which they obtained better results in vocal music reading quality. Thus, we can conclude that the degree of acceptance of one or another means was different in all cases. All this is in line with the postulates of the models of technological acceptance mentioned in the literature review (Davis, 1989; Goodhue & Thompson, 1995; Venkatesh & Davis, 2000; Venkatesh, *et al.,* 2003). We conclude that the instrument is accepted when the students have basic technical-musical knowledge, whereas the music notation software is preferred when the user lacks such technical-musical knowledge.

Figures 2 and 3 show the interpretation of the results based on the research questions proposed.

After addressing the research questions, and in view of the obtained results, we can conclude that, considering the diversity of musical background and the different musical contents of the subject "Musical Practices and Fundamentals" of the Degree of Primary Education at the University of Seville, the incorporation of music notation software would be a highly useful tool to reduce the learning difficulties that the students are exposed to. As was stated by Jeremic *et al.* (2020), the incorporation of this type of software could provide alternative learning strategies, generate confidence and reduce differences among the students, who have different musical experience regarding the content of the subject. Moreover, the versatility of these programs and their ease of use not only allow the user to copy and reproduce music sheets, but also to perform other types of activities, such as musical dictation and composition, which would enrich and complement the reading learning of the students. Thus, and as was suggested by Savage (2010), the program would be used not only to reinforce one type of content, but also to explore its wide range of possibilities to enrich the contents and the methodological approach of the subject.
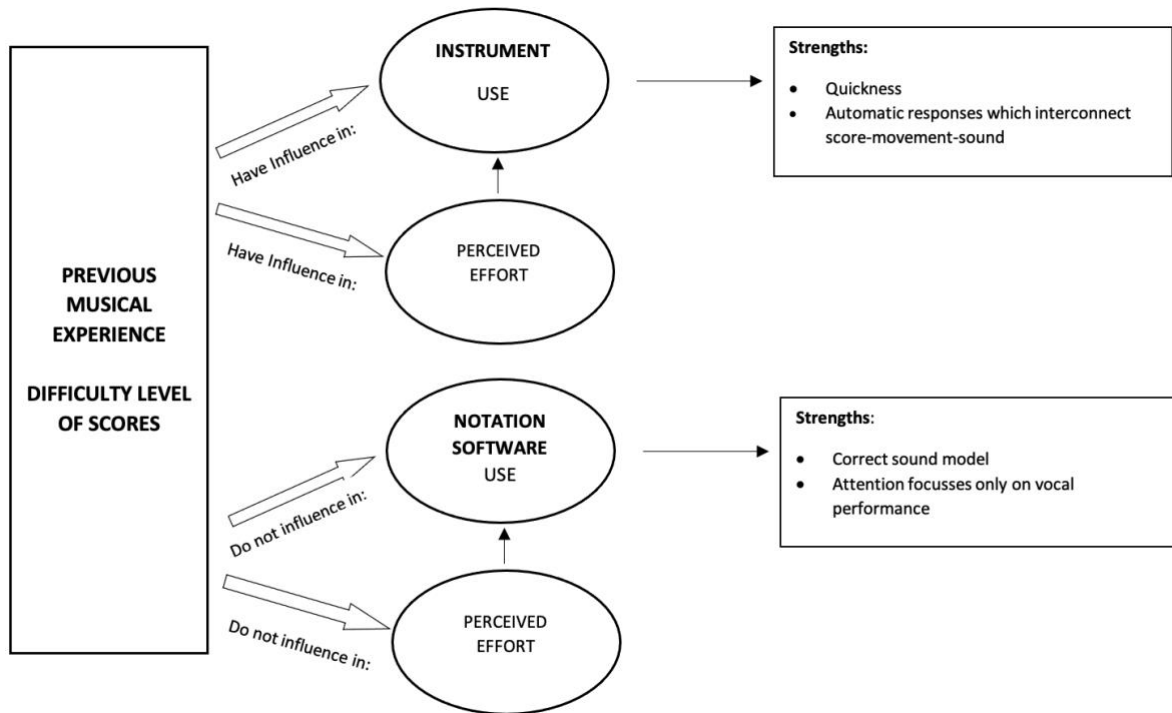
Figure 2 – Interpretation of the results of the interviews regarding the use, ease of use and usefulness of the instrument and music notation software as means of support during the sight-reading of the music sheets
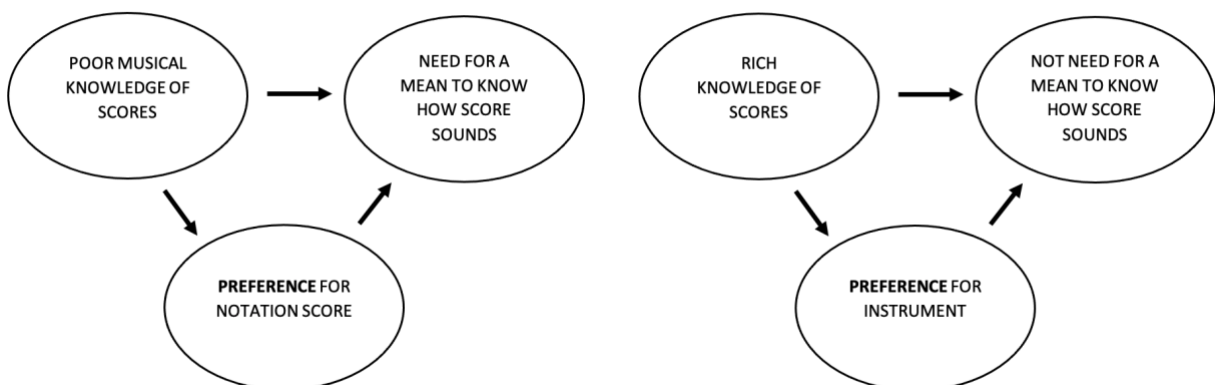

Figure 3 – Interpretation of the results of the interviews regarding the preference for one means or the other

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