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Can blind people conduct musical ensembles? The deconstruction of visual dependency in conducting teaching through *Maestro v0.1*

Cegos não podem reger? A desconstrução da dependência visual no ensino da regência através do *Maestro v0.1*

Erickinson Lima[1]
Research Centre on Didactics and Technology in the Education of Trainers, Aveiro, Portugal.
erickinson.bezerra@ua.pt
https://www.cienciavitae.pt/portal/8A1E-D65C-6485

Abstract: This academic work exemplifies an investigative journey aimed at promoting accessibility, inclusion, and integration of blind students in conducting, using technology as an educational resource. The narrative is structured around two fundamental and interrelated elements: the first is a theoretical analysis that questions the primacy of visuality in acquiring skills and competencies in conducting, and the second highlights *Maestro v0.1* as a potential technological resource to support the technical and individual studies of blind students in conducting. The methodological procedure adopted for technological development is based on User-Centered Design, placing the user at the center of attention, comprehensively articulating the needs, limitations, desires, and experiences of the user to create a prototype that effectively meets these elements. Twenty-five blind students volunteered for usability tests, providing comparative data that corroborates the effectiveness of *Maestro v0.1* prototype feedback as support for the technical teaching and learning of conducting for visually impaired students.

Keywords: Conducting and visual impairment; Conducting teaching; Maestro v0.1, Musical performance studies and visual impairment.

1 PhD and Master in Conducting (University of Aveiro). Currently a doctoral researcher integrated into the Research Centre on Didactics and Technology in the Education of Trainers (University of Aveiro), and a CEEC-IND researcher at the Foundation for Science and Technology (FCT). Deputy coordinator of the Advanced Studies Group in Conducting.

Resumo: Este trabalho acadêmico exemplifica uma jornada investigativa voltada para a promoção da acessibilidade, inclusão e integração de alunos cegos na regência, utilizando a tecnologia como recurso didático. A narrativa estrutura-se em torno de dois elementos fundamentais e interligados: o primeiro é uma análise teórica que questiona a primazia da visualidade na aquisição de aptidões e competências na regência, e o segundo destaca o *Maestro v0.1* como um potencial recurso tecnológico de apoio aos estudos técnicos e individuais de alunos cegos em regência. O procedimento metodológico adotado para o desenvolvimento tecnológico baseia-se no *User-Centered Design*, que coloca o usuário como ponto central das atenções, articulando de maneira abrangente as necessidades, limitações, desejos e experiências do usuário para a criação de um protótipo que atenda efetivamente a esses elementos. Vinte e cinco alunos cegos voluntários participaram dos testes de usabilidade, fornecendo dados comparativos que corroboram a eficácia do feedback do protótipo *Maestro v0.1* como suporte ao ensino e aprendizagem técnica de regência para alunos com deficiência visual.

Palavras-chave: Regência e deficiência visual; Ensino da regência; Maestro v0.1, Estudos em performance musical e deficiência visual.

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1. Introduction

We inhabit a predominantly visual teaching reality, which often leads to underestimating the potential of students with visual impairments. This limited perception of reality reflects the lack of means and skills to deal with the teaching and learning process of these students (NIEMINEN et al., 2024; TOMLINSON; KILLINGBACK, 2024). This extends to the field of music, especially in performative disciplines such as conducting, which lacks methodological resources and structured didactic interactions to ensure proper and balanced understanding of theoretical and practical foundations (LIMA, 2021a; SMEETS et al., 2023).

Conducted over the first 20 years of the 21st century, Lima's study (et al., 2023) effectively highlights a reflective gap about teaching and learning of conducting, with inclusive perspectives still lacking. Lopes (2017), addressing instrumental learning, makes it clear that the teaching process of preparatory performance for blind students is still pedagogically deficient. In the teaching of singing and instruments, Trindade (2008), Oliveira (2013), and Tudissaki (2014) are examples of research that focuses on pedagogical perspectives for the musical education of blind students but without technological assistance.

Utilizing technological advances, Buxton (et al., 1980), Matthews (1989), Fujinaga, and Tobey (1996) developed software designed for conducting practice. Despite the importance of these studies, there is a temporal gap in scientific production considering current days, the impracticality of use by blind students, and the fact that they were developed by researchers unfamiliar with the intrinsic peculiarities of musical performance.

Assistive Technologies (AT), understood as equipment and strategies designed to enable or enhance the abilities of blind people (TSIHRINTZIS et al., 2022), in a general context, are focused on mobility, reading, Braille printing, and writing, a factor reinforced by Ahmetovic (et al., 2023) and Abusukhon (2023). In the musical field, AT is centered around screen readers and music notation for

Braille. Examples of academics in this field include Tomé (2003), Siligo (2005), Garbunova (2018).

Unlike these approaches presented, the present work is led by an educator and performer with expertise in the technological field, with a focus on the performative accessibility of conducting, providing a solid foundation for the development of the perspectives that structure *Maestro v0.1*.

In the experience I had as a teacher of blind and sighted students, I could see that visually impaired students take longer to reach the organicity of movements, in relation to sighted students. Analogous to these points, body movement is fearful, a reflection of the insecurity caused by the lack of the notion of spatiality and what constitutes an obstacle in this space, which consequently generates new points:

1. Body attitude is always static, even with the musical discourse in progress;

2. The gestural geometry of the time signature patterns becomes imprecise as the movements are repeated. Sometimes it is too open or closed, below the waist or high. They are always robotic gestures;

3. Difficulty in establishing a precise relationship between gesture and sound response — dynamics, character design, *Legatos* and *Non Legatos* — in other words, which gesture will be responsible for provoking certain sound responses, for example.

4. Another point to be considered, which aggravates the above considerations, is the fact that the effective experience of the visually impaired student is reduced only to the classroom. This is because individual study outside the classroom domain is impaired, as it is dependent on the availability of colleagues or the teacher to observe their practice and perhaps correct them.

Reflections on the dilution of the presented points, made me consider the possibility of using New Information and Communication Technologies (NTIC) as a mean of favoring the teaching-learning relationship and the performative practice of conducting for visually impaired students. The use of technology makes it possible to transform our educational concepts and our didactic perspectives. It also leads us to reflect on the new possibilities and demands regarding interactions with our students (DORNELES, 2007).

Maestro v0.1 is a software that performs visual sensing through a webcam, analyzes the student's technical action by comparing it with the information contained in its database. After analysis, it sends haptic or auditory feedback making the necessary technical corrections (LIMA, 2024).

The originality of the present theme and the articulation with other scientific areas, regarding the dialogic reciprocity between music, education and software engineering, make the future investigative results to bring a new look at the performance teaching of music and its relationship with visually impaired students. Therefore, this work constitutes a step to foster the interest of new approaches, in order to dissolve the scarcity of reflections and concrete academic actions that surround the field of this research.

2. Theoretical framework

Having the concept of the "gaze" as a corporal materiality for the constitution of knowledge and learning, will make it impossible to bring blind individuals to the perspectives of this investigation. Therefore, "Who sees and who looks are not just the (carnal) eyes, but the sensitive body" (PORTO, 2005, p. 25). To better immerse and reflect on the perspective raised, it can be understood according to Diniz (2007, p. 08) that: "Being blind is just one of the many bodily ways of being in the world. [...] visual impairment does not mean isolation or suffering, as there is no biological sentence of failure for someone not seeing. What exists are social contexts that are not very sensitive to the understanding of body diversity".

The author Ana Carrolo (2009) emphasizes the particularity of the visually impaired people to overcome blindness through the experience lived through other sensory pathways. “The blind body sees. The blind body is seen. Seeing is an experience that goes beyond the sense of sight. It is perceiving, feeling, knowing, touching, relating, experiencing. Experience that is inscribed in the body, the presence of the human being in the world, and, originally familiar with the context in which it is understood/inserted” (CARVALHO; FERNANDES, 2007, p. 04). Complementing this perspective, the author Sacks (2010, p. 180) points out: “To be someone who sees with the whole body is to be in one of the most centered human conditions”.

Authors such as Lima (2013) and Laboissière (2007) place music as an abstract art in relation to other artistic languages — such as painting or sculpture, for example — that bears obscure zones that force the interpreter (conductor) to decode. This process of decoding the music sheet, in other words, of interpretive construction, starts from an individual structure in which the conductor places her/himself before the work, in short, a mental action. Pareyson (2001, p. 2007) states that a concise interpretation is only achieved after scrutinizing, confronting, questioning, establishing a true and proper dialogue with the composition consisting of “questions and answers, questions that were known to be asked and answers that were able to capture, sought the most revealing perspective and the most eloquent aspect; in short, it developed an intense and continuous activity”. Author Lima (2013) adds that music allows mankind to establish direct contact with its sensitivity and subjectivity, both from a mnemonic perspective and from an associative perspective. “It is in this contact that individuals creatively develop their emotional, cognitive and physical potential” (LIMA, 2013, p. 132).

The previous study of a work (mental action) consists of a starting point for interpretive paths and rehearsal planning, possible strategies in the search for solutions to technical, stylistic and aesthetic problems. It is at this moment that a technical set of gestures is also structured, that is, a compendium of bodily actions necessary to communicate previously structured interpretative intentions. Compositions such as the ballets by Igor Stravisky (1882-1971) and Ionisation (1929–1931) by Edgard Varèse (1883-1965), are examples that express technical-compositional intentions that produced a refined technical gesture by the conductor — which does not mean that the gesture is the starting point in the preparation of the works. Even within the time interval between the 20th and 21st centuries, there is a wealth of compositions that demand more from the sound conception (mental actions) than the insipid gestural clarity (corporeal actions), as in Lontano (1967) by György Ligeti (1923- 2006) and Threnody (1960) by Krzysztof Penderecki (1933-2020).

Certainly, the "gaze" has its relevance for musical performance and there is no intention of disregarding it, but it is important to re-signify the meaning we give to it, going beyond the meaning that is concluded from the "look with the eyeball". To overcome this thought is to go against the conducting that is structured in a dialogical reciprocity between mental and corporeal action. Constituting the "gaze" as a determining factor of deprivation of access to a certain knowledge, depresses cognition as an active psychological agent in the construction of knowledge, denies all the processes inherent and participating in this acquisition, such as: thought and language, reasoning, memory perception, attention and imagination, for example. Therefore, the blind person is not devoid of cognitive processes.

It is in this same sense that Merleau-Ponty (1999) stated that materiality is constituted by the body, and the corporeal experience teaches how to structure the rooting of space in existence. According to his reflections, the body is not in space, it exists in space, and in this way human uniqueness is expressed through the body and its relationship with the world in which it exists. The "experience of one's own body teaches us to root space in existence [...]. To be a body, we have seen, is to be tied to a certain world, and our body is not primarily in space: it exists in space." (MERLEAU-PONTY, 1999, p. 205).

The basis of this thought allows connecting the development of the blind individual to the technical development of conducting, as it is visible to believe that this individual has the capacity to structure and carry out the necessary interconnections between the other experiences lived and the current ones. In this sense, attributing meanings that make those experiences particularly personal, and that consequently reflect on the blind individual's learning of conducting, "the practice of conducting is, in essence, the psychomotor expression of musical contents" (MATEUS, 2009, p. 18).

This corporeal sensibility in a relational dialogue with the world, structures the perception of information through another sensory path — in this case, touch, for example — does not seem to confuse the mind of the blind person, on the contrary, they are capable of generating clear mental images of what perceived by tactile acuity. Congruently, said Ana Carrolo (2009, p. 17): "it was possible to verify that the cognitive performance in the scope of visual mental images, in blind people is similar to what happens with sighted people, in the ability to memorize in a superior way images of concrete words, to the detriment of abstract words".

Correlating the idea of generating mental images provoked exclusively by the tactile sensory pathway seems to be something unfeasible to think about when blind people are involved. However, it is something possible. Evidence of this factor is found in the studies of the neuroscientist Sadato (et al., 2002). With the participation of 15 blind and 8 sighted volunteers, submitted to a functional magnetic resonance imaging (MRI - Magnetic Resonance Imaging) while performing tactile activities.

A particularity highlighted by Sadato (et al., 2002), corresponds to the eye movement of sighted volunteers. According to the aforementioned neuroscientist's delineation, the saccadic movement of the eyes can suppress the functional potential of the cortex, even when the individual is in the dark, triggering a "decline in the net amount of excitatory neurotransmitter in the visual cortex" (SADATO, et al., 2002, p. 2179). In order to dilute the factorial interference of saccadic movements, a visual projection of a completely filled small circle was used — approximately 1.5 meters away from the eyes, on a screen — and the participant was asked to observe himself during the sections.

The study showed that in blind people the primary visual cortex showed more intense activity when performing tactile actions. The behavior of this brain area is more significant in relation to sighted people. The question raised by Sacks (2010, p. 192) becomes pertinent, "What happens when the visual cortex is no longer limited or compelled by the input of visual information?". According to the aforementioned author, the visual cortex is hypersensitive to internal stimuli, such as: Signals coming from other brain areas — tactile, verbal and auditory areas — its own autonomous activity, memories, thoughts and emotions.

As Damasio (2011) had exposed, the distinctive feature of the human brain is its ability to build maps. From the moment the brain creates maps it informs itself. This information can be used unconsciously in the effective direction of motor behavior - which operates within the perspective of the body-archive. As a consequence, when creating and structuring maps, the brain is also structuring images. "And finally, consciousness allows us to experience maps as images, manipulate these images and apply reasoning to them" (DAMÁSIO, 2011, p. 87-88).

When interacting with objects, people, places and machines (technologies), for example, the brain creates maps, in other words, the constitution/structuring of these maps affects from the outside to the inside. Interaction allows the constitution of maps to be remembered as an important factor for the improvement and refinement of actions. Maps are also constructed when moments that are dormant in memories are evoked. Another factor is that this construction does not fall asleep during sleep (DAMÁSIO, 2011).

The lines in this subchapter direct that musical knowledge, notably the technical apprehension of conducting and its expression in the performative act, comes from the body field, a sensitive body that "sees" from its experience with the other and with the world. "A thought of unity about the body is instituted, integrating the biological, the psychic and the cultural, therefore, experiencing one's own body, which is a body always in process, in search, a subject-body, which feels and embodies the experience" (ALMEIDA, 2013, p. 30). To provide a more solid foundation for this perspective, I highlight musicians who have overcome the inherent difficulties of blindness, assuming conducting roles in instrumental and choral ensembles.

Sidney Marzullo (1940-2005) was born in Rio de Janeiro (Brazil). He was a figure whose conducting education remains obscure, without information available at both UNIRIO[2] and IBC[3]. Despite this gap, a Music Education monograph provides insights into his role as a conductor. According to Sant'Anna (1995), Marzullo led the IBC's Silver Choir for 23 years, a remarkable achievement, especially considering that, in addition to being blind, all choir members also shared this condition.

In Porto Alegre (Brazil), Artur Elsner (1899-1978), congenitally blind, assumed the conducting position of the Municipal Band in 1913. In the United States, Robert Marcellus (1928-1996), a clarinetist and conductor, transcended diabetic retinopathy and was praised by the Chicago Tribune (REICH, 1987) for leading orchestras in the USA and Canada. In Florina, Greece, Demetrios Liotsis (1919), as reported by journalist Stella Tsolakidou (2012), began his conducting career after losing his sight, founding the local children's choir. In Argentina, pianist, composer, and conductor Gabriel Bergogna (1960), congenitally blind, stands out as a guest conductor in the country's orchestras (Biografias y vidas 2016). In November 2023, I conducted an academic interview with a young Spanish conductor with visual impairment, closely observing both the rehearsal process and the concert performance, with a professional orchestra in Portugal.

In exploratory research conducted in March 2016, I conducted an interview with conductor João Maria Bezerra Pereira (1970), who leads the wind orchestra at Varela Barca State School, located in the northern zone of Natal (Brazil). The maestro's conducting career began after the loss of his vision.

2 Federal University of the State of Rio de Janeiro.

3 The Benjamin Constant Institute (Instituto Benjamin Constant - IBC).

> I learned many of the technical elements of conducting on my own and from what I remember from other conductors I observed. On the day I decided [laughs] to attend a conducting course, it caused quite a stir. I overheard conversations among other participants, and I also noticed the teacher was a bit lost. I ended up feeling embarrassed and didn't go back. They didn't believe in me because I am blind. (PEREIRA, 2016)[4].

This encounter provided an in-depth analysis of the conductor's role in the context of music and the necessary adaptations for the effective leadership of a musical performance, highlighting the specific challenges and achievements faced by conductors with visual limitations.

The theoretical framework presented supports the perspective that teaching and developing technical skills in conducting are viable for people with visual impairments. As highlighted in the introduction of this work, blind students face a lack of didactic resources that would allow them to enhance their technical practice without restricting them to the classroom environment, thus promoting their independence in technical studies.

3. *Maestro v0.1* objectives

The structuring objectives of the development of Maestro v0.1 are based on three parts, namely:

1. Main Purpose:

• Providing a product capable of allowing the blind conductor to study and improve, in a safe and efficient way, as well as independent of third-party supervision.

4 **In Portuguese**: "Muitos dos elementos técnicos da regência aprendi sozinho e pelo pouco que lembro de outros maestros que vi. No dia em que inventei [risos] de ir a um curso de regência, causei espanto. Ouvi conversinhas de outros participantes, e também percebi o professor um pouco perdido. Acabei me sentindo constrangido e acabei não indo mais. Desacreditavam em mim por ser cego" (PEREIRA, 2016).

2. Pedagogical-Musical Objectives:

• Enabling means through the construction of new technologies that make accessible and dilute the temporality of the teaching-learning process of the technical contributions of conducting for blind students;

• Decreasing the level of dependency of the visually impaired in acquiring skills, in the practice of these skills and in the individual study of the technical-performative contributions of conducting, through the use of new technologies.

The objectives make it possible to summarize the architectural structure of *Maestro v0.1* on two elements: the software responsible for the synthesis of the system's functioning, and the hardware responsible for transmitting the haptic feedback to the blind user. The functional dynamics of *Maestro v0.1* can be described as follows:

1. The user's gestures are captured by the camera;
2. The processing of this gesture is carried out by a Software;
3. The processed data is transmitted to the blind user through somatosensory feedbacks (haptic or auditory).

The hardware prototype is placed on the student's arm as a bracelet with a vibrator system. The interactivity between three elements, body movement, electronic board with wifi system with four vibrators (electronic bracelet), and computer (or laptop), works together to generate the necessary feedback for the student to practice. A database is stored on the computer — or a laptop — with information on spatial margins. The bracelet will transmit the data generated from the movement in front of the computer's webcam, which will read this data and send a response to the bracelet, activating the vibrational system.

As for the software, its base starts from a webcam that will act as an artificial kind of "eye" that will capture the image of the gestural movement. All the decoding of the captured information will be in charge of the software developed for this purpose. Its functionalities — in this version, *v0.1* — consist of:

1. Analyzing the gestural processing and, based on the database, enabling corrective guidelines through sound or vibrational feedback (use of the bracelet);
2. Providing recorded data in the form of graphs that make it possible to send the record to the professor in order to follow the student's progress;
3. Permitting the printing of these graphic files in high relief so that tactile reading is also possible;
4. Allowing awareness of the notion of spatiality, making it possible to work on the autonomous movement of technical gestures in space;

Maestro's differential is to work/exercise the blind student's proprioception, at the same time that it will try to reduce the level of dependence on third-parties in their individual practice. All input and output interaction with *Maestro v0.1* take place in a continuous process of action and reaction.

3.1 Survey participants[5]

In order to understand the possible effects and contributions of using *Maestro v0.1* on the teaching and learning process of blind students, the experience with the system was limited to students who are taking or have taken the conducting course during this

5 This research involves the participation of human volunteers, within the scope of the social sciences of education (Special Education). They are people of legal age capable of giving informed consent to their participation in this research proposal. The research does not involve invasive methods or that put the lives of its participants at risk. The participation of volunteers will occur through the capture of footage in interaction with the features of the Maestro prototype. At the end of the interaction with the prototype, a questionnaire was be applied to each participant, to collect data about its use, in the light of the perspectives of Human-computer-interaction (DIX et al., 2004). Each volunteer signed a "term of free and informed consent", which informed all the steps to be necessarily observed so that people invited to participate in the research can express themselves, autonomously, consciously, free and informed. The research will preserve the anonymity of its participants, and the data collected will only be published in publications and scientific events.

research development. The temporal framework of this delimitation occurred in the space between February 2017 and December 2018.

The methodological procedure to achieve the research objective is based on User-Centered-Design. It focuses on technological development, considering the user as a central point, aiming to articulate their needs, limitations and desires for the creation of a prototype that meets these elements (DIX et al., 2004).

It is important to highlight that this research started with a representativeness of only two blind students, who ended up stablishing contacts with other blind students that they knew about. Eventually, they all became new participants to engage in the experiment. This evolutionary process culminated in the participation of a total of 25 volunteers, indicating an organic expansion of the sample through the initial involvement of these two students and the subsequent broadening of the network.

Altogether, 25 people, aged between 20 and 55, participated in this study. The time of disability and musical studies, as well as ages, were also remarkably wide within this group. However, all had at least 2 years of disability and music study at the time of the experiment. The group, despite being heterogeneous, served the purposes of the experiments in question. All participating subjects were active volunteers who gave an affirmative answer when invited to participate in this investigative stage (LIMA. 2020).

To preserve the anonymity of participants, specific codes were used. The designation "**U**" indicates "users", followed by a sequential number representing the order of participation. Additionally, I used the acronyms "**LM"** to identify students currently pursuing a Licentiate degree in Music, **GM** (Graduated in Music) for those who have completed their courses, and "**IS**" for Informal Music Students characterized by their learning with private music teachers.

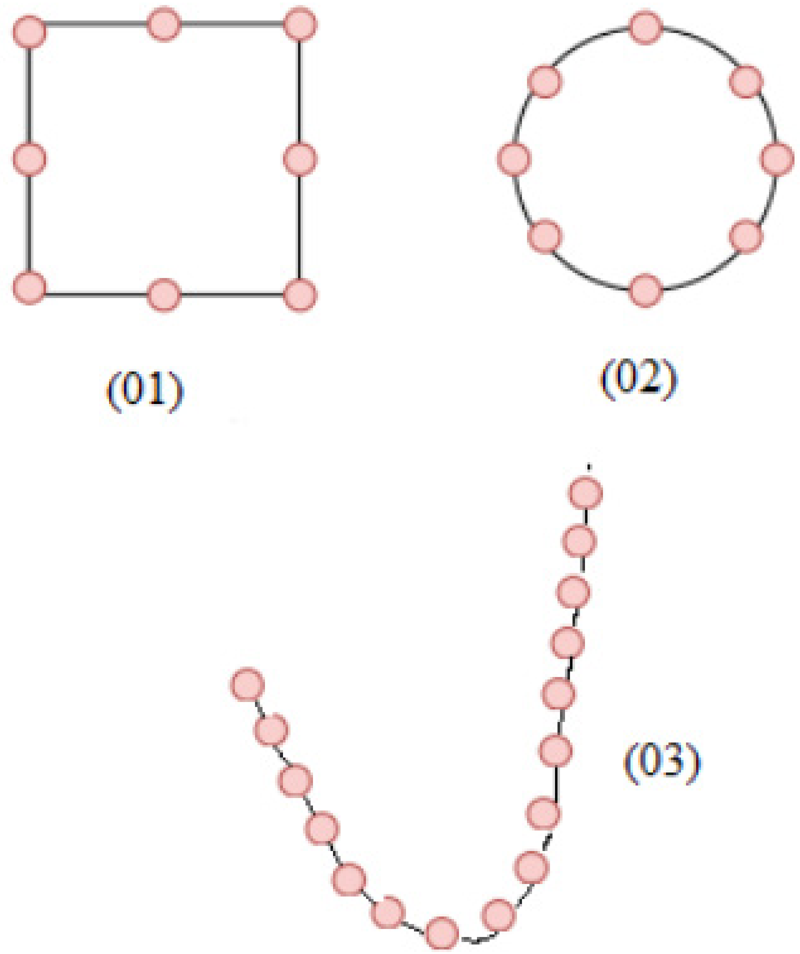
3.2 Usability tests and results

The test run can be divided into 2 parts:

1. Motion execution without any of the *Maestro v0.1* feedbacks;
2. Execution of the movement with each of the feedbacks.

Considering the above, three scenarios were idealized: the square (scenario 01), the circle (scenario 02) and the semi-hyperbole (scenario 03).

Figure 1 – Gestural Scenarios.



Fonte: Prepared by the author.

Each collected data consists of the value generated between the user's execution and the trajectory that is registered in the *Maestro v0.1* database, thus having the numerical value of the error in relation to the trajectory. This value corresponds to the average distance between pixels. Thus, in sequence, the values between the execution with and without the use of feedback are compared.

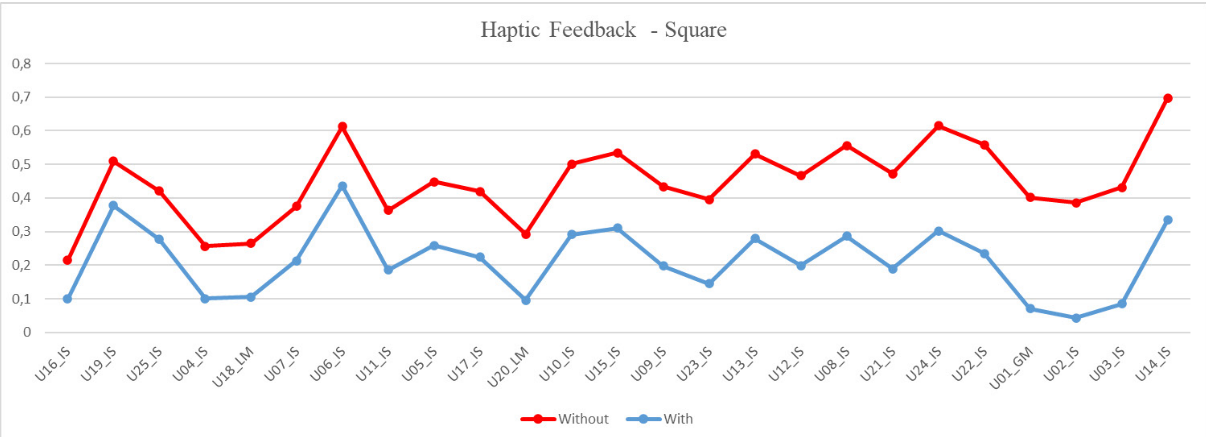
In the subsequent example, it is possible to visualize how the value of the gestural execution error is obtained.

The purpose of this disclosure is not to place or expose which feedback is the "best", or to define from that what is materialized as the only effective action/reaction functionality. The intention is for *Maestro v0.1* to have two possibilities that are up to the choice of its users. In the exposed data, the two possibilities provide their users with the elements that induce the gestural correction of the course of the trajectory. The reaction time of this corrective induction is in fact particular and depends on the organic/idiosyncratic action/reaction of each being.

The numerical comparison is derived from a practice that incorporates haptic and auditory feedback during a 1-hour session, divided into 30 minutes with the use of the bracelet and the subsequent 30 minutes with an emphasis on auditory feedback.

Following is the graph resulting from the haptic feedback numerical data, trajectory of the square:

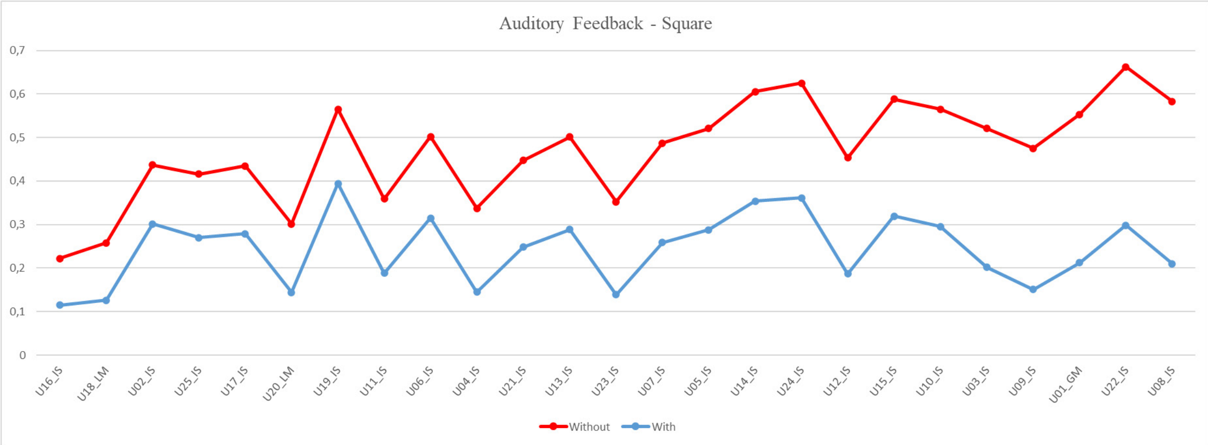
Graph 1 – Gestural Scenarios: results of usability with haptic feedback, scenario 1, square.



Fonte: Prepared by the author.

In sequence, the graph corresponding to the auditory feedback — still considering the trajectory of the first scenario:

Graph 2 – Gestural Scenarios: results of usability with auditory feedback, scenario 1, square.



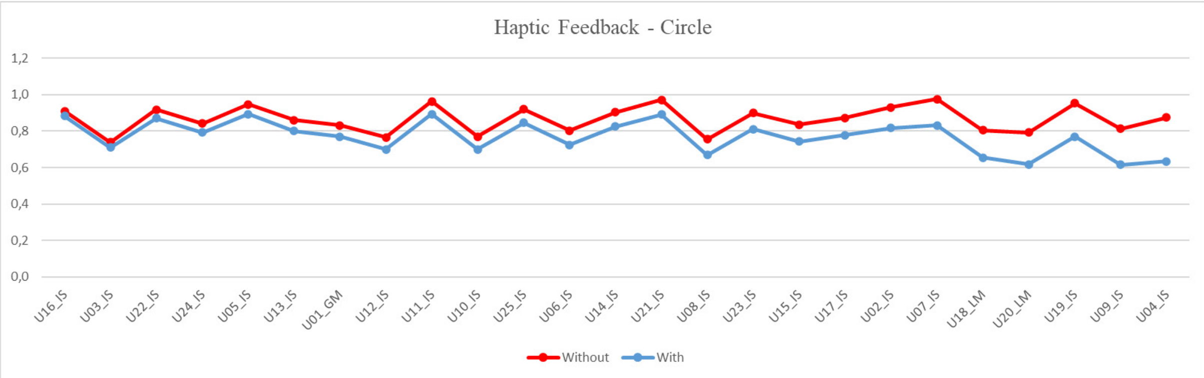
Fonte: Prepared by the author.

Comparison between the red lines (without using feedback) and the blue ones (with using feedback), show that the auditory and haptic feedback induce users to correct the trajectory necessary. The data show a significant corrective difference, thus corroborating the feasibility of these outputs on scenario 01.

In haptic feedback, user **U02_IS** achieved the highest rate of error reduction using the wristband — 89% — while **U19_IS** achieved only 26%. These same users, with the use of auditory feedback, obtained different reactions. **U02_IS** now has 31% of trajectory error dilution — the second lowest error dilution index — while **U19_IS** maintained the lowest index, with 30%. However, apparently with a 4% positive grade asymptotic reaction when using auditory feedback. With this feedback, the highest level of error reduction was from user **U09_IS** with 68%. The same user, regarding the use of the wristband (haptic feedback), obtained an error reduction of 54%.

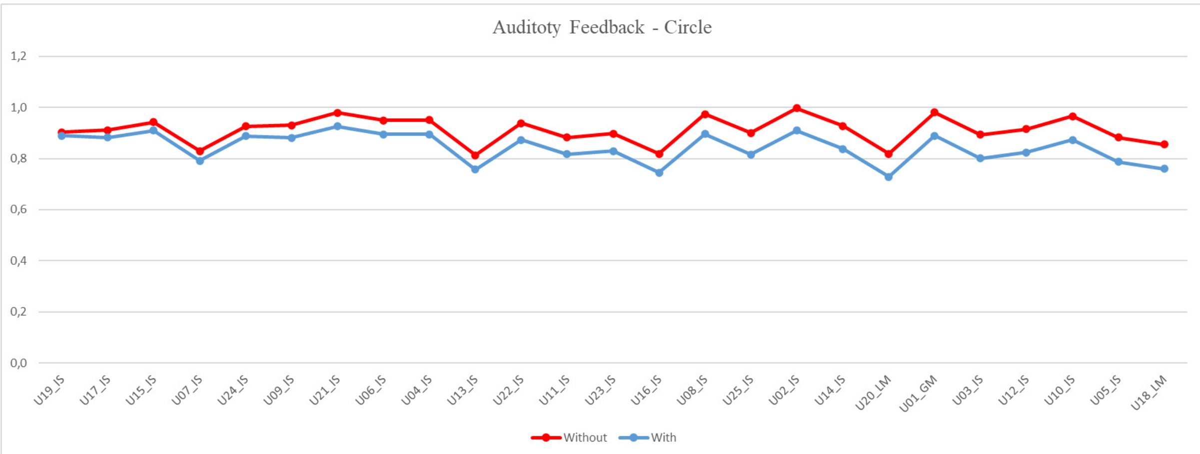
Analyzing the second scenario — the circle — it is considered, from the analysis on the dilution of the trajectory error, as a more complex execution structure. It is notable that users had a considerably lower rate of error decrease when comparing the values in relation to the first scenario.

Graph 3 – Gestural Scenarios: results of usability with haptic feedback, scenario 2, circle.



Fonte: Prepared by the author.

Graph 4 – Gestural Scenarios: results of usability with auditory feedback, scenario 2, circle.



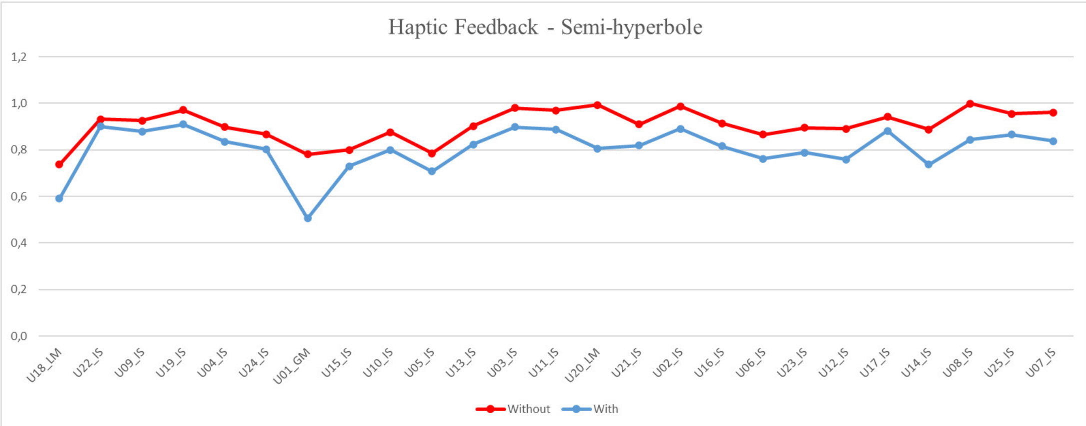
Fonte: Prepared by the author.

Despite the numbers showing a high error rate in the second scenario — the circle — it is still evident that feedback, when acting in this context, promote corrective action.

Comparing the trajectory error dilution performance of the **U19_IS** between scenarios 1 and 2, we observe its reaction to the haptic feedback — circle — with the fourth best performance. However, there is a return to the lowest index when using auditory feedback. Still considering the second scenario, the user **U04_IS** obtained a higher reduction rate of 28% — with the use of the bracelet — but, with the auditory feedback, he obtained only a 6% reduction. With the use of auditory feedback **U05_IS**, and the two licensees: **U20_LM** and **U18_LM** obtained an 11% error reduction. In the use of the bracelet, **U18_LM** (19%) and **U20_LM** (22%) obtained a better performance, while **U05_IS** had only a 6% reduction.

The Graph that shows the dilution of the error with the use of the bracelet in the execution of the third scenario, has the structure below:

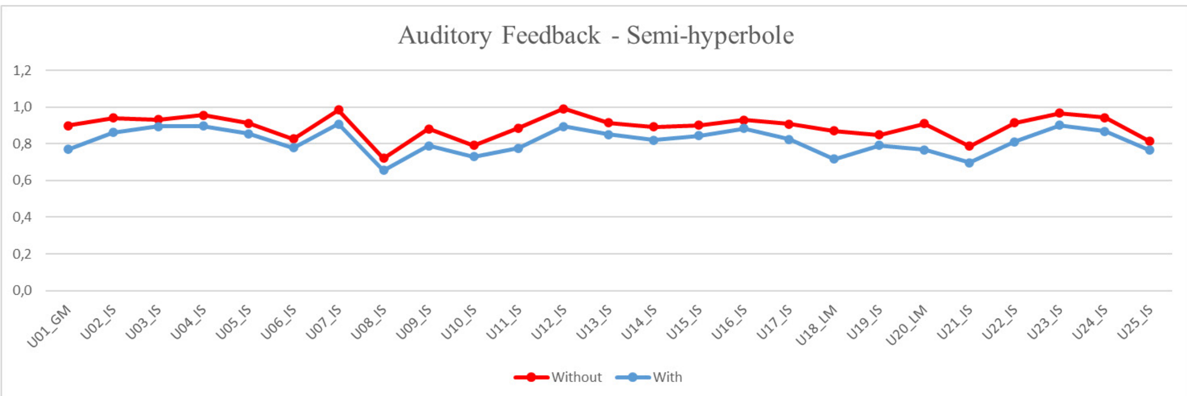
Graph 5 – Gestural Scenarios: results of usability with haptic feedback, scenario 3, semi-hyperbole.



Fonte: Prepared by the author.

The graph corresponding to the dilution of the error with the use of auditory feedback, has the structure presented in sequence:

Graph 6 – Gestural Scenarios: results of usability with auditory feedback, scenario 3, semi-hyperbole.



Fonte: Prepared by the author.

In the execution of the third scenario, the **U01_GM** obtained the error reduction index of 35% with the use of the bracelet, and 18% with the auditory feedback. User **U22_IS** had the lowest error dilution index with haptic feedback, obtaining a greater reaction with auditory feedback. On the other hand, the third scenario proved to be comparable in execution complexity in relation to the second scenario.

Among all three trajectory scenarios, the square showed the lowest error rate using any feedback — as can be seen in comparison to the presented data. The conjecture that can be raised to explain this result is that the square corresponds to a common geometric figure, it can be easily drawn because it has straight lines. That is, its format probably made it simpler for the user to understand the control signals sent by the feedbacks.

Although the trajectory error reduction rates in the second and third scenarios are lower compared to the first, it brings to light that the fact of being visually impaired users did not constitute an obstacle to understanding a corrective action, provided by *Maestro v0.1*, which is a factor that can be visible by analyzing the behavior of the exposed graphics. Considering the percentage values of trajectory error dilution, comparing the types of feedbacks in the three scenarios, the data show asymptotic numerical differences between users.

The constant reactive alternation of users in relation to any feedback in the three scenarios dissolves the occurrence of interference/dependence of age variables, time of disability and time of musical studies on their relaxants, in other words, there is interference, however, minimal. For example, user **U24_IS** is congenitally blind and is the oldest among users (55 years old). This user performed better — in scenario 01 — in relation to **U25_IS**, thirty-five years younger and congenitally blind. Still in the same scenario, in relation to **U14_IS**, also congenitally blind and thirty-five years younger, his difference in relation to **U24_IS** with both feedbacks is 1%. The possible explanation for these cases is that the **U24_IS** has more time studying music and more life experience.

Considering users **U24_IS** and **U21_IS** with close ages — 55 and 52 years old — **U21_IS** has less time studying music and performed better in the three scenarios and with both feedbacks, in relation to **U24_IS**. The possible explanation is the shorter period of disability of the **U21_IS** (6 years), in relation to the **U24_IS**. However, user **U23_IS** has been disabled longer (13 years) compared to **U21_IS**, and in the three scenarios with haptic feedback, he performed better. In this case, **U23_IS**'s age and length of musical studies may have been a factor influencing his performance. On the contrary, in the third scenario, the user **U21_IS** had a better reduction of the trajectory error with the auditory feedback in relation to the user **U23_IS**.

U20_LM, majoring in music, congenitally blind and older than **U18_LM**, also majoring in music and with less time of disability, obtained equal or different rates in 1% with the use of auditory feedback in the three scenarios. Considering the second scenario and the use of two feedbacks, **U20_LM** achieved better error reduction than **U01_GM**, who is graduated in music and with less time of disability.

Considering that **U01_GM** is the most musically experienced of the entire group, he obtained a lower error reduction index than **U02_IS**, less experienced and of similar age (41 and 42 years), in the first scenario with the use of the bracelet. In the same scenario and with the use of auditory feedback, **U01_GM** had a smaller error reduction than **U08_IS** and **U09_IS** who are less experienced.

Considering age and musical experience, **U01_GM**, in the second scenario, with the use of the bracelet, obtained a lower error reduction index than **U21_IS**, the second oldest in the group and with only four years of musical experience. Still in the second scenario, **U04_IS**, **U07_IS** and **U10_IS**, the least musically experienced in the group (2 years of experience respectively) achieved better trajectory error reduction with the use of the bracelet compared to **U01_GM**, with **U10_IS** having the best error reduction with the two feedbacks in relation to the more experienced one, in scenario 02.

In the third scenario, users **U04_IS**, **U10_IS**, **U19_IS**, **U21_IS** and **U24_IS**, with different characteristics of age, time of disability and time of musical studies, presented percentage differences between the use of both feedbacks of 1%. The same occurred considering the second scenario with the users: **U10_IS**, **U11_IS**, **U13_IS**, **U14_IS** and **U25_IS**.

The exposed evidences are examples that the variables of age, time of disability and time of musical studies, did not significantly influence in the interactivity/obtaining of the feedbacks provided by *Maestro v0.1*, on this sample group of users. In summary, it is possible to visualize, older users with better error dilution in relation to younger users, users with little musical experience performing better than more experienced ones, and congenitally blind or users with longer time of visual impairment, obtained a better reduction of the error that users with little time of disability. However, this scenario is unstable in case of changes in scenery and/or feedback.

These evaluations and the exposed numbers show that the twenty-five users demonstrated a factual propensity to corrective *Maestro v0.1* stimulus. The possible explanation for the constant fluctuation of users' performance between the use of feedback, as well as the difference in error dilution between the first scenario, and scenarios two and three, raise the conjecture that these factors may be correlated with the familiarity with using the system. In other words, only with more time of practice, there would possibly be a more expressive correction of the gesture movements. This reflection was based on a comparative analysis of the graphs generated by *Maestro v0.1* itself, after the user had finished using the system.

4. Final considerations

As seen, the conceptualization of conducting is structured by the dialogic amalgamation of theoretical and practical elements. The mental action, constituted by the understanding of the musical ideas contained in the archetype of a composition, is of fundamental relevance in the interpretative construct of a certain work. Analyzing and cross-referencing the information obtained constitutes, in turn, a tool linked to this work, thus providing the basis for performative paths or decisions to be taken before the execution of the composition. The practical translation of this theoretical architecture is personified and expressed by bodily action, responsible for reflecting the conductor's technical and artistic conduct.

In this dialogic interaction between actions — mental and corporeal — language and thought, reasoning, memory, perception, attention and imagination, examples of inherent and active processes on these actions are constituted. In other words, the student, being visually impaired, is not devoid of cognitive processes, they only need the necessary stimuli to achieve adequate development, the technical-performative fundamentals of conducting. Therefore, the axis of dependence on visuality shifts towards the acquisition of technical-performative knowledge of conducting.

Haptic and auditory feedback form the heart of the system. It is these stimuli that direct the students' technical actions, providing them with the information that is appropriate for their technical correction. The structuring characteristics of the haptic and auditory stimuli did not consist of a peculiar result of this author's individuality, but of the collective disclosure of users through usability tests, approaching, therefore, the real perspectives of the target audience, to which the intentions investigations were intended (see LIMA, 2021a). In this approach, I had the constitution of my gaze founded on the subjectivity that fell to me as a "spectator/user" and rooted by the objectivity that fell to me through the authorial position.

The technological result of this investigation offers attributes that contribute to a more meaningful learning of conducting. It becomes, in fact, evident that the mediation of the construction of a certain knowledge, carried out by technological resources, may favor the equal insertion of students with visual impairment.

Although the prototype is in an embryonic phase, the author believes that the analyzes developed provide a subsidizing basis for new investigative procedures, which will involve teaching-learning and the technical-performative construction of visually impaired students, in other fields of the musical mastery, beyond conducting (LIMA, 2021b).

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