

## The interrelated learning of mathematics and music



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### ABSTRACT

The present research, developed in the João de Deus de Alvalade School Garden and in the Ajuda National Palace, deals with the valorization of artistic and heritage education, considering the improvement and innovation of learning, through the interdisciplinarity between artistic subjects and other curricular subjects, this study was developed through creative partnerships, through a platform of interprofessional collaboration between artists and teachers in interrelationship with students of the 1st cycle, valuing a confrontation of practices and orientations, which allowed the construction of significant knowledge for personal and collective existence. Through a culture of cooperation, it was intended to diversify profiles and skills, using integrated forms of dynamization, expanding the places of learning, which enabled a collection of data for the construction, planning and structuring of a didactics in art education, which focuses on the interrelated learning of mathematics and music.

An action-research methodology was adapted, through pedagogical strategies complemented with the realization of theater, visual arts and music performances, which allowed to enhance skills and competencies in the motor and cognitive domains. The didactic proposal consisted of the elaboration of structured mathematical exercises with elements of the musical language, which aimed to achieve transformative learning.

In addition to other values, this study aimed to achieve positive goals for the development of skills and principles aimed at responsible and free citizenship.

**Keywords:** Art education, Culture, Heritage, Collaborative process, Citizenship.

## 1 INTRODUCTION

This research proposal focuses on the contribution of artistic and heritage activity to education with a focus on the interrelated learning of mathematics and music and on the study of the pedagogical and didactic partnership between artists and teachers, seeking to assess what knowledge they mobilize



in the development of pedagogical activities, but also what skills the artists, teachers and students of the 1st Cycle, together, they develop throughout this partnership. This study aims to reflect on the need to construct the epistemological field of Art Education.

The activities raised by the Education, Art and Heritage proposal, hereinafter referred to as EAP, were carried out in an interdisciplinary environment, in the Ajuda National Palace and in the João de Deus Alvalade School Garden.

It is now proposed a research where new intervention strategies are developed, which involve mobilizing the knowledge built in the EAP project and the professional knowledge of the participants, in a pedagogical proposal, based on collaborative education, which promotes significant learning about artistic and heritage education, but now extended to the interrelated learning of mathematics and music. (Schönberg, A., 1995; Gardner, H., 1993; Rodrigues, J. F., 1999; Carneiro, I. 2018; Loureiro, C.; Regatão, J. P., 2019).

The articulation of the aforementioned partnership aims to understand how the link between fields of knowledge with their own specificities can be operationalized, while at the same time the specific concepts of each area are transversally related. It is an interdisciplinary approach to the development of integrated formal education practices.

An innovative perspective of transmission of musical and historical content is related to music and its symbology, which seeks to embody the most abstract mathematical reasoning. The sonority or repetition of sounds, and also the association of musical writing with numbers, allows a better understanding of these reasonings, which leads teachers and artists to share knowledge. In this way, direct and indirect applications on mathematical and musical knowledge were identified throughout this study, while ensuring the deeper acquisition of aspects of tangible and intangible heritage.

It is important to be aware of the need to incorporate content related to the formulation of learning objectives and the selection of strategies and activities indicated for learning in formal education spaces, through personal and social experiences in environments outside the school (Bruno, A., 2014; Cascais, M. G. A & Terán, A. F., 2014), such as the Music Room, among other spaces of the Ajuda National Palace.

In theoretical terms, it is proposed to situate this study in a constructivist (Piaget, 1971; 1973; 1983; 1999), cognitivist (Vygotsky, 1998; 2001; 2012) and sociocultural (Bourdieu & Passeron, 2014) framework, of education through art (Santos, J., 1966, 2008; Lowenfeld, V., & Britain, L. 1970; Santos, A., 1999, 2000; Read, 2013), art education (Eisner, 1985, 2008, 2009; Barbosa, A. M., 1991, 1998, 2001, 2004, 2010; Smith, R., 2004; Barbosa, A. M. & Coutinho, R. (Orgs.), 2009), for artistic education (Fischer-Lichte, E., 2005; Baldacchino, J., 2008, 2014, 2015; Touriñan López, J. M., 2006, 2009; Rogoff, I., 2010; Atkinson, D., 2006, 2012, 2015; Paiva, J. C., 2017; Ó, J. R. do, 2017; Loureiro, C.; Regatão, J. P., 2019; Calado, M., 2015, 2018, 2021), and by the image reading methodology



(Arnheim, R, 1969, 1974; Parsons, M., 1992; Gombrich, E. H., 1995, 2006; Hernandez, F., 2000, 2001; 2005, 2007; Panovsky, E., 2011). In methodological terms, a qualitative study is chosen (Bogdan and Bilken, 1994; Stake, 2016), by action research (Coutinho, C.P. et al., 2009; Amado, J., 2014).

The exercise of a grounded, responsible and solidary citizenship implies the understanding of the scientific dimension of the current problems addressed in this research, which tried, among others, to find significant results in what confers pedagogical innovation, through the partnership between artists and teachers, trying to find strategies that aim at the articulation of art and culture in the educational space. as well as the importance of the relationship between visits to museums and monuments and curricular subjects, at the same time that we were concerned with finding criteria for understanding the reading of a work of art and how it contributes to the development of students' critical sense (Tavares, C. A., 2010).

In this regard, it is essential to promote artistic and heritage education from a lifelong learning perspective, regardless of the profession that children may exercise (Souto, O., 2017; Sotto, O., 2018).

Regarding the expected results, and taking into account the conclusions of the master's degree on the subject, we point to the collaborative work between the participants, through which data were collected for the construction, planning and structuring of a new didactics in art education.

It is important to mention that in the 2019-2020 school year we found ourselves in an atypical year due to the covid-19 pandemic, which hit the world, which accentuated the lack of resources in the educational field, the social inequalities of students, (Bourdieu, P., 1998) as well as changed the paradigm of functioning of the artistic and cultural universe, giving rise to new forms of survival and artistic creation (Atkinson. D., 2015).

For this reason, as of March 2020, there was a need to adapt to other forms of work to achieve it, face-to-face classes were replaced in alternating periods by online classes through digital platforms. Therefore, some of the students' work was carried out at home and, since the tasks required a search for content, the children were motivated to a research process.

As a permanent expression of our humanity, music occupies a central place in the arts and its characteristics, namely its written representation and sound dimension, as well as the way in which all its rhythmic, melodic and harmonic elements interact (Haunschild, F. 1998; Fão, A., 2000), which allowed the realization of interrelated learning with mathematics, in which the syllabus foreseen in the planning of this science accompanied the teaching of music using logical reasoning. It equitably allowed the development of an aesthetic and artistic sensibility through the realization of various musical activities, which made it possible, on the one hand, to enjoy it and, on the other, the development of cognitive and emotional mechanisms, which were influenced by sensations and feelings provoked by music.



From different theoretical currents, it is intended to understand the importance of art and culture in the educational space and in the school trajectory, considering the relationship and the intersection of the art of music with mathematics.

Through the history of the Ajuda National Palace, a reference monument within the scope of this proposal and whose heritage is of particular identity importance, as a model for a citizenship based on aesthetic and ethical values, it became possible to fulfill in this study integrated from the perspective of artistic and heritage education, the objective of an orientation for the reflection of the awareness and symbolism of heritage and the arts.

In this context, the importance of the image reading methodology was evidenced as a driver of the development of knowledge and skills, through learning that is materialized through vision, the use of imagination and creativity. The process of "reading" allows us to see beyond the observable, considering the abstract value of the image when it is translated into the emotional plane, allowing the challenge of perceiving an absent reality to another with several possible meanings. It was the object of a historical framework within the scope of reflections and studies, which sought through different perspectives a definition for Visual Culture. (Hernandez, 2000, 2001, 2005, 2007; Henriques, L., 1993)

The image would be a door (or a bridge) to other images, a kind of path to be taken by the one who looks. It is up to it to elicit an event that transmits and magnifies the other, that combines with it and produces, for all those who come to look at it and for each singular glance resting on it, a limited series of new passages. (Foucault, M., 2001, p.352).

The curricular contents of mathematics related to the 1st and 4th year of Basic Education were equally investigated, with a view to its articulation with interrelated learning with music.

In particular, the performances of music, visual arts and dramatic expression were promoters of the evolution of cognitive, emotional, sensorial and motor mechanisms, which aimed to promote various skills, such as observation, reflection and critical argumentation skills. Training and the development of individual and group knowledge acquisition were also analyzed.

Since the curricular programs have similarities and the age range of the students is close, the didactics presents the possibility of adapting the educational modules, specifically to the 2nd and 3rd year of Basic Education.

The study visits to the Ajuda National Palace, prepared in advance through scripts prepared and organized with the aim of telling its history, allowed the knowledge of the different periods of the Baroque, Classical and Romantic, as well as references to the experience of its historical figures. These meetings at the aforementioned monument were privileged with practical workshops, which allowed a pedagogical intervention designed to ensure an aesthetic and ethical awareness of the participants in relation to the Arts and Heritage, benefiting from the natural predisposition of the students for the taste of History and artistic works. It was through this experience and this direct contact with the monument,



as well as with its history and architectural and decorative styles, that the children developed research that led them to the elaboration of artistic works, and to the development of visual literacy and aesthetic education, which aroused emotions and feelings.

The planning of the sessions, the structuring of the contents transmitted in line with the curricular program and the activities carried out throughout the two intervention cycles, which covered the academic years 2018-2019, 2019-2020, allowed the elaboration and management of the didactics. Its implementation followed an essential criterion, which consisted of the importance of providing, from the beginning of schooling, contact with differentiated and innovative educational practices that trigger and promote interdisciplinarity and provide effective and positive learning.

Associated with all the aforementioned frameworks, the focus will be on the operationalization of pedagogical practices, promoting the cognitive, emotional and social development of the participants, as well as the application of the concepts of psychological activation, creativity and the provision of an educational service, which aims to have a positive and innovative impact on learning and contemporary society.

The analysis and interpretation of the data are based on the discussion of the results produced in the pre-tests and tests, surveys, questionnaires, semi-structured interviews, photographs, audiovisual records and various activities, such as practical exercises of mathematics and performances of music, plastic arts and dramatic expression, which attested to the teaching-learning process and allowed the interpretation of the results and objectives achieved. including through the assessment of acquired skills, abilities and values.

It is concluded about the results of this investigation, considering the evidence observed as a result of the learning of the participants in the two school years, in the different activities (at school and in the monument), which prove the validity for the development of interrelated learning of mathematics and music and with regard to artistic sensitivity, aesthetic education, personal skills, Students' ability to critically analyse, in general their development in relation to individual psychology and social life.

With this research we are convinced that we will achieve substantive contributions to the scientific and pedagogical training of teachers, who can benefit from new knowledge through an artistic perspective, as well as an understanding of the functioning of new strategies that highlight individual uniqueness (Popkewitz, T. 2015), as well as the equality of opportunities that is reflected in children's learning, as to their social integration and the possibility of achieving positive and significant results (Bourdieu, P. 1998; Paiva, J. C., 2017; Atkinson, D., 2016).

In the course of this study it was possible to verify that educational institutions should have the sensitivity to take organizational and pedagogical measures that would allow to highlight the awareness about the role of artistic education and its impact on children, which can contribute to



innovative educational experiences. On the other hand, this research has provided benefits for the continuous development of artists' skills and a better understanding of the school universe, as well as for students' learning, valuing the affective relationship between all. (Barthes, R. 2003; Damasio, A, 2015).

## 1.1 THE INFLUENCE OF MUSIC IN A SOCIAL CONTEXT AND ITS FRAMING IN THE LEARNING PROCESS

"Music is a higher revelation than all wisdom and philosophy"<sup>1</sup> Ludwig van Beethoven Music is present in human life in the most varied social contexts and has the ability to influence the individual in the most diverse situations of daily life. One of the most relevant dimensions, which represents the starting point for the existence of music as a language, in its communicative and artistic dimensions, is the fact that it is part of human nature, is internal, and can be developed through imagination and creativity.

These faculties result from the interaction of the human being with the family, social and cultural environment, but also from the evolution of physical, cognitive and emotional capacities, which represent the two essential components of growth, naturally including the development of musical techniques and knowledge. It is in the face of this reality and characteristics of the individual that the existence of all musical creation is understood. It is important to mention that this artistic creation has been constituting a heritage, which has been transmitted over time through scores, also through music of oral tradition, as well as through the technological development of the twentieth century, which allowed the emergence of various records, such as magnetic tape, vinyl, the CD, and currently the digital records that exert a permanent influence on the most varied social contexts and situations of human life.

It should be noted that the human being's capacity for musical production, as well as the hearing and internalization of musical works and their multiple sonorities, influence behavior at the physical, psychological, cognitive and emotional levels, which has a direct repercussion on social interaction.

As can be seen, in addition to the human organism obeying the natural rules of evolution, it is the interaction with the environment, which also includes the musical dimension, that allows to a large extent the development of the personality. This includes knowledge, values and references, to which a certain degree of affection is always associated and which constitute the individual heritage. In any case, it is clear that certain traits or characteristics of personality and character are already inscribed in the genetic matrix. To what extent the environment does or does not shape this predisposition of personality traits is not known for sure. (Damasio, A. 2017).

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<sup>1</sup> "Music is a revelation deeper than all knowledge and all philosophy." Ludwig van Beethoven



As seen throughout the human adventure, education plays a central role in the development of skills and competences from childhood to adulthood. The family environment and the school environment constitute the two main universes in which the transmission of values and knowledge takes place. The social context, omnipresent, represents a very important component, since it constitutes the background in which the entire formation of the child takes place, although it is considered that only later, from the 2nd cycle, the social space, in which the child already moves with some autonomy, gains greater prominence and also constitutes a framework of cultural references. It is important to point out that access to digital media has contributed to anticipating contact with all the information available regarding this social dimension outside the school, and that nowadays they exert an increasing influence on children, in relation to the references that they observe and learn.

It is through the senses that the growth and formation of the human being develop in its physical, cognitive and emotional dimensions. Interaction with the family, teachers and other children in the family, school and social space allows the development of affections, mother tongue and other languages, such as music, essential for survival and personality structuring.

Affective life and cognitive life are therefore inseparable, although distinct. They are inseparable because any exchange with the environment presupposes, at the same time, a structuring and an appreciation, without ceasing to be less distinct, since these two aspects of conduct cannot be reduced to each other. Thus it would be impossible to reason, even in pure mathematics, without experiencing certain feelings, and, conversely, there are no affections without a minimum degree of understanding or discrimination; Therefore, an act of intelligence presupposes, in turn, an internal (interest, effort, ease, etc.) and external (value of the solutions sought and of the objects on which the research focuses) energetic regulation, but these two regulations are of an affective nature and remain comparable to all other regulations of the same order. (Piaget, J., 2013, p. 29)

The development of linguistic and musical skills, innate capacities of the human being, is only possible through progressive learning, at first in the family context and later in the school/family contexts. In this process, the visual, auditory and sensory senses of the human being interact with all the information that is transmitted verbally or through other forms of communication, such as auditory, behavioral or gestural.

In the case of hearing, it is important to mention the way in which the mechanism is processed, which allows us to perceive the sound universe.

In order to be able to recognize any type of sound or music, the human being has a hearing aid, through which all sounds, with their specific frequencies and timbres, are transformed into impulses or electrical signals, which in turn are interpreted by the brain, which is able to regulate the sensations caused by these sound vibrations. It is the same vibrations that provoke a bodily reaction and allow the emergence of emotions or feelings associated with these sound impulses. The physiological process is of enormous complexity, involving the entire auditory and cerebral apparatus, but it is important to highlight the ability that the human being has to distinguish sound frequencies, music, exalting the fact



that it is this ability that allows us to determine the influence of music on behavior in its various dimensions, as well as on the relationship of the human being with the outside.

It is known that music perception involves the primary, secondary, and tertiary areas of the auditory system, as well as the auditory association areas in the temporal lobes and Wernicke's area. This, in turn, is linked to the perception of language and the processing of most of the brain's intellectual functions. The primary areas receive signals from the inner ear through the thalamus and are involved in the early stages of musical perception such as frequency of a tone, melodic contours and volume. Secondary areas process more complex patterns of harmony, melody, and rhythm. The tertiaries allow a general perception of the music. (Guida, et. Al, 2007 apud Weigsding, J. A. & Barbosa, C. P., 2014, p.50)

As can be seen, the human auditory sense has anatomical characteristics capable of differentiating the most particular frequencies and sonorities, which allows at each moment a perception, interpretation and reaction to the surrounding sound universe. It is important to note that the functions of the two cerebral hemispheres act together, but it is in the right hemisphere that the apprehension of music takes place, which involves the notion of spatiality and intervals, among other elements, while the left hemisphere is more connected to the processing of rational and analytical functions, such as speech. (Binkowski, B. & Brändle, W. & Hug, M. & Koch, P & Prinz, U., 1982)

These capacities are fundamental for living and surviving in society, as can be seen, for example, in listening to a certain musical work, in which the human being has the possibility of selecting and focusing his attention on a certain musical instrument, even if mixed with the set of frequencies of the other instruments, without prejudice to the sound effect of the work as a whole and the sensation or emotion that it can cause.

The way music is perceived by each individual raises numerous questions, which are related to the experience, cultural and musical references of each one, but also to the individual genetic matrix. For this reason, it becomes possible to affirm that the effects that music triggers are necessarily different in each human being, despite the existence of common patterns.

Listening to a Beethoven symphony or a Beatles song is recognized by any listener for its musical characteristics, but the individual effects on the cognitive and emotional level is not something that is measurable. It is only possible to verify a satisfaction or pleasure in their hearing or, on the contrary, a rejection, which is related to the stimulus and the relationship that music establishes with the set of genetic and cultural references of each human being. In this plan, it is important to mention that the age and level of knowledge of music of the individual are variable, and that they play a very relevant role in the way music is felt and characterized in emotional terms.

The musical structure of the styles of works referred to, a defined rhythmic and harmonic organization, is to that extent transmitted to the hearing aid of the human being presenting the same code. The variables can consist of tempo, volume or timbre, which naturally influence the way the





music is perceived. However, the same music heard by different individuals exerts a particular and unique effect.

The genetic matrix of each human being allows for the growth and development of skills, in particular linguistic and musical abilities, in interaction with the surrounding cultural universe. It is considered that it is due to this unique matrix, combined with the experiential experience, that at the moment in which it interacts with a certain musical code, determines the type of sensation and emotion.

[...] Emotion is the combination of a mental evaluative process, simple or complex, with dispositional responses to that process, mostly directed at the body itself, resulting in an emotional state of the body, but also directed at the brain itself (neurotransmitter nuclei in the brain stem), resulting in additional mental changes. (Damasio, 1994, p. 153)

In the most varied social contexts of everyday life, there are also sounds or musical motifs, such as the arpeggio of a chord or even a melodic excerpt, which fulfill specific functions and aim to give guidance to a certain behavior. Examples of the use of music for this purpose are the sound signals at a traffic light or in an elevator, which indicate the right moment to perform the movement of crossing a road or using the elevator.

In this context, music directly influences, through its sound stimuli, social and individual behavior, namely with regard to decision-making.

It is also noted that music fulfills an important social function, which is reflected in the experiences, in the evolution of children's sensibility and knowledge, and that, within the scope of its possibilities, it allows the construction of a framework of fundamental references for the development of the learning process. The universe of references mentioned results from the realization of various manifestations, such as concerts, diffusion of music through radio and audiovisual means or in public spaces in general, such as shopping centers, shops or even public transport. To this extent, it is important to note that music influences behavior, since it fulfills a certain function, whether it is entertainment or as a means to create a certain sound environment. In this context, the musical stimulus acts on the body in a different way, that is, as entertainment, there is greater attention and awareness in relation to music, while ambient music, it is perceived in a more superficial and less conscious way. However, the physical and psychological effects remain depending on the type of sound vibration to which the human being is exposed. In general, sound vibrations affect behavior, which necessarily reflects a psychological state and a social influence.

When we hear a musical sound that we describe as pleasant, the feeling of pleasure is the result of a rapid transformation of the organism's state. We call this transformation emotional. It consists of a set of actions that alter background homeostasis. (Damásio, A., 2017, p.157)

The choice of certain music for these spaces, with their rhythmic, harmonic and dynamic patterns, which are present in the various musical styles with greater or lesser intensity, fulfills several



objectives and intentions, which have a direct influence on the organism and determine a greater or lesser degree of acceptance. The reality that can be observed in the context of the use of music in the most diverse forms in the social context, allows us to establish a direct relationship with the learning process, of which music is part and is inseparable, not only because it is transmitted as an area of knowledge, but also because it is used in the scope of numerous activities.

As previously mentioned, within the scope of the innate characteristics of the individual, musical ability is inserted, which begins to be developed even before birth.

From an early age, the child has the ability to perceive and remember rhythms, sounds and pitches, immediately recognizing a melody even when it is played at different times or times. Studies on the perception and response of newborn babies to music have led to the consideration that these abilities were probably already in place before birth, in the mother's womb. (Sousa, A., 2003, p.55)

The development of a child's musical abilities from birth to school age goes through several phases and accompanies their physical and cognitive evolution. Although it is not our objective to analyze how these skills are structured in this preschool phase, it is, however, possible to verify that when the child enters the educational space, he already demonstrates numerous musical abilities, such as the identification and ability to reproduce simple melodies and rhythms, or even if it has a faster or slower tempo, already showing an effective rhythmic perception. It is considered that it is from this stage that activities related to music gain importance in the development of the child's entire education.

As is well known, through the various musical elements, separate or combined, all levels of personality can be touched: physiological, psychic and social. More specifically, through sound and rhythm, sensoriality and motor skills; by melody, affectivity; for harmony, intellectuality. But, intertwined as these levels are, the totality of the human being is all involved by Music. (Sousa, A., 2003, p.188)

It is important to note that it is through speech that the child develops thought and memory, which also builds its references, associating thoughts and images, which give rise to intellectual development. As already mentioned, these references are always associated with sensations, emotions or feelings, which reflect the relationship that the emotional system of each human being develops and establishes with each object or content of learning.

Human language is essentially characterized by a verbal and written symbolic activity, and what characterizes the symbol is its possibility of becoming independent of the objects to which it is primitively attached (Wallon). The verbal or written symbol, once constituted, takes on independence and develops in diverse and unpredictable directions. [...] It would not be possible to teach reading without the child having been able to carry out certain graphic experiments and without the attitude and gesture having previously been thoroughly experienced. It would not be possible to teach in school if the children had not previously made all kinds of free verbal experiments with their mothers, and then with other relatives. (Santos, J. et al., 1966, p.33)



In this context, music also plays a fundamental role in education, since it allows the evolution of physical, cognitive and affective skills, as well as helping in the development of aesthetic sensitivity, through listening to musical works, which stimulate creativity, through the performance of activities, such as playing a musical instrument, in which a playful component can and should be present, and also, in order to make the whole learning process more interesting, since it stimulates an interaction of various dimensions of the organism and provides the construction of a feeling, without which learning will not have the same meaning and understanding.

The human species is as musical as it is verbal. And this predisposition to music can take many different forms. All of us (with rare exceptions) are capable of apprehending music, of learning sounds, timbres, distances between tones, melodic contours, harmonies and (perhaps most elementally) rhythms. We integrate all these elements and mentally "build" the music, using different parts of the brain to do so. And to this structural - largely unconscious - capacity to appreciate music is often added a deep and intense emotional reaction to music. "The inexpressible depth of music," wrote Schopenhauer, "so easy to understand and so inexplicable, is due to the fact that it reproduces all our deepest emotions, but detached from reality and its pains. Music expresses only the quintessence of life and its events, and never the events themselves." Listening to music is not only an auditory and emotional experience, it is also a motor one. (Sacks, O., 2008, p.13)

Musical listening activities or instrumental practice, as well as other actions related to music, are used as a teaching strategy with specific objectives, namely the awakening of attention, concentration, the desire to participate in the classroom and musical expression, which contribute to learning and are stored in memory. In this way, they are vital for the construction of knowledge and for human life.

Music allows interaction and is transversal to other areas of knowledge, that is, this language contributes to the development of mechanisms, which are essential for learning and which can be applied in the context of other disciplines.

In primary education, music should be interrelated with other areas or disciplines, such as art (the body reacts to sounds), mathematics, physics, Portuguese, science (recycled instruments), geography, history, foreign language (translation of foreign music), and computer science (creation of music or sounds using its own software) (Granja, 2006 apud Mendes, J. G. L., 2018, p.28)

The perception of the existing parameters in the musical language, such as frequency or pitch, timbre, tonality, intensity, rhythm, melody, harmony, among others, is carried out mainly through hearing, as well as developed through musical experience. That is, when listening to music or at the moment when practicing music, through vocal exercises or through instrumental practice, there is an interaction between the auditory, cognitive, emotional and motor systems. It is through this interaction and the observable results that it becomes possible to understand the importance of music in the development of skills and competences, which are achieved throughout teaching.



One of the most relevant activities that can be carried out in the school context is vocal practice, which has significant potential in the development of numerous skills, namely auditory, physical, sensory and emotional, as well as contributing to the achievement of several educational objectives. The act of singing allows the control of the vocal apparatus, so that it is possible to produce the desired musical notes, since singing is associated with knowledge and at some point is acquired in relation to the frequency of each musical note. This auditory training takes place, as seen, throughout the growth and pre-school phase, although it can acquire a much higher degree of efficiency, with the permanent listening of works or the learning of a musical instrument, which includes vocal practice.

It is considered that at the moment when a melody is produced vocally, several brain functions are immediately put into practice, such as auditory memory, related to the notes and the intervals between them, cognition, represented through the knowledge of the melodic structure itself, in which a rhythm and a specific sequence of musical notes are present. This factor also allows us to perceive the function of spatiality and sensory functions, which determine the degree of satisfaction acquired with the act of singing and the emotions that allow us to awaken.

Through this activity it is also possible to observe the musical expression of each student, elements that allow us to draw some conclusions regarding their physical and cognitive development. The difficulties at the rhythmic level, at the level of meter, at the level of tuning, demonstrate the degree of individual musicality, but at the same time reflect the level of motor and intellectual evolution. For clarification, we proceed to the explanation of an action already described in the 1st year observatory and which is considered to be of enormous importance. Therefore, it refers to the vocal practice of the children's musical theme (João's Balloon), which revealed few difficulties in execution, although some students demonstrated difficulties at the rhythmic level, not being able to maintain the determined tempo, and also difficulties in the level of tuning, since it presupposes an absolute control of the vocal apparatus, at the same time that it needs to obtain the correct brain impulse to produce a certain note. In other words, it is considered that a musical note can only be produced if the student is aware of its sound, which depends, as has already been seen, on a more accentuated and developed auditory training.

This vocal practice fulfilled several pedagogical objectives. Firstly, it is part of the scope of musical activities, normally present in teaching and which contribute to the construction of knowledge and skills. In this exercise, the students got to know the above-mentioned musical theme, developed their vocal capacity, which is equivalent to an evolution of physical abilities, namely in terms of the respiratory system, the hearing aid, which is stimulated through sonority and which allows the simultaneous development of the ability to recognize notes, musical intervals and harmony, which, taken together, allow the development of a sense of tonality.



It is considered that the alleged performance can bring many benefits to students, if it is developed repeatedly, since it activates numerous physical and brain mechanisms of the body, determinant for the evolution of the intellectual and emotional system.

In this context, it is important to highlight the importance that music plays in triggering sensations, emotions and feelings. It is in the emotional system of the human being that music acts with greater preponderance and all behavior, psychological state and creative action depend in some way on the balance of this mechanism. "Feelings are the experience of certain aspects of the state of an organism's life. [...]: a report on the state of life, at every moment within an organism." (Damasio, A., 2017, p. 151)

As a way of highlighting the importance of feelings in the context of human experience, in the social context, particularly in the school universe and in the respective learning, two types of feelings stand out, namely spontaneous and provoked.

Spontaneous feelings represent the general state of regulation of the life of an organism, be it good, bad or intermediate. Such feelings inform the respective minds as to the present state of homeostasis, which is why we call them "homeostatic." It is up to them to take care of homeostasis, they are its curators. Feeling the homeostatic feelings corresponds to listening to the endless background music of life, the continuous playing of the soundtrack of life, including the changes in tempo, rhythm, tonality, and even volume. When we experience homeostatic feelings, we are attuned to the workings of the interior. There is nothing simpler or more natural. [...] Subsequently, when the brain constructs representations of the geometries that have changed in the organism, we sense the change and create images of that change. This is the origin of provoked feelings, the kind of feelings which, unlike homeostatic feelings, result from a wide variety of "emotional" responses caused by sensory stimuli or by the activation of drives, motivations, and emotions in the conventional sense of the term. (Damásio, A. 2017, p.155-156)

As it is researched, music represents a sensory stimulus and influences the body. The individual's ability to express some kind of musicality may be an audible reflection of a spontaneous feeling, but its influence on the body, acting as a sensory stimulus, has the ability to provoke feelings, which are inscribed in the memory as affective experiences, even if positive or negative.

From this perspective, it can be seen that music, with its acoustic and sound characteristics, exerts a specific influence on the human being, capable of triggering the most varied feelings and behaviors, which derive from the alteration of the state of the organism at each moment. This evidence is of the utmost importance, since the interaction of human beings in the social, family and educational context is characterized by a certain behavior, which reflects a particular physical, cognitive and emotional condition. To this extent, music contributes within the scope of its capacities to influence and justify them, often revealing that it has the ability to regulate and balance this condition.

In this sense, and within the scope of the activities developed in this study, it is important to mention the performance of other types of exercises, such as listening to musical works, which is of particular importance, as it allows the development of knowledge regarding aesthetic sensitivity, as



well as auditory training, in the same way it can constitute a basis for the performance of other activities. namely the elaboration of drawings, as well as performances of dramatic expression inspired by a certain musical work, as verified through the exercises carried out by the students.

In fact, imagination, as the foundation of all creative activity, manifests itself in the same way at every moment of cultural life, allowing for artistic, scientific and technological creation. In this sense, definitely, everything that surrounds us and has been conceived by the hand of man, the whole world of culture, as opposed to the world of nature, all this is the result of human creativity and imagination. (Vygotsky, L. S, 2012, p.24)

The references to the actions described are only a part of the strategies that can be applied in the school context, and that allow us to demonstrate the relevance of music in the formation of children.

In this sense, it is important to mention that in the school context, it is more directed to the development of skills and values than to its musical education as a subject.

These two perspectives regarding music in the educational space complement each other, in this way, as already mentioned, it is possible to consider that through its influence and knowledge about this language that skills such as attention, memory, emotions and cognition are also developed.

The musical occupations performed together by the students in the school context also influenced the behavior, as they allowed respect for the space of performance of each student.

The role of music in the school context is much more than just entertainment. Music helps the teacher to instill self-discipline, to encourage creativity and participation and also stimulates cooperation among children, thus socio-affective bonds between students/students, students/environment and teacher/students. (Mendes, J. G. L., 2018, p.29)

On the physical level, particularly at the level of the vocal apparatus, musical discourse must be respected, through melodies or children's songs, and vocal balance must be maintained, as a way of respecting the musical activity of colleagues. That is, there are several parameters in the experience with music that allow the development of habits, attitudes or patterns of social behavior, through which the limits of individual freedom are shaped.

As mentioned, if the listening of musical works or themes is promoted, in addition to the knowledge they provide, it allows the creation of a certain environment in the classroom, considering that it contains potentialities, which can be used as a means to achieve certain educational objectives.

In another school space, namely in the playgrounds, music can accompany students in the exercise of different physical activities such as playing or dancing, among others, and which are very important for their development, that is, as a complement to the praxes, it is therefore considered that music plays an important role, since it provides an adequate rhythm and sound environment.

Music is also very important when it comes to a child's social life. It is through the type of music we like that we start as members of a certain social group. Music is inserted in the culture of the individual, through games, riddles, songs, legends that relate to our reality inserted in our culture. Music also helps the child when he learns some social rules: through circle games,



the child experiences, in a playful way, situations of loss, choice, disappointment, doubt, affirmation. (Veríssimo, I. M., 2012, p.12)

The combination of recreational activities and music in this leisure space also contributes to the development of the educational community, in which social values and mutual respect are promoted among all.

Through music, which exists in the dimensions of space and time, it is possible to provide students with a characteristic perception that is associated with the school universe in which they operate. It is considered that musical time, together with its own style, applied in a given school situation, clearly interferes in the psychological time of each child, also providing a perception and integration in that space in its own way.

Another dimension that is important to mention is the fact that music is a universal language and, to that extent, constitutes a gateway to different cultures. The diversified musical styles that are embraced by the auditory sense and that are characterized by their own specificities, refer to a certain culture, even if in the childhood learning phase, cultural references are scarce.

In any case, there is a greater or lesser degree of identification with music on the part of those who always listen, that is, each child likes more or less a certain work or musical style. This aspect can be important from a psychological point of view, since music can be seen as a companion, filling some inner space or even some affective need.

For many listeners, listening to music means an encounter with a singer, musician or conductor, whereby the performer is perceived as a partner due to the special emotional involvement in listening. It is not uncommon for identification processes to occur. Its psychological significance lies in the fact that people experience their own drives in identification as fulfilled, so that frustrations can be avoided in this way. (Binkowski, B. & Brändle, W. & Hug, M. & Koch, P & Prinz, U., 1982, p.165)<sup>2</sup>

However, the differences in environment are evident, which provide classical music, rock-pop, African, Brazilian or Indian music, among other styles. From this perspective, it presents and reflects an interculturality, often a fusion of styles, which represents knowledge and also symbolizes a form of integration and respect among all.

It is not within the scope of this research to analyze the dimension or power that each culture exerts in the elaboration of music curricula, nor what is its influence on the school environment, since it depends on several factors, not only related to all the media, but also to the elaboration of curricula, which depend on the executive branch and the time in which they are produced.

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<sup>2</sup> "For many listeners, listening to music means an encounter with a singer, a musician or a conductor, since in the act of listening there is a particular sentimental component, which leads to the performer being felt as a companion. Not infrequently, identification processes arise. Its psychological significance consists in the fact that the human being considers through identification his own impulses as fulfilled, so that frustrations can be avoided." (Binkowski, B. & Brändle, W. & Hug, M. & Koch, P & Prinz, U., p.165) [Author's translation]



This analysis would imply making an exhaustive survey or even a statistic about the amount of music from the various cultures that occupies the social space, in all its dimensions. However, with globalization and the fusion of musical styles, it becomes possible to say that there is an increasing influence of music in the school space. It is considered that this diversity is enriching and also contributes to the complete formation of students.

As can be seen, since music is a means of communication between peoples, it is intended that, through it, the child values his cultural environment and awakens in him an interest in other musical cultures. Therefore, from different musical activities (such as listening to different musical genres from different eras, practicing a musical instrument, performing songs, knowing the main events in the history of music, etc.), it is intended, in general, to provide the child with a global view of the various musical cultures existing in the world and, also, a knowledge of the musical culture of your region and your country. (Reis, C. M. S., 2012, p. 40)

As can be seen, the influence of music on learning is diverse and decisive for children's education. The musical experience stimulates the senses and provides an interaction with the surrounding environment, which translates into motor, intellectual and emotional development. These dimensions are decisive for understanding and integration in the social and cultural environment and also provide for the development of imaginative and creative capacities.

## 1.2 THE IMPORTANCE OF ART IN THE INTERRELATED LEARNING OF MATHEMATICS AND MUSIC

The interest that human beings manifest with regard to the arts represents a living testimony since the most remote times of history, as they have always made use of visual language to express themselves and communicate.

Throughout the history of humanity, art has also assumed the representation of beauty and feelings, but beyond beauty and taste, it has come through the ages to symbolize the cultural identity of peoples. In line with these approaches, numerous artistic and aesthetic currents are identified that have deserved the attention of analysis of various authors such as, for example, Immanuel Kant (1724-1804), who, in addition to his dedication to science, and especially to philosophy, deeply analyzed the relationship between the human being and art, considering it a fundamental dimension of life, distinguishing the intellectual and rational dimensions. of fruition, in which he considers that there is a place for the awakening of feelings and aesthetic appreciation.

Kant asserted that Beauty consists in the awakening of a certain feeling in relation to an object through the faculty of imagination. His critical philosophy classifies sensible knowledge as more intuitive, and distinguishes it from rational knowledge, and the evaluation of Beauty is conditioned by the subjective way in which the relationship between the individual and the object takes place.





According to Romano Galeffi, regarding Kant's thought, the following analysis can be observed:

[...] - beauty is that which pleases without interest - and in order to better clarify the value of this proposition Kant makes an inquiry into the various modalities in which a pleasure can manifest itself in connection with interest, a modality which he reduces to the following three: I) to the pleasure provoked by the pleasant; II) the pleasure caused by the useful; III) the pleasure caused by the good. (Galeffi, R., 1986, p. 297)

The present research values the arts in education and their magnitude in the development of the individual, while intending to validate their importance in the subjects of study, involving the art of music with mathematics. (Dewey, J. 1934)

Art education has been gaining ground in study centres and educational policies, and has been included as compulsory in schools. "However, in October 1986, the Basic Law of the Educational System was already published with the government's commitment to legislate on "Artistic Education", which only happened in 1990, with Decree-Law No. 344/90". (Santos, A., 2008, p.23)

Even so, and over time, in the history of education, art disciplines have always been discriminated against and relegated to the background in the school environment.

From what we can see, art in education is a path that will still need time to take root in the educational universe, and it will also have to invest in the specific and continuous training of teachers in order to acquire a new vision of work on artistic languages. Contemporary art in schools still encounters enormous resistance on the part of teachers regarding its valorization and dissemination, and the same is still true of parents. For this reason, there is an awareness that much will have to be done to change this situation, although the role of art, despite the efforts of professionals in the field, has already achieved enormous progress in education. "To rethink education from the point of view of art, from visual culture, is to do so, in part, from the position of the losers, because almost no one considers this knowledge valuable for the formation of younger citizens." (Hernández, F., 2000, p.63)

Artistic languages help the human being to develop various aspects in the different stages of life and it is considered that this is one, among many other reasons, why it is considered to be of enormous importance the emergence of new proposals that exalt art as a facilitator of learning. "Impregnated in today's world with the most varied artistic manifestations, as perhaps never before, the place of the Arts in the formation of personality cannot be underestimated, but the problem lies in the way educators adequately equate it." (Santos, A., 2008, p.20)

Art plays a fundamental role in the evolution of the human being. Numerous pedagogues and educational theorists, such as Herbert Read and Arquimedes dos Santos, among others that we have already mentioned, have defended the use of art as a means of developing knowledge and skills, allowing a better understanding and interpretation of the surrounding cultural and social world, as already mentioned, a construction of values, which define the identity of the individual.



It is assumed, therefore, that the general aim of education is to encourage the development of what is individual in each human being, while at the same time harmonizing the individuality thus induced with the organic unity of the social group to which the individual belongs. (Read, 2013, p.21)

Art contributes to the development of knowledge, imagination, creativity, sensitivity, critical thinking and the expression of feelings and values. These dimensions of the inner world cannot be separated from reality, which surrounds the human being. (Bondía, J. L., 2000; Smith, R. 2006; Santos, J., 2008; Barbosa, A.M. 2010; Vygotsky, 2012; Souto, O., 2017; Sotto, O., 2018)

The proposal developed in this research contemplates the development of the child as a critical, productive being, capable of analyzing, dialoguing, concluding, discussing social, political and cultural issues (Bourdieu & Passeron, J.C., 2014) and in this sense, it is important to learn to develop a creative process in its various dimensions: Artistic creation, criticism, sensitivity and perception, fruition and reflection.

To understand the psychological mechanism of imagination and the creative activity connected with it, it is best to begin by clarifying the connection between fantasy and reality in human behavior. We have already drawn attention to the erroneous common-sense idea that establishes an unbridgeable divide between reality and fantasy. (Vygotsky, L. S., 2012, p.29)

These areas, which define the human being, do not in most cases find development in more formal learning, generally in the learning of languages or the exact sciences, such as mathematics or physics.

In this context, the interrelated learning of music and mathematics was considered, taking into account artistic and patrimonial activity, as an added value and as a way to contribute to the interrelationship of all cognitive and emotional dimensions, in order to promote and develop them.

Considering the mathematical reasoning, which is present in the functioning of several dimensions of the musical language, it is understandable that it allows the establishment of direct relations with mathematical domains, such as arithmetic reasoning, specific operations of addition or division, among others, and mental calculation, which in a generic way presupposes the knowledge of areas such as multiplication tables, composition or decomposition of numbers, measured, namely of length or weight, which together allow a cognitive development associated with a stimulation of artistic sensibility interrelated with music. These languages, as science and art, are part of knowledge and constitute an important dimension of heritage.

It is necessary, in schools, to disseminate the notion of Heritage, whether in the human sciences or in the exact sciences: the knowledge that is transmitted in school is the result of a past and the child, already in a period of greater development, begins to read that past, begins to be aware that there has been a path to get there, therefore, Heritage Education ends up constituting a uniting feature between the various disciplines (Cottinelli Telmo, 1989; Cardoso, C. & Valsassina, M. et al., 1998; Dewey, 2007 apud Souto, O., 2017, p.29; Sotto, O., 2018, p.50)



One of the contents that music offers consists of sonority, which affects the sensory and emotional dimensions as mentioned above. Listening to music directly arouses sensations and emotions, without the need for any explanations through language. "Music has the astonishing ability to exert a hypnotic, euphoric or uplifting effect on our senses." (Stehman, J., 1964, p.13)

To this extent, music allows the construction of an image, elaborated from sensations and emotions, and refers to an abstract dimension, also allowing the attribution of a sound "image" to numbers, which quantify and characterize mathematical operations. These images are constructed according to the degree of empathy that develops through what is given to be heard. (Panovsky, E., 2011)

Music as a written artistic language, where musical compositions are represented, and as an art that creates sonorities, through the voice or instruments built throughout the history of music, represents a fundamental artistic dimension, insofar as it provides students with the development of knowledge with its own specificities, represented in the scores and audible through presentations or recordings. as well as providing the construction of mental images, which are achieved through sound and the physical and emotional effect it causes.

Their interpretation, as well as musical writing in its most varied forms, or the images constructed through the senses, presuppose a reading and are part of the entire imagery universe, which can be understood as part of visual culture. Image reading becomes, therefore, fundamental to the understanding of the world. Everything that is observed can be interpreted in the most varied ways, which depend on the experience of the human being in its different dimensions. (Gombrich, E. H., 2006)

Nowadays, the image exerts a huge influence on people, especially the youngest, and reality translates into an increasingly visual world. Nowadays with new technologies, there is a growing increase in the use of the image as a form of communication and expression and the decoding of signs, which are placed before our eyes, which are insistently waiting to be interpreted and apprehended. There is an awareness that images are part of the world and that human beings are faced with a huge challenge to find ways to interpret them, from the most diverse points of view. (Arnheim, R., 1969)

On the other hand, with the growing excess of visual resources, there is also a contamination with all kinds of images, this excess of representations compromises the observation of details and thus there is no place for a decoding of the integrated messages.

To see, it is first necessary to learn to see. Learning happens through an "infinite backward," the explanation of one thing in terms of a previous one. The representations are based on illusion, the rules of persuasion of which change over time. If our perception is able to accept a current illusion, the work will be assimilated. (Gombrich, E. H., 1995, p. 82)



In the activities requested from the students, such as the elaboration of a drawing from the hearing of a musical theme, or the choice of an image to illustrate a certain work, they represent ways of constructing mental images and discovering their meaning.

It is important to emphasize the importance of interpreting reality, using the power that the image has to convey messages, whether they are emotional or other, as they all have an intention and can be interpreted in different ways, taking into account who decodes them. An image is not just a simple illustration without expression, it must be a fundamental element in the process of knowledge construction.

“In a work of art, an abstract pattern organizes the visual matter in such a way that the intended expression is directly conveyed to the eyes. This is perhaps most strikingly demonstrated by analyzing in some detail a work that at first glance seems to offer little more than pretty triteness displayed in a standard naturalistic manner.” (Arnheim, R. 1974, p.152)<sup>3</sup>

From a closer look at visual culture, from photography, newspapers, magazines, television programs, cinema, advertising, computer games, among other image supports, there is a multiplicity of languages that reflect different domains and forms of communication, representing, ultimately, a reflection and an important dimension of modern society. The decoding of these languages depends on the observer, although the historical and sociocultural context in which they appear are decisive for their interpretation. In this sense, according to the understanding of the images, you should take into account certain criteria:

- Historical-anthropological: visual representations and artifacts are the result of certain contexts that produce and legitimize them. For this reason, it is necessary to go beyond a perceptive approach to what is seen in the production, to establish connections between the meanings of this production and tradition: values, customs, beliefs, political and religious ideas that generated them.
- Aesthetic-artistic: this aspect refers to systems of representation. The aesthetic-artistic aspect is understood in relation to the culture of origin of the production, and not in universal terms, since the Western European code is not the only valid one for the critical understanding of visual culture.
- Biographical: representations and artifacts foster a relationship with identity processes, building values and beliefs, visions of reality.
- Critical-social: representations and artifacts have contributed to the current configuration of the politics of difference and power relations. (Hernández, 2000 apud Sardelich, M. E., 2006, p.215)

Throughout the present research, it became evident that one of the shortcomings that teachers present is the fact that they generally make use of oral and written language and do not evidence the use of image as a starting point for the construction of knowledge.

Art in Education as a personal expression and as a culture is an important instrument for cultural identification and individual development. Through Art it is possible to develop perception and imagination, to apprehend the reality of the environment, to develop critical

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<sup>3</sup> "In a work of art, an abstract pattern organizes the visual matter in such a way that the intended expression is directly adapted to the gaze. This is perhaps most strikingly demonstrated by the detailed analysis of a work that at first glance appears to offer little more than beautiful vulgarities organized in a standard naturalistic way. (Arnheim, R. 1974, p.152) [Author's translation]



capacity, allowing to analyze the perceived reality and to develop creativity in order to change the reality that has been analyzed. (Barbosa, A. M., 2010, p. 2)

The intervention of art in individual development and the consequent reflection that it causes in the relationship of the individual with his environment, represents one of the most important factors in the construction of an identity and ways of understanding reality. It is considered, therefore, that the artistic musical language intervenes in the same way in the promotion of knowledge, in the awakening of curiosity and senses, for a historical-cultural universe.

## 2 CONCLUSION

The present research sought to determine, through the construction and implementation of a didactic proposal with its own specificities, how the artistic and patrimonial activity focused on the interrelated learning of mathematics and music, can contribute to education, improving learning.

In this context, numerous reflections have emerged on the problems and challenges faced by education, which are the result of the evolution of contemporary society, in its multiple dimensions, namely political, social and technological, among others.

Through the contemporary view of the profound changes that have been transforming modern society into a space of multicultural interaction, as a result of the policies implemented in recent decades, as well as the growing information and communication in the written, imagery and artistic dimensions, it is verified that in the educational panorama the necessary reforms to integrate this evolution in the scope of new languages and knowledge, are not sufficiently effective in the educational environment.

However, the transformations and reforms in the area of education imply, on the one hand, appropriate policies for the advancement of knowledge and permanent social evolution, which have not been satisfactorily verified so far, and, on the other hand, they presuppose a receptivity of those involved in the teaching process regarding the adaptation to new strategies and work habits. However, we found on the ground that the official guidelines regarding teaching have resisted a change in the educational paradigm and are still strongly based on the traditional model.

Regarding the behavior of the students, it is noted that it should preferably be in accordance with a framework of ethical and moral values.

The traditional teaching model developed from the end of the eighteenth century, responding to the emerging educational needs, and results from the profound political and social transformations that characterized this era.

Its action extended through the nineteenth and twentieth centuries and defined the official educational panorama, having contributed to the creation of specific patterns of behaviour and learning. This method resulted in educational practices, which still have an influence on the design,



orientation and functioning of the educational system and institutions, particularly with regard to curricula, certain pedagogical strategies and the form of assessment, which favours the quantitative method.

On the other hand, this didactic proposal is based on a methodology that seeks to respond to contemporary educational challenges, using pedagogical strategies that contemplate an articulation between various areas of knowledge, namely artistic, visual and communicational languages, thus promoting interdisciplinarity.

The realization of diversified activities, in which performances of music, plastic arts and dramatic expression were inserted, integrating and favoring the interrelationship with history and heritage, allowed us to accompany creativity in its cognitive and emotional dimension through a permanent qualitative evaluation.

It is in this context that the potential of artistic education is considered as an added value for the teaching-learning process of students and for the training of teachers, assuming it as a methodological reference, with the necessary transformative capacity to respond to the numerous questions that arise in the sphere of education and whose advantages have been demonstrated throughout this study.

The present research proposal seeks not only to highlight and prove its relevance, taking into account teachings and benefits evidenced in proposals such as education through art, art education and art education, but also its epistemological contribution to education, allowing to raise awareness of the need to make changes, namely in the educational institution where its development took place.

Regarding the intervening teachers, in view of the results obtained in the sharing of knowledge with the guest artist and the researcher-participant, they presented different perspectives and demonstrated to be able to articulate artistic contents and concepts with other areas of knowledge, through a confrontation of practices, for the development of skills with regard to teaching and intervention in the field of artistic education.

In this sense, it is hoped that teachers, based on this experience, can contribute to respond to educational, social, ethical, contemporary and future challenges.

In fact, it was demonstrated that the pedagogical action of the participating teachers allowed to establish a relationship and articulation with the contents of various artistic areas, in particular music, visual arts and dramatic art.

In this context, it is also possible to conclude that the transmission of the syllabus of mathematics, history and Portuguese has taken into account a reflection and articulation with the various artistic languages.

Evaluating the goals achieved, the objective is a change in the educational paradigm, considering it essential that the student's education is based on a set of skills, capacities and values,



which can allow in the future an integration and social intervention that contributes to the transformation of society, which is intended to be more balanced, fair and ethical and in which the values of sharing, differentiation and respect among all is a reality.

It is of particular importance to highlight two dimensions, which guided and allowed the construction of this project, influenced by artistic and heritage education, giving it its own specificity.

On the one hand, the inclusion of science, represented here by mathematics, is highlighted, aiming at its interrelated learning with that of music.

The connection of these two areas has taken on a specific educational domain, in which a dialoguing and creative vision of teaching is envisaged, which includes an innovative articulation of its contents. On the other hand, music as an intangible domain and art with historical and patrimonial value, allowed a learning experience, which intensified the awareness of these values.

In this way, an interrelationship between art, science and heritage was affirmed, in an innovative perspective of transmitting content for teaching and learning, whose interests were preserved through the benefits that the proposal promoted, resulting in a teaching strategy that allowed a transformative influence on the current practices of the traditional model.

As for the results that are intended to be highlighted, we conclude that the three main objectives were fulfilled: 1) the construction and application of the didactic proposal; 2) the effect of the scientific and pedagogical training shared through the platform of collaboration between artists and teachers with students in the 1st and 4th year of the 1st Cycle; 3) the internalization of the values of heritage and the arts.

In more detail, with regard to the implementation of the didactic proposal in the 1st year class, with regard to the 2018-2019 school year, and taking into account that the students were in an initial phase of learning to read and write, artistic practices and pedagogical practices were implemented, intending and interactive, fulfilling the objectives proposed in the field of music, mathematics, fine arts, history and heritage.

With regard to the learning of music, it is concluded that the selected rhythmic and harmonic contents, fundamental for the understanding of this artistic language, were understood by the students through theoretical explanations, although always complemented with the hearing of musical themes and practical exercises of music, namely vocal and instrumental, which allowed to associate the musical symbology with a sonority, making it more evident as to its meanings. This strategy allowed, on the one hand, the students to better understand the functions of musical symbology and, on the other hand, to resort to the practice of inherent mathematical reasoning, namely addition, subtraction, division and multiplication, making them more apt to learn mathematics and music.

With regard specifically to mathematics, the students exercised the ability to use reasoning, evaluating and interrelating it with music, identifying patterns, articulating musical and mathematical



symbology, which made it possible to conclude that it contributed to the evolution of their analysis and resolution skills, fostering cognitive development.

In order to guide reflection and awareness of the symbolic value of heritage and the arts, an experiential relationship was established during the school year, 2018-2019 and 2019-2020<sup>4</sup>, with the Ajuda National Palace, considering the methodology of the EAP project, as a model that facilitates the learning of the history of Portugal and the musical heritage between the seventeenth and nineteenth centuries.

In this context, the history of the Baroque and Neoclassical periods was referenced with mention of their historical figures, as well as a framework of the history of music, which involved some of its composers and their respective works.

In the study visits carried out to the monument, greater emphasis was given to certain interior spaces, namely the Music Rooms, the Ambassadors, D. Luís, D. João IV and D. João VI, in which plastic arts performances were developed and which allowed the consolidation of the historical contents and techniques worked on in the course of learning. These dynamics provided a direct involvement with cultural heritage and expanded the knowledge of the participants regarding the history of music, the history of Portugal and heritage. In addition to the achievement of these objectives, it is concluded that the performances and the encounters with History, awakened the sensitivity to heritage values, taking into account their importance as a cultural reference and also for the formation of individual identity and citizenship, which is seen in a historical past.

The various approaches to the visual arts allowed direct contact with various materials, allowing the exploration of the creative dimension of the students, during the course of analysis in the construction of the point and the line, as well as in the exaltation of stain and color, through rhythm and differentiated harmonies, stimulating the awakening of the senses and emotions, which guided them to the exploration of multiple meanings.

The objective of these dynamics was to provide methods that would help children to develop their imagination through the combination of ideas, aiming to reinforce behavior and creative spirit, a fact that was proven through the qualities of the works carried out.

With regard to the 4th grade group, it is concluded that the proposed learning objectives were also met, taking into account the differences that distinguish the two educational modules, previously described in the observatories of the application of the model.

In the field of music, the same basic musical contents were transmitted, although articulated with greater complexity, taking into account the curricular program of the 4th year and the age group of the students. The learning of mathematical contents was also fulfilled, through theoretical

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<sup>4</sup> Due to the Covid-19 pandemic, from the mandatory confinement in March 2020, classes started to be taught using digital platforms.





expositions, which were supported by the practice of mathematical exercises elaborated using rhythmic and harmonic elements present in music. Through these exercises, students had the opportunity to exercise the ability to transform and express meanings composed of sounds, exalting their sensitivity to rhythm, melody and harmony, which allowed them to combine the reading of a score with the use of voice and percussion musical instruments.

We are certain that these educational practices allowed the development of the students' logical and mathematical reasoning skills, as well as made them more apt to solve the exercises presented, not forgetting their relevance in the everyday situation.

In the field of learning historical and heritage contents, as well as with regard to performances, two substantial differences should be highlighted:

1) The 4th year students had the opportunity to develop their research skills by requesting works related to the history of music, its composers, as well as the historical heritage, also represented by the Ajuda National Palace, which included content on the Baroque, Neoclassical and Romantic periods. These researches carried out by the students provided the development of greater autonomy, as well as the awakening of sensitivity and taste for knowledge, skills that are of vital importance for future learning processes.

2) As for the performances, in addition to the aforementioned practical results intrinsically achieved with regard to music and visual arts, the 4th year students had the opportunity to practice during the 2019-2020 school year theatrical techniques, which developed motor skills, cognition and exalted their emotional and behavioral dimension, In this specific case, well expressed through movement and the free involvement of the body, rhythm, melody and harmony, framed in the language of emotions, surrounded by imagination and creativity.

Through the practice of voice exercises, supported by breathing techniques and correct use of the diaphragm, it was possible to contribute to the development of the motor part. These techniques highlighted a greater awareness of physical abilities and were of significant importance in the interaction and relationship with their peers, contributing to a better experience in the school environment. In addition, they allowed the strengthening of learning regarding the Portuguese and History of Portugal, through the way they were articulated, as well as interpreted.

In general, the children developed the sharpness of the gaze and senses and also improved the knowledge of the body and its limits and in this way created and recreated tasks and artistic works, which stimulated and allowed the awakening to the development of skills, competences and values that are part of the central educational objective, which consists of the continuous learning of the students and the ensuring of a social and cultural awareness, directed towards a citizenship that values differences, allowing for better integration in the world and its challenges.



In addition to the contents taught and the artistic tasks promoted in the school space, the study visits, as well as the activities developed in the aforementioned monument, allowed to diversify and expand the places of learning, providing innovative experiences for students, regarding their knowledge about the concepts of heritage and the arts.

In this context, it was possible to apprehend that artistic education significantly influenced the creative potential of students, awakening the importance of emotions in school learning. The performances became revealing of their creativity, as well as their multiple meanings, which provided the development of imagination, motivating the children for a more active, inventive and questioning learning, allowing them to follow a path of fantasy exalting the potential of individual divergent thinking.

It is important to mention that, due to the Covid-19 pandemic, there was a change in school education and teaching work, to this extent to continue the teaching-learning process we had to face new challenges and dilemmas, which forced us to reflect and reinvent a new way to teach and learn, taking into account the systematization of conditions, Considering that each student is unique and represents an individual universe.

However, in this period of adaptation in which new solidarity strategies were adopted, which enabled learning and intended to value teaching, distance education through digital platforms was chosen. However, with regard to the ongoing research with regard to practices carried out in a non-formal environment, it has not undergone methodological changes, namely with regard to study visits, which were carried out in the period prior to the first confinement.

From this perspective, it should be noted that this change has forced us to rethink our routines and tasks, as well as the sharing of affections and human contact, measures that have caused enormous emotional disturbance and exhaustion. For this reason, in addition to the new restructuring of the educational process, we are faced with numerous insecurities and difficulties that have been reflected in the stability of the human condition, also leaving an open field for reflection on the way we enjoy natural resources. However, this crisis has had a huge impact on the social, economic and political framework, severely affecting already fragile education systems, with regard to inequalities and the education of the individual for freedom.

Regarding the learning acquired and taking into account all the means they had at their disposal, it was possible to conclude that the students individually presented their own profile, which contributed to an articulation between theoretical and practical knowledge, and to a better awareness about the artistic and historical value of contents related to artistic languages. This learning resulted in an improvement in the interrelationship of knowledge sharing among colleagues, and the development of motivating experiences, which made students more apt to perform future tasks.



We are convinced that through this pedagogical proposal, the principles of cooperation and affectivity, fundamental for individual development and social interaction, have been developed, and the values of inclusion have been promoted through the activities implemented, which are decisive to activate the development of cognitive and emotional capacities, fundamental for the feeling of equality that must remain internalized in all of us.

These results are representative of an enriching didactic proposal for all participants within the scope of the 1st Cycle, in particular with regard to the sharing of knowledge, the learning of the contents taught and the strategies and activities developed.

In this sense, it is a project directed towards the future, through which strategies and activities are proposed appropriate to what is understood as the global training of students, in its cognitive, emotional and ethical dimensions, but also to the training of teachers in the artistic area, contributing to the adoption of innovative pedagogical strategies and to the promotion of an interdisciplinarity that is considered beneficial for teaching and learning.

This research, in addition to promoting a positive development awareness of the participants, with regard to the encouragement and implementation of new procedures and criteria, as well as significant learning and skills, has a broader social impact, insofar as through the structuring of a dynamic collaborative process, knowledge and experiences were shared, as well as the civic spirit and solidarity among all.

From this perspective, this study, which is situated within the scope of educational policies for the valorization of culture and the arts, presents transformative learning methodologies, and aims to exercise active citizenship by promoting a progressive education contextualized outside the traditional teaching parameters.

The participation and collaboration between the participating researcher, the teachers responsible for the 1st and 4th grade classes, the guest artist and the students, the school entity, as well as the involvement of the educational services of the Ajuda National Palace and the aforementioned monument, as a museum institution and learning space, gave this study a global and impactful scope, which allowed the integration of all stakeholders in a dynamic of artistic, scientific, heritage and social learning, which envisaged a better preparation for current and future challenges.

For this reason, it is expected that the present didactic proposal anchored in the principles of artistic education, which applies learning mediators such as exploration, interaction, creation and dissemination, can contribute to the enrichment of models within this area, with the purpose of transforming, within its limits, the perspectives that still persist on the traditional teaching paradigm. It is hoped that certain renewal guidelines in relation to educational policies can bring benefits to a mission that goes beyond the intellectual development of children, taking into account that institutions must also take responsibility for their emotional and social development.



The objectives achieved in this study allow us to assess that it is a proposal in the scope of artistic education directed to contemporary educational needs, in which it is sought to promote an articulation and interrelationship between the various areas of knowledge, in the artistic, scientific, historical and heritage domains.

It is concluded that the present research aims to conquer space for reflection, as well as to contribute to new perspectives and approaches in teaching and learning.

A harmoniously structured, solid and united society is at the basis of the evolutionary success of the human species and also at the origin of the development of the adaptive potential of children and young people, art turns out to be a cornerstone of cultural and scientific evolution, since it is based on a continuous expansion of the imagination. (Souto, O., 2017, p. 16, Sotto, 2018, p. 37)

With the conviction that there is still a long way to go to build the "ideal" educational model, we believe in change, through different perspectives, which propose to open new referents and themes, which can reconcile positive and innovative experiences to find new answers regarding the interrelationship of knowledge between art and education.



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