The Operetta of Multiple Intelligences: Music and Theater as Partners in Science Education

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Abstract
This case study details the development and presentation of the operetta *The Operetta of Multiple Intelligences*, performed by the Science, Art, and Education group at Universidade Federal do Rio de Janeiro, in collaboration with the Chamber Orchestra of Ilha do Governador and students from Anísio Teixeira Municipal School. Inspired by historical scientific events and Howard Gardner's theory of multiple intelligences, the operetta creatively integrated theatrical and musical elements to explore various forms of intelligence, such as Linguistic, Logical-Mathematical, and Bodily-Kinesthetic. Presented as part of the *Amazing Science* extension project, the operetta served as an active learning methodology, encouraging students to take charge of their educational process while integrating art, science, and culture. The project aimed not only to disseminate scientific concepts but also to inspire students to engage with the university and consider careers in science, thereby contributing to societal advancement.

Keywords: operetta; music; theater; education; sciences.

1 Introduction

In the 21st century, a significant portion of educational practices still reflects a traditional teaching model, possibly inspired by Plato's Academy, founded in Athens around 387 BCE (Malato, 2009). In this model, the teacher plays a central role as the sole holder of knowledge, while students are seen as passive recipients who merely absorb and memorize the information transmitted. This structure persisted for centuries and was criticized by prominent Brazilian educator Paulo Freire (1921–1997), who referred to it as "banking education" (Freire, 1968). According to Freire, this type of education limits critical thinking and student empowerment,

perpetuating power and submission dynamics (Gadotti, 1996). In this context, teachers control the educational process, and students assume passive and subordinate roles.

Technological advancements and social transformations in recent decades highlight the need to rethink this classic paradigm. Given that (i) knowledge is now widely disseminated and easily accessible through the internet, (ii) students are digital natives, and (iii) they have access to powerful technological tools such as artificial intelligence, there is a growing consensus that the traditional lecture-based model is becoming obsolete (Prensky, 2001; Selwyn, 2011). There is an increasing need for dynamic and participatory classes that recognize students' multiple intelligences and diverse interests. Thus, contemporary educational models should emphasize enjoyable and collaborative learning environments, where students are acknowledged as active and competent individuals (Vygotsky, 1978; Dewey, 1938). Modern pedagogical approaches should foster a pleasurable and engaging learning experience, emphasizing the role of well-being in knowledge construction and personal development (Brown, 2019; Sabec *et al.*, 2020). Therefore, a clear shift is underway toward more interactive and horizontal pedagogical practices that recognize students as co-authors of knowledge. This transition is not only a response to the technological and cultural demands of contemporary society but also an opportunity to reclaim Freirean ideals of transformative and liberating education (Freire, 1997; Morin, 1999).

Based on these principles, we developed the theatrical production titled *Operetta of Multiple Intelligences*, a collaborative project involving students from different educational levels, ranging from primary school to postgraduate studies. This production was conceived within a postgraduate course in "Biosciences education" and aimed to explore the evolution of the concept of intelligence in psychology, from the 19th century to the present. This experience is documented in this report, in which we discuss the application of creative and inclusive methodologies in education, highlighting their potential to engage both students and audiences in the pursuit of meaningful and transformative learning experiences (Kolb, 1984).

1.1 The Use of Arts in Bioscience Education

The incorporation of arts, particularly music and theater, in bioscience education has proven to be an innovative and effective pedagogical approach, fostering a more engaging, dynamic, and meaningful learning process. Research has shown that these practices can enhance student motivation and promote a deeper understanding of scientific concepts (Silva *et al.*, 2024). The integration of music and theater into bioscience curricula bridges scientific content with students' cultural and personal experiences, making learning more inclusive and interactive (Carvalho *et al.*, 2020). This approach also aligns with the principles of inclusive and emancipatory education, fostering equity and student autonomy (UNESCO, 2015).

1.1.1 Cognitive and Emotional Benefits

The use of arts in science education goes beyond making learning more engaging; it facilitates the comprehension of complex concepts while fostering cognitive and emotional development. Eisner (2002) argues that the arts significantly contribute to cognitive growth and stimulate critical and creative thinking. Theater, for instance, engages students in a creative process, enabling them to explore concepts and develop problem-solving skills through interaction and artistic expression (Fels & Belliveau, 2008). McNiff (2008) highlights that integrating the arts can positively impact student motivation, creating a more dynamic and inclusive learning environment.

Moreover, studies suggest that artistic activities, such as music and theater, not only enhance memorization but also develop critical thinking skills essential for solving complex problems (Hardiman, Rinne & Yarmolinskaya, 2014). Research by Rieger and Chernomas (2013) in nursing education demonstrates that incorporating artistic elements enriches the learning experience, making it more holistic and integrative—an approach that can be extended to bioscience education.

1.1.2 The Transdisciplinary Approach

The application of artistic methods in science education is closely related to the concept of transdisciplinary integration between different fields of knowledge. Marshall (2014) argues that such integration can enhance learning across multiple disciplines, including the sciences. Arts education not only develops cognitive, emotional, and social skills but also fosters students' holistic development (Upitis, 2011). By incorporating theater and music into science teaching, we promote an integrated learning experience that respects diverse forms of knowledge and stimulates intellectual curiosity.

Transdisciplinarity, as emphasized by Chassot (2003) and Santos (2007), allows for a more comprehensive education, encouraging students to understand the complex relationships between science, art, and society. This perspective is crucial in promoting scientific literacy as a social practice, enabling students to critically assess the societal implications of scientific discoveries.

1.1.3 Memory Enhancement and Social Relationships

The integration of artistic and playful activities in science education also strengthens memory retention and social interactions among students. The practice of theatrical activities,

such as scriptwriting and rehearsals, creates a collaborative environment that enhances teamwork and interpersonal connections (Cardoso *et al.*, 2021). Eisner (2002) and Carvalho *et al.* (2020) suggest that involving students in artistic projects boosts motivation and fosters positive emotional bonds, which are essential for a productive and healthy learning environment.

1.1.4 Scientific Theater and Science Literacy

The concept of "scientific theater" has gained prominence in education, with theatrical productions exploring scientific and human themes, contributing to the formation of critical spectators and the comprehension of both basic and complex scientific concepts. Classic plays such as *Life of Galileo* by Bertolt Brecht and *Copenhagen* by Michael Frayn illustrate how theater can humanize science, making it more accessible and thought-provoking (Brecht, 1966; Frayn, 1998). These plays not only address scientific issues but also explore ethical and moral dilemmas, connecting science, history, and philosophy.

Thus, using theater and music in science education also promotes scientific literacy in an engaging manner, facilitating the understanding of complex and historical concepts (Teles & Oliveira, 2021; Machado *et al.*, 2024). Operettas, for example, are an effective way to explore multiple intelligences, providing a more sensory and integrative learning experience. In our own work, inspired by these classics, we present a multisensory approach that highlights the potential of each intelligence, demonstrating how art can be a powerful tool for understanding science.

Finally, the integration of arts—such as music and theater—into bioscience education has proven to be a rich and diverse pedagogical approach, facilitating the learning of scientific concepts while promoting students' holistic development (Silva *et al.*, 2024). This practice encompasses cognitive, emotional, and social dimensions, fostering a more inclusive, creative, and reflective learning environment. By adopting a transdisciplinary approach, we contribute to building a more holistic education that respects diverse forms of knowledge and encourages the development of critical and socially aware individuals. This process supports a more inclusive and comprehensive educational experience, as implemented in the course "Science, Art, and Education Workshop" and in the current production of the "Operetta of Multiple Intelligences."

2 Methodology

In this study, we explore the creative process behind the *Operetta of Multiple Intelligences*, conceived as part of the postgraduate course "Science, Art, and Education Workshop", within the field of "Biosciences' education". The project culminated in a public performance as part of a university outreach initiative.

An operetta is a form of musical theater that lies between opera and musical theater, known for being light, entertaining, and often presented in a comedic manner. It typically combines musical elements such as arias, duets, choruses, and instrumental music with spoken dialogue. In this project, all scenes featured original compositions, arranged and conducted by maestro Erivaldo Fraga and performed by the Chamber Orchestra of Ilha do Governador, which included seven violins, two violas, one double bass, one electric bass, one keyboard, two flutes, two Bb clarinets, and percussion. Our goal was to develop the production following the standards of classic operettas, but with a simple, light, and accessible plot, contrasting with opera, which is typically more elaborate and formal, requiring professional singers and cast.

Operettas gained popularity in the 19th and early 20th centuries, especially in Europe, with composers such as Johann Strauss II, Franz Lehár, and Jacques Offenbach producing notable works in the genre. Historically, operettas were performed in theaters and concert halls, and some were adapted into stage productions or films. Although the genre has fallen out of common use today, operettas hold a special place in the history of musical theater, appreciated for their pleasant music, charming storylines, and relaxed atmosphere compared to traditional opera. Our intention was to revive some of this history, intertwining it with scientific themes and bringing together students, teachers, and artists on the same stage.

2.1 The Origins of the Operetta of Multiple Intelligences

The “Science, Art, and Education Workshop” was a course designed to train students—most of whom are current or future primary and secondary school teachers—to incorporate artistic techniques into the teaching of biological sciences, making learning more innovative and engaging. Since its inception in 2015, the course has stood out for breaking traditional boundaries between biological sciences, the arts, and the humanities, allowing students to experience an interdisciplinary approach that integrates theater, music, photography, and visual arts to convey scientific concepts and ideas creatively.

The workshop consisted of 15 weekly sessions, each lasting three hours, totaling 45 hours. Each class was divided into a lecture segment (~50 minutes) reviewing literature and state-of-the-art research on the topic of the day, followed by practical and dynamic activities in small groups. These activities involved techniques such as illustration, graphic design, songwriting, photography, and theatrical studies. Many sessions took place in alternative university spaces, such as amphitheaters and outdoor areas, to encourage greater interaction between participants and their environment.

In the theatrical activities, students, tutors, and teachers developed scripts for short sketches on bioscience topics, incorporating theatrical exercises (Boal, 1998). In the musical activities, participants were encouraged to compose songs on bioscience-related themes.

Using a pedagogical model we developed (Silva *et al.*, 2025), students first identified 10–20 keywords related to their chosen topic. They then created rhyming poetry using these words and were encouraged to sing their verses naturally, sketching a melody. Based on this draft, the course tutor—a conductor and musician with experience in orchestral conducting—developed a harmonic structure and adjusted metric, rhythm, and prosody to refine the composition.

The development of the Operetta also involved a collaboration among students from primary, secondary, and higher education, including undergraduate and postgraduate students at UFRJ. The initial concept emerged during a class discussion about the limitations of conventional intelligence models in schools and universities, which inspired the storyline of the *Operetta of Multiple Intelligences*. The Chamber Orchestra of Ilha do Governador, led by maestro Erivaldo Fraga, played a crucial role in the production. The maestro, a PhD student, composed several original themes for the presentation and rehearsed with his musicians, incorporating Brazilian musical classics such as *Aquarela do Brasil* by Ary Barroso (1939).

The objective was to present, discuss, and critically analyze classic and modern theories of intelligence through the questions: What is intelligence? Are there different types of intelligence? What are they? Thus, we developed a musical and theatrical performance rooted in the history and philosophy of science, engaging students in an environment of joy, emotional connection, and aesthetic appreciation. This project was also the main theme of the maestro's doctoral thesis (Silva, 2024).

2.2 Historical Review of the Concept of Intelligence in the 19th and 20th Centuries

Intelligence is often considered a complex and multifaceted mental capacity, encompassing the ability to learn, understand, reason, solve problems, adapt to new situations, and interact effectively with the environment (Oliveira-Castro & Oliveira-Castro, 2001). Its exact definition varies depending on theoretical perspectives and fields of study but generally includes the ability to apply knowledge in practical ways. Intelligence is culturally influenced (Ianoco & Bart, 2023), and different cultures may define and measure it differently. Additionally, intelligence is not static—it evolves over time and is shaped by environmental, educational, and life experiences.

The concept of intelligence has undergone significant transformations over the 19th and 20th centuries, reflecting shifts in scientific and cultural paradigms. In the 19th century, intelligence studies emerged as a scientific field with the development of early measurement theories and methods. Influenced by positivism and Charles Darwin's evolutionary theories, Francis Galton (1822–1911) pioneered efforts to quantify intelligence, introducing concepts of heredity and individual differences. In *Hereditary Genius* (1869), Galton argued that intelligence was inherited and attempted to measure mental capacities through questionnaires

and psychophysical tests, assessing factors like reaction time and sensory perception. He also introduced statistical methods, such as correlation analysis, though his work was controversial, particularly due to its association with eugenics.

2.2.1 Alfred Binet and the Development of IQ Tests in the First Half of the 20th Century

At the beginning of the 20th century, Alfred Binet (1857–1911) and Théodore Simon (1873–1961) advanced intelligence studies by creating the first standardized test to assess cognitive abilities. Their test focused on practical skills such as memory and problem-solving. Lewis Terman later adapted Binet's test for the American context, creating the Stanford-Binet test, which popularized the use of the Intelligence Quotient (IQ) (Terman, 1916). The IQ score soon became a widely used measure of general intelligence.

A major milestone in IQ test development was the work of the French psychologist Alfred Binet. In 1908, Binet and Simon published the *Échelle Métrique d'Intelligence*, the first intelligence test in history, designed to evaluate the intellectual development of children (Binet & Simon, 1908). Commissioned by the French government, the test aimed to identify students with learning difficulties in schools (Mazur-Mosiewicz & Davis, 2011). Although controversial and often criticized today, the test was originally intended as a tool to identify children in need of additional educational support, rather than as a fixed measure of innate intelligence (Júnior *et al.*, 2018).

Binet's test introduced the concept of *mental age*, comparing a child's intellectual capacity to the average level for their age group. This represented a significant shift in intelligence studies, moving away from a static, unidimensional perspective toward a more dynamic and contextualized approach (Júnior *et al.*, 2018). However, Binet himself was not fully satisfied with the idea of a single intelligence measure and warned against rigid interpretations of IQ test results (Binet & Simon, 1916; Gould, 1981).

Binet's work had a lasting impact on psychological assessment and intelligence studies, serving as the foundation for later intelligence tests, including the Stanford-Binet Intelligence Scale, developed by Lewis Terman (Carrana, 2015). Another significant milestone in IQ testing history was the creation of the Wechsler-Bellevue Intelligence Scale in 1939 (Wechsler, 1939). David Wechsler (1896–1981), a U.S. psychologist, made major contributions to psychometrics, the field of psychology that focuses on measuring mental abilities and psychological traits.

Wechsler sought to address some of the limitations of previous IQ tests. He introduced the standardized IQ scoring system, where the average score was set at 100, allowing for easier comparison between individuals and population norms. He also developed separate tests for adults and children (Mello *et al.*, 2011). His tests included multiple subscales measuring different aspects of intelligence, but primarily focused on three key areas: (i) verbal

abilities; (ii) perceptual reasoning skills; and (iiii) memory capabilities (Wagner *et al.*, 2010). Wechsler's work had a profound impact on psychological assessment and our understanding of individual intelligence differences.

At the same time, Charles Spearman, influenced by psychometrics, proposed the "*g factor*" theory of general intelligence, suggesting that intelligence was a single underlying ability that influenced all cognitive tasks. Using factor analysis, he demonstrated that specific cognitive skills were correlated with this general factor, meaning that individual differences in cognitive performance could be explained by variations in *g* (Spearman, 1904). In contrast, L.L. Thurstone challenged the *g factor* theory, proposing the Primary Mental Abilities theory. He argued that intelligence could not be reduced to a single factor but was composed of multiple independent abilities, such as memory, verbal fluency, and reasoning (Thurstone, 1938).

2.2.2 Howard Gardner and the Theory of Multiple Intelligences

IQ tests originally developed by Binet and later refined by Terman, Simon, Wechsler, and Thurstone were fundamental for a long time and are still widely used today in educational assessments, learning disability diagnostics, employee selection, scientific research, clinical evaluations, and cognitive monitoring in aging or brain-related conditions (Sternberg & Kaufman, 2011).

However, over time, several criticisms of these methods emerged. One major issue was that many IQ tests reflected cultural and social biases, favoring certain cultural or socioeconomic groups, raising concerns about equity and fairness in intelligence assessment (Peterson, 1948). Another criticism related to the complexity of intelligence — IQ tests often failed to capture the full range of human intelligence, neglecting aspects such as creativity, practical skills, emotional sensitivity, and other cognitive abilities (Lloret-Segura *et al.*, 2014). Additionally, IQ tests focused primarily on verbal and logical-mathematical skills, overlooking other essential forms of intelligence, such as artistic, physical, interpersonal, and intrapersonal abilities (Guilford, 1968). Finally, some researchers pointed out that IQ scores did not always correlate with real-world success in areas such as professional performance or practical problem-solving.

The response to these criticisms led, in large part, to the development of the Theory of Multiple Intelligences (Gardner, 1983), proposed by the U.S. psychologist and educator Howard Gardner (1943–). Gardner correctly argued that intelligence could not be reduced to a single score or a few intellectual characteristics. He also recognized that different individuals possess distinct cognitive abilities. Gardner proposed that intelligence consists of multiple independent abilities, each representing a specific type of intelligence. His initial eight types of intelligence included: (i) linguistic; (ii) logical-mathematical; (iii) spatial; (iv) musical; (v) bodily-kinesthetic; (vi)

interpersonal; (vii) intrapersonal; and (viii) naturalistic (Gardner, 1999). This theory suggests that individuals may excel in one or more of these intelligences regardless of their IQ scores (Pavan, 2014). Gardner's approach provides a broader and more inclusive perspective on intelligence, recognizing the diversity of human abilities and considering the influence of cultural and social context. While the Theory of Multiple Intelligences has generated considerable discussion and research, it is not universally accepted by psychologists. Some scholars advocate for broader models of intelligence, while others question the empirical foundation and measurement validity of Gardner's intelligences, raising doubts about its practical applicability (Pocinho & Mendes, 2021). As a renowned researcher with a long career at Harvard University, Howard Gardner founded *Project Zero*, an interdisciplinary research center focused on learning, art, and cognition. His work has significantly influenced educational practices, leading to teaching strategies that emphasize student strengths, personalized learning, and creative approaches to education.

2.3 The Science Outreach Project: "The Incredible Science of Leopoldo de Meis"

Following its initial development within the "Science, Art, and Education Workshop", we decided to expand the idea of discussing intelligence models through music and theater into a full performance as part of a university outreach project. The extension program "The Incredible Science of Leopoldo de Meis" (affectionately called *Incredible Science*) was founded in 2019 to produce theatrical performances, discussions, and interactive activities for students, faculty, and staff at the Leopoldo de Meis Institute of Medical Biochemistry in Federal University of Rio de Janeiro (IBqM-UFRJ).

The second edition of the project, held on August 24, 2019, focused specifically on intelligence theories. The event included three segments: (i) a musical and theatrical performance (the *Operetta of Multiple Intelligences*); (ii) a panel discussion featuring experts in neuroscience, philosophy, and biochemistry, debating the questions: What is intelligence? What are the roles of neuroscience, emotions, and artificial intelligence?; (iii) interactive games and discussions, inspired by educational videos produced by the institute. The event gathered over 100 attendees, in addition to the cast and organizers. The performance was recorded and is available on YouTube (https://www.youtube.com/watch?v=MTenw3aTTqY).

2.4 The Chamber Orchestra of Ilha do Governador (OCIG)

A chamber orchestra is a smaller ensemble than a symphony orchestra, typically performing a dedicated repertoire in venues such as palaces, churches, small theaters, or intimate meeting halls. It consists of string instruments—(i) first violin, (ii) second violin, (iii) viola,

(iv) cello, (v) double bass—and soloists who played various roles in the musical arrangement, including flute, Bb clarinet, keyboard, drums, and percussion instruments.

For the performance of the *Operetta of Multiple Intelligences*, the composition of each piece served as a soundscape for the opereta's scenes, helping to describe and set the atmosphere for the characters. Since we did not incorporate elaborate stage design, the music itself functioned as both a scenic and aesthetic backdrop. One notable moment was the contralto solo composed specifically for the scene depicting naturalistic intelligence, performed by one of the instrumentalists. Additionally, the operetta's theme song, "Múltiplas São", was performed by a choir of actors and students on stage, serving as a refrain between songs and being played as the grand finale of the operetta.

The Chamber Orchestra of Ilha do Governador was founded in 2008 and has contributed to the musical training and development of dozens of young musicians from socially vulnerable backgrounds. For many of these young artists, music became a means to showcase their talents and intelligence, providing them with a sense of purpose and direction. Some of these musicians pursued professional music careers or enrolled in university music programs, while others joined musical groups and orchestras without following an academic path.

Several of the soloists who portrayed the different intelligences in the operetta were undergraduate students, lending their voices to the characters and contributing to the artistic and educational experience.

For the performance of the *Operetta of Multiple Intelligences*, the following musicians participated: Isaac Newton as concertmaster (Spalla); Thyago Ribeiro and Pedro Henrique on first violins; Samuel Cândido on second violin; Anderson Cândido and Moises Ferreira on viola; Adam Fox and Matheus Barreto on cello; Natan Vieira on double bass; Josias Nunes and Serebias Lourenço on flute; Jonatas Conrado on clarinet; Elineia R. Martins on keyboard; Neemias Pinheiro on drums; and Gilmar Ferreira as sound engineer.

3 Results

3.1 The Production and Rehearsal Process of the *Operetta of Multiple Intelligences*

The *Operetta of Multiple Intelligences* was developed over approximately six months by the authors of this study, along with a large cast, under the leadership of maestro and then PhD student, Erivaldo Fraga da Silva. The production was part of his doctoral dissertation in the Education, Management, and Dissemination of Biosciences Program (PEGeD) at the Leopoldo de Meis Institute of Medical Biochemistry (IBqM), Federal University of Rio de Janeiro (UFRJ). The operetta was presented within the framework of the university outreach project "Incredible Science".

Our goal was to create a playful and engaging performance that would contribute to the popularization of scientific knowledge on intelligence while educating students through an active teaching-learning methodology, in which they were both co-creators and protagonists of the production. The operetta format allowed both actors and the audience to experience a historically and philosophically informative performance enriched with aesthetic and musical beauty.

The script briefly narrated the story of Alfred Binet and the development of mental age and IQ tests, followed by the evolution of intelligence theory toward a broader perspective based on the work of Howard Gardner and his Multiple Intelligences theory. Initially, we expanded a draft script originally proposed during the course “Science, Art, and Education Workshop”. Then, the maestro (that was also a teacher from Anísio Teixeira Municipal School) selected students from elementary education who were interested in participating in the play by portraying one of the intelligences.

Our team conducted rehearsals over eight consecutive Friday afternoons leading up to the event, along with two full dress rehearsals in the final week. Students were welcomed to rehearsals every Friday, and the maestro/teacher worked with each of them individually during their regular music classes at Anísio Teixeira Municipal School. Additionally, students practiced independently at home before attending the final two dress rehearsals before the main event.

3.2 The Culmination Event of the *Operetta of Multiple Intelligences*

The culmination event of our performance took place within the framework of the “Incredible Science” outreach project (Figure 1), presented at the Paulo Rocco Auditorium in the Center for Health Sciences at the Federal University of Rio de Janeiro, on August 24, 2019. The event involved the participation of approximately 200 people, including students, musicians, actors, and the audience.

The performance was divided into three acts, developed by the Chamber Orchestra of Ilha do Governador (Figure 2a) and presented by a narrator, who guided the scenes and helped the spectators situate themselves within the narrative (Figure 2b).

The first act took place in Paris, depicting the psychologist Alfred Binet administering an intelligence test to students (Figure 2c). In a humorous approach, we portrayed a Binet character who rejected some of the eight students (each of whom would later represent one of the multiple intelligences in the third act), failing them for demonstrating “a very childish intelligence.”

The second act presented researcher Howard Gardner, recognizing the multifaceted nature of cognitive abilities and becoming inspired to propose the concept of multiple intelligences (Figure 2d).

Finally, the third act consisted of brief theatrical performances, where students and other actors portrayed aspects related to each of the intelligences proposed by Gardner (Figures 2e, 2f, and 2g). The concept of multiple intelligences was extensively explored through the creative and symbolic representation of the different types of intelligence. As we will see next, each intelligence was associated with one or more characters, who personified its distinct characteristics and abilities, establishing a connection between theory and artistic practice (Table 1).

Figure 1. Presentation banners for the play *Operetta of Multiple Intelligences*.
a) Banner for the event "Incredible Science #2; b) Specific banner for the operetta, showing the figures used as stage design to represent each of Gardner's multiple intelligences.

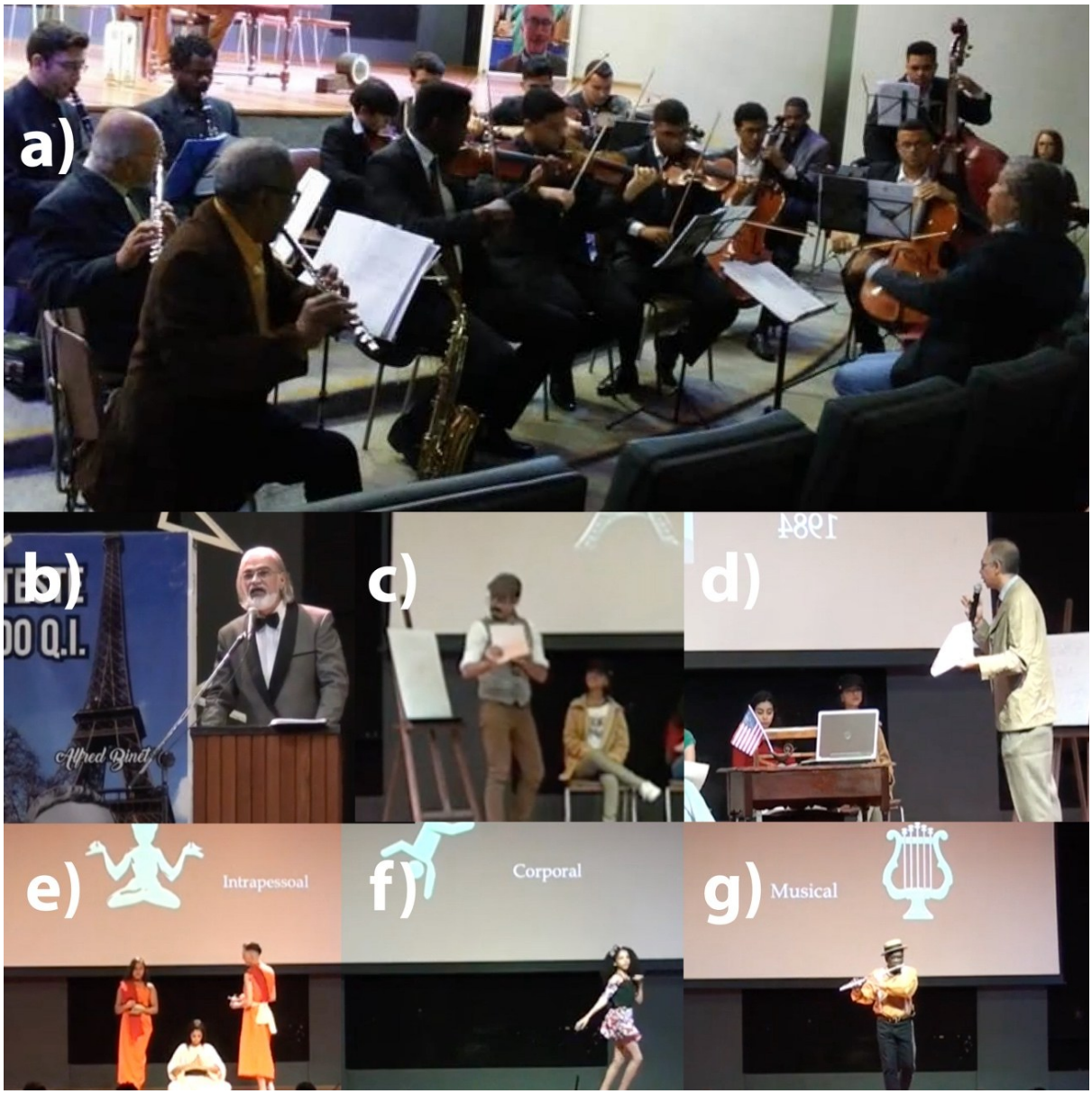

Figure 2. Photos from the performance of "The Operetta of Multiple Intelligences," presented on August 24, 2019, at the UFRJ campus on Ilha do Fundão, Center for Health Sciences.
a) The Chamber Orchestra of Ilha do Governador, conducted by Maestro Erivaldo Fraga, performs original compositions and classic Brazilian songs;
b) Hiran Costa Júnior served as the narrator and master of ceremonies;
c) Act 1: Francisco Prosdocimi portrays Alfred Binet, presenting the intelligence test to students;
d) Act 2: Júlio Mignaco portrays Howard Gardner, explaining his theory of multiple intelligences;
e, f, g) Act 3: Performances representing the different intelligences, featuring actress Pâmela Silva, dancer Kerolyn Kauany, and the late flutist Josias Nunes (*in memoriam*).

Table 1. The 8 multiple intelligences originally described by Howard Gardner and their representations in the musical and theatrical performance *The Operetta of Multiple Intelligences.*

Intelligence	Description	Representation in the Performance
Linguistic	Skill with words, language, and communication	Poetess
Logical-Mathematical	Ability with logic, patterns, numbers, and problem-solving	Mathematician
Naturalistic	Sensitivity and knowledge regarding the natural environment	Gardener
Visual-Spatial	Ability to perceive the world visually and in three dimensions	Illustrator
Intrapersonal	Self-awareness and understanding of oneself	Yoga and meditation practitioner
Interpersonal	Ability to understand and interact effectively with others	Communicator and politician
Bodily-Kinesthetic	Physical ability and motor coordination	Samba dancer and capoeira performer
Musical	Sensitivity and ability to play musical instruments, compose, distinguish tones and pitches, and recognize rhythms	Flutist, singer and members of the OCIG orchestra

For each intelligence, we also chose an iconic symbol that was projected on the screen at the back of the stage by a projector, which served as the backdrop. To start each of the scenes, the narrator presented the intelligence in question and provided a basic explanation of the associated cognitive abilities. All the scenes were accompanied by an orchestra playing instrumental music that interacted with the plot and maintained an atmosphere of suspense, inspiration, disappointment, or joy.

The (i) linguistic intelligence, which involves the skill with words, language, and communication, was represented by the figure of a poetess, a character who used language as a tool for expression and connection. For this, a seventh-grade student from Colégio Anísio Teixeira wrote and recited an original poem on the theme “Soulmates.” The (ii) logical-mathematical intelligence, associated with the ability to work with logic, patterns, numbers, and problem-solving, was represented by a ninth-grade student with a passion for mathematics, symbolizing abstract reasoning and solving complex challenges. The student solved a complex equation in front of the participants while the orchestra played an appropriate theme. Next, (iii) naturalistic intelligence, related to sensitivity and knowledge of the natural environment, came to life through a gardener, a ninth-grade student responsible for caring for nature with a deep understanding of the biological world and how to care for plants. The student from Colégio Anísio Silveira carefully planted a seedling in view of the audience. The (iv) visual-spatial intelligence,

which involves visual perception and the ability to handle three-dimensional space, was represented by an illustrator, a graduate student, responsible for creating graphical representations and exploring the visual universe. The graphical representation of a brain was made on an easel facing away from the audience and, once completed, was presented to the audience, receiving their applause. The (v) intrapersonal intelligence, which refers to the knowledge and understanding of oneself, was symbolized by the practice of yoga and meditation, activities aimed at seeking self-knowledge and inner balance. An actress representing a Tibetan nun entered the scene with two assistants and performed meditation to the sound of the orchestra and an original song composed for this scene, also sung by a student. The (vi) interpersonal intelligence, focused on the understanding and effective interaction with others, was embodied by two communicators and politicians, figures who depend on empathy and the ability to connect with others. The first reflected on the issue of communication and its importance in society, while the second gave a metalinguistic speech, suggesting that the play itself was an act of interpersonal intelligence. The (vii) Bodily-kinesthetic intelligence, which relates to physical skill and motor coordination, was represented by a samba dancer and a capoeirista, who demonstrated the fluidity and dexterity of movement through their body expressions. The dancer was a seventh-grade student from Colégio Anísio Teixeira and presented a small dance scene, sambaing to the sound of *Aquarela do Brasil*.

Our *grand finale* was held with musical intelligence, associated with sensitivity and the ability to play instruments, compose, and distinguish tones. Five students from different grades of elementary and high school entered playing their violins, while the late flutist Josias Nunes (*in memoriam*) presented an original melody of his own composition. To close, the narrator once again praised the broad and liberating vision of intelligences according to Gardner's worldview and invited all the actors back to the stage to sing the theme of multiple intelligences composed by maestro Erivaldo Fraga. In this way, the show not only brought to light the diversity of human abilities but also the idea that all these intelligences can manifest and be expressed in creative and interconnected ways, reflecting the multiple dimensions of being human.

4 Discussion

In the present work, we detail the process of creation and development of the *Operetta of Multiple Intelligences*, an artistic production initially conceived within the context of the undergraduate and graduate course *Science, Art, and Education Workshop*, which is part of the area of Education in Biosciences. This course aimed to integrate active teaching-learning methodologies and creative practices into the teaching of biosciences, encouraging the articulation between different forms of artistic expression and the construction of scientific knowledge (Sabec *et al.*, 2020; Silva *et al.*, 2024). New teaching models have also been inspired by adrienne maree brown's concept of "pleasure activism," which highlights the

importance of creating a learning environment where students can experience pleasure, well-being, and a sense of agency throughout the lessons (Brown, 2019). By integrating music and theater into teaching, this project revived the ideals of a dynamic and participatory education, as advocated by Paulo Freire, and offered a model that moves away from educational traditionalism, where students are seen only as passive receivers of information (Freire, 1968). Instead, the students acted as protagonists, co-creating the performance and reflecting a more horizontal and emancipatory approach, aligned with current teaching trends that value interactivity and student agency. Furthermore, one of the course tutors, a doctoral student, conductor, and elementary school teacher, took the idea to his students at Colégio Anísio Teixeira and invited some of them to participate in the event. The project culminated in a public performance as part of the university extension program “Incredible Science,” highlighting the potential of the arts as a tool for teaching and science outreach, and integrating students from elementary school to graduate school in the same playful space for transmitting knowledge. We believe that our project offered an interesting perspective on the teaching of biosciences, exemplifying how active and creative methodologies can transform pedagogical practice and promote an inclusive and collaborative education.

The construction of this operetta was marked by an interdisciplinary approach, which brought together elements of music, theater, and science to create a rich and engaging educational experience. In addition to bringing students and teachers from different educational levels and age groups together, promoting intergenerational education (Kaplan, 2002). The project also involved the external community, encouraging the exchange of knowledge and experiences. This exchange was carried out through an open discussion on the theme of intelligences with the presence of a neuroscientist, a biochemist, and a philosopher, where the audience was able to interact and ask questions. This integration of teaching, research, and extension demonstrates the transformative potential of interdisciplinary practices, showing that science can be communicated in an accessible, creative, and culturally relevant way. At the same time, it reaffirms the importance of rethinking the traditional boundaries of academic disciplines to provide a more holistic and inclusive education, capable of addressing the demands of the 21st century.

In addition to the presentation of historical and playful approaches, as we did here, similar and interesting proposals can and should be used by teachers interested in adding artistic, scenic, musical, and/or theatrical dynamics to their classes. As a suggestion, we propose the realization of some types of activities that can be used in a pedagogical context, such as (i) dramatizations of scientific concepts: where teachers can produce short plays or skits that illustrate specific scientific concepts, such as biological processes, important historical events, or scientific experiments (Palmer, 2000); (ii) interactive simulations: putting students in specific roles in scientific scenarios, such as laboratory simulations or hypothetical scenarios that require

the application of scientific principles (Guha, 2013); (iii) fictional scientific interviews with famous scientists or historical figures related to science, allowing students to explore biographies and discover the contributions of scientists while also practicing interview skills (Maharaj-Sharma, 2008); (iv) theatrical science fairs, where students can create theatrical booths to present scientific concepts, using costumes, sets, and live demonstrations to communicate ideas in a more dynamic way (Éthier & Lefrançois, 2025); (v) creation of interdisciplinary and transdisciplinary projects involving music, theater, and science, such as discussions on the ethical implications of scientific advances, incorporating elements of ethics and philosophy (Brown, 2019); (vi) visits by artists or scientific activists who use music and theater to communicate science, organizing workshops or performances at schools, inspiring students and providing practical insights on how to integrate art and science (Chappell & Muglia, 2023).

Finally, it is important to emphasize that, when developing theatrical activities based on scientific knowledge, it is essential to promote creativity, collaboration, and the emotional engagement of students (Weissberg, Wang, & Walberg, 2004). These activities make learning more engaging and help students develop interpersonal skills, effective communication, and a deeper understanding of scientific topics and the sociology of science (Driver *et al.*, 1996; Elias *et al.*, 1997; Robinson, 2011). That is, activities that combine theater, music, and science in schools allow students to work on their multiple intelligences in an integrated and enjoyable way, contributing to their emotional, affective, and cognitive development (Gardner, 1983; Durlak *et al.*, 2011; Brown, 2019; Machado *et al.*, 2024). Finally, the *Operetta of Multiple Intelligences* stood out as a significant contribution to education by implementing an active methodology that valued the diverse forms of intelligence and promoted the integration of different knowledge areas. Aligned with Paulo Freire's emancipatory principles, the project revived the ideals of a more human, critical, and reflective education. Participants and spectators described the experience with adjectives like "incredible," "fantastic," "delicious," and "interesting," reinforcing our commitment to continue developing similar initiatives. This experience highlighted the transformative potential of the operetta as a pedagogical tool, capable of making scientific knowledge more accessible, engaging, and inspiring, broadening horizons and providing high-quality academic products for both participants and audience members.

5 Acknowledgements

This work is dedicated to our dear friend Josias Nunes (*in memoriam*), a talented flutist who gave us a brilliant performance in the piece as the main representative of musical intelligence. His motivation, humor, love, and kindness will always inspire our work.

We deeply thank all the actors, characters, and musicians who enlightened our performance and made its realization possible. Among them are Maria Kelly Souza, Narazê Rodrigues, Ana Beatriz Penha, Thaís Fontenelle, Pâmela da Silva, Cliff Gonçalves and Antonio

Carlos, Luan Costa, Kerolyn Kauany and Letícia Freitas, Josias Nunes (in memoriam), Isaac Newton, and Hiran Costa Jr. We also thank the Leopoldo de Meis Institute of Medical Biochemistry at UFRJ and its director at the time, Prof. Fábio Ceneviva de Almeida, who encouraged the performance and enabled its realization. Thanks to professors Carla Polycarpo, Sérgio Ferreira, Francisco Rômulo Monte Ferreira, Tuane Vieira, Dr. João Silveira, and student Luiza Malizia. Thanks also to sound and lighting technician Mr. Sylvio Petrônio, camera technician Mr. Orbino Cosme, producers Elaine Petronilho, Karina Martins, and Antonio Casalinho, and to the students, teachers, and directors of the Anísio Teixeira Municipal School, who were present and provided essential support. We also thank the entire audience who were able to attend and follow the realization of our performance.

Finally, many of the ideas and discussions presented here were developed in our creative space with the entire group from the UFRJ Laboratory of Science, Arts, and Education. Therefore, we thank the dedicated members of the space: Ana Maria Landeira-Fernandez, Wanessa Bomfim Machado, Aline Hammes Silva, and Luísa Taranto. This work was partially funded by the Rio de Janeiro State Research Support Foundation (FAPERJ) through the CNE scholarship for FP (E-26/200.940/2022).

6 References

Baixinho, C., Ferreira, Ó., Cardoso, M., Nascimento, P., Pedrosa, R., & Gonçalves, P. (2020). Autopercepção dos estudantes sobre a participação em atividades extracurriculares de transferência de conhecimento: o exemplo da transição segura. New Trends in Qualitative Research, 588-601. https://doi.org/10.36367/ntqr.2.2020.588-601

Barros, A. (2020). Mfundisi we-africa: um itinerário educacional de enfrentamento do racismo e da desigualdade. Educação & Sociedade, 41. https://doi.org/10.1590/es.221321

Bastos, M. (2016). O que é a história da educação no brasil hoje? tempos de reflexão. Espacio Tiempo Y Educación, 3(1), 43-59. https://doi.org/10.14516/ete.2016.003.001.4

Binet A, Simon T. Le développement de l'intelligence chez les enfants. L'Année psychologique, vol. 14, 1908, p. 1-95.

Binet, A., & Simon, T. (1916). *The Development of Intelligence in Children (The Binet-Simon Scale)*. Williams & Wilkins Company. (Originally published in French in 1905).

Boal, A. (1998). Jogos para atores e não-atores. Rio de Janeiro: Ed. Civilização Brasileira.

Brown AM. Pleasure Activism: The Politics of Feeling Good. Chico: AK Press; 2019.

Cardoso, M., Baixinho, C., Ferreira, O., Nascimento, P., Pedrosa, R., & Gonçalves, P. (2021). Aprender prática baseada na evidência pelo envolvimento em atividades de investigação – autopercepção dos estudantes. Cogitare Enfermagem, 26. https://doi.org/10.5380/ce.v26i0.79806

Carrana, P. (2015). Avaliação dos riscos psicossociais nos trabalhadores da indústria de limpeza = evaluación de riesgos psicosociales en los trabajadores de la industria de la limpieza = psychosocial risk assessment in the workers of the cleaning industry. https://doi.org/10.18002/10612/5951

Carvalho, M., Gonçalves, R., & Silva, A. (2020). A faculdade de educação do acre no contexto de implantação do ensino superior. Revista Amazônida Revista Do Programa De Pós-Graduação Em Educação Da Universidade Federal Do Amazonas, 1(01), 142-166. https://doi.org/10.29280/rappge.v1i01.7876

Chappell CR, Muglia LJ. Fostering science-art collaborations: A toolbox of resources. PLoS Biol. 2023 Feb 9;21(2):e3001992. doi: 10.1371/journal.pbio.3001992. PMID: 36757944; PMCID: PMC9910691.

Chassot, A. (2003). Alfabetização científica: uma possibilidade para a inclusão social. Revista Brasileira De Educação, (22), 89-100. https://doi.org/10.1590/s1413-24782003000100009

Clift, R., Houston, W. R., & Pugach, M. C. (1990). Encouraging Reflective Practice in Education. Teachers College Press.

Dewey, J. (1938). Experience and Education. Macmillan.

Driver, R., Leach, J., Millar, R., & Scott, P. (1996). Young people's images of science. McGraw-Hill Education (UK).

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. Child Development, 82(1), 405-432.

Eisner, E. W. (2002). The Arts and the Creation of Mind. Yale University Press.

Elias, M. J., Zins, J. E., Weissberg, R. P., Frey, K. S., Greenberg, M. T., Haynes, N. M., Kessler, R., Schwab-Stone, M. E., & Shriver, T. P. (1997). Promoting social and emotional learning: Guidelines for educators. ASCD (USA).

Éthier, M.-A., & Lefrançois, D. (Eds.). (2025). *Bringing history to life: Teaching fact and fiction*. University of Ottawa Press. https://press.uottawa.ca/en/9780776641447/ bringing-history-to-life/

Fels, L. M., & Belliveau, G. (2008). Digital storytelling: Capturing lives, creating community. Digital Education & Culture, 2(1), 22-35.

Francklin, A. (2017). O trabalho docente na rede pública estadual mineira em face dos discursos sobre as tecnologias educacionais. Ead & Tecnologias Digitais Na Educação, 5(7), 40. https://doi.org/10.30612/eadtde.v5i7.6637

Frayn, M. (1998). Copenhagen. London: Methuen Drama.

Gadotti, M. (1996). Paulo Freire: uma biobibliografia. Cortez Editora. ISBN: 85-249-0610-3 (https://acervo.paulofreire.org/handle/7891/3078)

Galton, F. (1869). Hereditary Genius: An Inquiry into Its Laws and Consequences. Macmillan.

Gardner, H. (1983). Frames of Mind: The Theory of Multiple Intelligences. Basic Books.

Gardner, H. (1999). Intelligence Reframed: Multiple Intelligences for the 21st Century. Basic Books.

Gould, S. J. (1981). The Mismeasure of Man. W. W. Norton & Company.

Guha, S. (2013). A historical journey in science education through role-playing. *Teaching Science*, 59(3), 45-49.

Guilford, J. (1968). The nature of human intelligence. American Educational Research Journal, 5(2), 249. https://doi.org/10.2307/1161820

Hardiman, M. M., Rinne, L., & Yarmolinskaya, J. (2014). The effects of arts integration on long-term retention of academic content. Mind, Brain, and Education, 8(3), 144-148.

Jensen, A. R. (1998). The g Factor: The Science of Mental Ability. Westport, CT: Praeger.

Júnior, C., Cirino, S., & Gutierrez, L. (2018). Untitled. Revista De Psicología, 27(1), 1. https://doi.org/10.5354/0719-0581.2018.50748

Kaplan, M. (2002). Intergenerational programs in schools: Considerations of form and function. International Review of Education, 48(5), 305-334.

Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Prentice Hall.

Lloret-Segura, S., Ferreres-Traver, A., Hernández-Baeza, A., & Tomás, I. (2014). El análisis factorial exploratorio de los ítems: una guía práctica, revisada y actualizada. Anales de Psicología, 30(3). https://doi.org/10.6018/analesps.30.3.199361

Machado, W. B., Landeira-Fernandez, A. M., Silva, A., Fraga da Silva, E., Mignaco, J. A., & Prosdocimi, F. (2024). Gaia-Pachamama: an educational theater performance to foster environmental consciousness. *Environmental Education Research*, 1–17. https://doi.org/10.1080/13504622.2024.2435509

Maharaj-Sharma, R. (2008). Using role-play to develop science concepts. Caribbean Curriculum, 15, 25–43. https://journals.sta.uwi.edu/ojs/index.php/cc/article/ download/608/540/1348

Malato, M. L. A Academia de Platão e a Matriz das Academias Modernas. Notandum, v. 19, jan.-abr. 2009. CEMOrOC-Feusp / IJI-Universidade do Porto. (http://www. hottopos.com/notand19/malato.pdf)

Marshall, J. (2014). Transdisciplinarity and art integration: Toward a new understanding of art-based learning across the curriculum. Studies in Art Education, 55(2), 104-127.

Mazur-Mosiewicz, A., Davis, A.S. (2011). Binet, Alfred. In: Goldstein, S., Naglieri, J.A. (ed.) Encyclopedia of Child Behavior and Development. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-79061-9_338

McNiff, S. (2008). Art-based research. Jessica Kingsley Publishers.

Mello, C., Argollo, N., Shayer, B., Abreu, N., Godinho, K., Durán, P., Bueno, O. (2011). Versão abreviada do WISC-III: correlação entre QI estimado e QI total em crianças brasileiras. Psicologia Teoria e Pesquisa, 27(2), 149-155. https://doi.org/10.1590/s0102-37722011000200002

Moreira, L. and Marandino, M. (2015). Teatro de temática científica: conceituação, conflitos, papel pedagógico e contexto brasileiro. Ciência & Educação (Bauru), 21(2), 511-523. https://doi.org/10.1590/1516-731320150020015

Moraes, M. (2023). A recepção de espetáculos cênicos na escola e/ou no teatro: formação de público, plateias, espect-atores ou espectadores? https://doi.org/10.56238/sevedi76016v22023-008

Morin, E. (1999). *Les sept savoirs nécessaires à l'éducation du futur*, Paris, Seuil, 141 p. ISBN 978-2-02-041964-2. https://unesdoc.unesco.org/ark:/48223/pf0000117740_ fre

Oliveira-Castro, J. and Oliveira-Castro, K. (2001). A função adverbial de "inteligência": definições e usos em psicologia. Psicologia Teoria E Pesquisa, 17(3), 257-264. https://doi.org/10.1590/s0102-37722001000300008

Palmer, D. H. (2000). Using dramatizations to present science concepts. Journal of College Science Teaching, 29(3), 187-190.

Pavan, K. (2014). Ensino orientado pelo respeito às inteligências múltiplas: as contribuições de howard gardner para o exercício da docência. Administração Ensino e Pesquisa, 15(3), 631. https://doi.org/10.13058/raep.2014.v15n3.19

Peterson, H. A. (1948). The measurement of intelligence. In H. A. Peterson, *Educational psychology* (pp. 418–467). MacMillan Co. https://doi.org/10.1037/14617-015.

Pocinho, M. and Mendes, C. (2021). Avaliação das inteligências múltiplas em crianças do ensino fundamental. Psicologia Teoria e Pesquisa, 37. https://doi.org/10.1590/0102.3772e37304

Prensky, M. (2001). Digital Natives, Digital Immigrants. On the Horizon, 9(5).

Rieger, K., & Chernomas, W. M. (2013). Arts-based learning: Analysis of the concept for nursing education. International Journal of Nursing Education Scholarship, 10(1), 1-10.

Robinson, K. (2011). Out of Our Minds: Learning to be Creative. Capstone.

Rocha, F. and Santos, V. (2021). Teatro no contexto escolar: para uma prática investigativa, experimental e compartilhada. Cena, (34), 109-118. https://doi.org/10.22456/2236-3254.110558

Santos, W. (2007). Educação científica na perspectiva de letramento como prática social: funções, princípios e desafios. Revista Brasileira de Educação, 12(36), 474-492. https://doi.org/10.1590/s1413-24782007000300007

Selwyn, N. (2011) Education and technology: Key issues and debates. Bloomsbury Academic.

Silva, E. F. (2024). A inteligência musical: aspectos transdisciplinares envolvidos na composição e aplicação de biocanções como instrumento para o desenvolvimento cognitivo, emocional e afetivo de alunos do ensino fundamental. Doctoral thesis defended in 09/09/2024, Pós-Graduação em Química Biológica, IBqM, UFRJ.

Silva, E. F., Mignaco, J. A., & Prosdocimi, F. (2024). Biosongs: enhancing cognition and emotional development through an active teaching-learning method in biosciences. Brazilian Journal of Development, 10(3), e68092. https://doi.org/10.34117/bjdv10n3-046.

Silva, E. F., Mignaco, J. A., & Prosdocimi, F. (2025). Biocanções: música para aprender biologia e biologia para ensinar música. Editora ArtecomCiência (in press).

Spearman, C. (1904). "General Intelligence," objectively determined and measured. The American Journal of Psychology, 15(2), 201-292.

Sternberg, R. J., & Kaufman, S. B. (ed.). (2011). The Cambridge Handbook of Intelligence. Cambridge University Press.

Teles, T. and Oliveira, J. (2021). A alfabetização científica em atividades didáticas para educação em saúde por meio do uso de textos de divulgação científica: uma pesquisa bibliográfica. Revista Práxis, 13(25). https://doi.org/10.47385/praxis.v13.n25.3045

Terman, L. M. (1916). The Measurement of Intelligence. Houghton Mifflin.

Thurstone, L. L. (1938). Primary Mental Abilities. University of Chicago Press.

UNESCO. (2015). *Rethinking education: Towards a global common good?* UNESCO Publishing.

Upitis, R. (2011). Arts education for the development of the whole child. Encounters on Education, 12, 44-57.

Valério, J., Machado, G., Batista, K., & Oliveira, J. (2020). O teatro de temática científica no ensino: percepções de professores espectadores da peça o mágico de o2. E-Mosaicos, 9(20), 145-158. https://doi.org/10.12957/e-mosaicos.2020.45076

Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.

Wagner, F., Pawlowski, J., Yates, D., Camey, S., & Trentini, C. (2010). Viabilidade da estimativa de QI a partir dos subtestes Vocabulário e cubos da WAIS-III. Psico-USF, 15(2), 215-224. https://doi.org/10.1590/s1413-82712010000200009

Wechsler, D. (1939). The Measurement of Adult Intelligence. Williams & Wilkins Co.

Weissberg, R. P., Wang, M. C., & Walberg, H. J. (ed.). (2004). Building academic success on social and emotional learning: What does the research say? Teachers College Press.

Zins, J. E., Weissberg, R. P., Wang, M. C., & Walberg, H. J. (ed.). (2004). Building academic success on social and emotional learning: What does the research say? Teachers College Press.