

Movement and neuromotricity in the context of artificial intelligence: Future prospects for global development

FRANCISCO JAVIER ROMERO-NARANJO¹

¹ Department of Innovation and Didactic Training, University of Alicante, San Vicente del Raspeig, SPAIN.

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Abstract:

The purpose of this article is to explore the potential applications of artificial intelligence (AI) in relation to neuromotricity and body percussion, highlighting its versatility across various disciplines such as physical activity and sport, theater, foreign language learning, body expression, and music, among others. There is ongoing debate about whether AI should be referred to as "intelligence," with many authors discussing whether it is more accurately termed talent or ability. In this study, we will refer to it as intelligence and focus on three main objectives: 1) and 2) Applications and uses of AI in this field, and 3) Reflection on the ethical and social implications. These points will be based on the twelve areas of neuromotricity with body percussion already established in other publications with the aim of narrowing their range of action in order to provide new bases for development in relation to artificial intelligence. The proposed link between artificial intelligence and neuromotricity and body percussion in this paper is articulated in the following very specific points that are developed and may lead to an individual approach to each of them. The points are: 1. Recognition and analysis of rhythmic patterns. 2. Human-machine interfaces. 3. Generation of adaptive accompaniments. 4. Analysis of movement and biomechanics. 5. Personalization of teaching. 6. Algorithmic composition. 7. Neuroscientific research. 8. Augmented and virtual reality. By way of conclusion, lines related to the ethical and social implications are provided, where we highlight the precise interpretation of the answers, biased information, digital divide and the possible excessive dependence on technology. The purpose of this article is to explore the potential applications of artificial intelligence (AI) in relation to neuromotricity and body percussion, highlighting its versatility across various disciplines such as physical activity and sport, theater, –foreign language learning, body expression, and music, among others. There is ongoing debate about whether AI should be referred to as "intelligence," with many authors discussing whether it is more accurately termed talent or ability. In this study, we will refer to it as intelligence and focus on three main objectives: 1-) and 2-) Applications and uses of AI in this field, and 3-) Reflection on the ethical and social implications. These points will be based on the twelve areas of neuromotricity with body percussion already established in other publications with the aim of narrowing their range of action in order to provide new bases for development in relation to artificial intelligence.

Key Words: Motor control, education, technologies, BAPNE, Body percussion.

Introduction

Artificial intelligence (AI) is emerging as a transformative tool in education, with significant potential to enhance and personalize learning, automate tasks and provide new opportunities for both students and educators. First of all, it is important to raise the existence of a broad debate on the terminology itself: should it be called artificial intelligence? is it really an intelligence? is it an incorrect term but it sells very well? does it have all the characteristics that an intelligence should have? (Colom, 2021, 2024). Important authors debate about it highlighting the publication of Chomsky, Roberts, & Watumull (2023) that clearly question it. All this has generated great debates as shown by the proposals of Grassini (2023), Farrelly & Baker (2023), García-Peñalvo et al., (2024) or Motlag et al., (2023) among many others. It should not be forgotten that the term "intelligence" involves much debate, even at present with the term "emotional intelligence" which also has its detractors as it is not considered an intelligence but an "aptitude" or "personality trait" (Colom, 2021; Petrides et al., 2007).

Clearly, the aim of this article is not to debate whether it should be called artificial intelligence or "artificial talent" since it is not the focus of this publication, but it is an important aspect to take into account due to the disparity of criteria among authors. In this text we will always call it artificial intelligence, leaving the debate on its denomination to other specialists.

The possibilities offered by artificial intelligence at the educational level can be included in the five areas described below:

1. Personalization of Learning: AI can adapt the content, pace and learning activities to the individual needs of each student, maximizing their potential and improving their performance.

2. Task Automation: AI can automate repetitive and administrative tasks, such as test grading and records

management, freeing up time for educators to focus on personalized student interaction and support.

3. **Intelligent Tutoring:** AI-based tutoring systems can provide instant, personalized feedback to students, guiding them through their learning process and helping them overcome difficulties.

4. **Accessible Educational Resources:** AI can facilitate access to high-quality educational resources, such as digital libraries, online learning platforms, and translation tools, for students of different backgrounds and abilities.

5. **Data Analytics for Continuous Improvement:** AI can analyze large amounts of educational data to identify patterns, trends, and areas for improvement, enabling educators to make evidence-based decisions and optimize their teaching practices.

Neuromotricity and Body percussion is a booming discipline that allows for a wide range of uses from foreign language learning, motor skills, drama, music education, ethnomusicology, philosophy, body expression and many other subjects. Through its research it has diverse fields of application due to its multidisciplinary nature, being established in the following twelve areas (Romero-Naranjo, 2013, 2020, 2022):

1. *Didactic*

It is the area that provides practical resources at the didactic level, with its own graphics. This does not mean that these contributions are subsequently validated and published with quantitative statistical studies (Yamada, 2000; Romero-Naranjo, 1998-2024).

2. *Ethnographic - Ethno Musicological*

They are publications that deal with the use of the body in other cultures in relation to its use, meanings and functions (Kartomi, 1980, 2017; Romero-Naranjo, 2008; Di Russo & Romero-Naranjo, 2023, 2024a, 2024b; Navarro-Maciá, 2024a, 2024b).

3. *Neuropsychological*

This area is linked to research focused on cognitive and executive functions with validated tests and mainly with control and experimental groups (Arnau-Mollá & Romero-Naranjo, 2023, 2024). This includes proposals on embodied cognition (Gregorio-Nicolás & Alonso-Sanz, 2013).

4. *Kinaesthetic*

This area is integrally related to the sciences of physical activity because of its relationship with publications linked to neuromotricity (Andreu-Cabrera & Romero-Naranjo, 2021), as well as body schema, motor skills, physical condition, kinematic analysis or body expression (Carretero et al, 2014; Pérez-Díaz, 2016; Romero-Naranjo & Andreu-Cabrera, 2022, 2023, 2024; Romero-Naranjo, 2024).

5. *Socio-Emotional*

Research that provides both, proposals as well as measurements, of improvement in the socio-emotional environment (Moral-Bofill, et al. 2020; Romero-Naranjo & Romero-Naranjo, 2022, 2024).

6. *Space and Architecture*

Educational proposal of adequate architectural spaces for the implementation of this type of activities (Bango-Melcon, et al 2017).

7. *Team Building*

Studies that propose and systematize the use of body percussion in the business environment (Romero-Naranjo et al, 2017).

8. *Historical*

Publications on the antecedents and precursors of neuromotricity and body percussion (Trives-Martinez et al, 2018; Sánchez-Gonzalez et al, 2018).

9. *Rationale - Justification*

Publications that justify the methodological line by carrying out an extensive literature review study to find out everything that has been published so far and then contribute new lines of work. (Romero-Naranjo, 2008; Romero-Naranjo & Andreu-Cabrera, 2023; Romeu-López et al, 2019).

10. *Cross Learning*

It is the one that has body percussion not as its main object but uses it as a tool for learning another subject such as solfege or musical language (cognitive music theory), a foreign language, mathematics, geography, body language, performing arts, etc. (Alonso-Sanz & Romero-Naranjo, 2015; Fernández-Molina, J. et al, 2020; Romero-Naranjo, 2020).

11. *Entertainment*

It is the contribution that is made through the performing arts in which body percussion is the central axis of the show. We highlight companies such as Stomp or Barbatuques among others (García Sala et al. 2018).

12. *Technology*

This area is linked to the application of artificial intelligence, virtual reality and augmented, as well as applications and software that can provide us with resources for posture correction, evaluation, kinematic analysis and creation of activities in relation to neuromotricity (Boillos-García & Romero-Naranjo, 2024a, 2024b).

Taxonomy of publications on Body percussion worldwide.

All the existing bibliography on this subject can be classified into four large blocks according to the classification of publications on neuromotricity and body percussion of a scientific-academic nature proposed by

Romero-Naranjo (2022):

- (a) Of justification or substantiation. These are publications that justify and support the entire repertoire of activities. Among them all the justification of its link to cognitive and executive functions, the 5 paradigms of the dual task, the four forms of learning, etc.
- b) Of a didactic nature; these are publications whose purpose is to create a whole repertoire of activities to be carried out. This does not imply that these activities are contrasted and validated by means of validated tests with a control and experimental group.
- c) Research design. These are the publications that specifically describe the research design, the hypotheses and objectives of the research, as well as the possible expected results.
- d) Statistical results. These are publications that show, by means of quantitative or qualitative analysis, the hypotheses proposed in the research design.

Purpose.

Once we have seen all the aspects previously explained about artificial intelligence and neuromotricity with body percussion, we will proceed to the purpose of the research with its main objectives. This research is structured on the basis of the following points, which will be expanded in each section.

1. To know the academic state of the art on this subject.
2. Exploration of the potential of AI to generate new fields and paradigms in relation to neuromotricity and body percussion.
3. Reflection on the ethical and social implications of AI in neuromotricity and body percussion.

State of the art.

The existing high-impact literature (WOS & SCOPUS) on artificial intelligence and education provides a very large number of publications in this regard, where its implementation also poses challenges and ethical considerations that need to be carefully addressed (Bearman et al., 2023; Chan & Hu, 2023; Chiu et al., 2023; Crompton & Burke, 2023; Labadze et al., 2023).

From the movement point of view there have been many publications in recent years that provide new avenues of development as well as challenges in sport. Regarding physiotherapy there are novel applications such as TRAK which is having excellent results (Button et al., 2024), but regarding the sport domain the contributions are gigantic collected in various thematic Review (Claudino et al., 2019; Ghosh et al., 2023; Hammes et al., 2022; Molavian et al., 2023; Zhou et al., 2024).

Regarding music education, artificial intelligence provides numerous resources highlighting specific applications as well collected by several authors (Jiang, 2021; Hong et al., 2022; Rohwer, 2024; Wei et al., 2022; Yan, 2022; Yu et al., 2023);

Regarding dance if there are contributions linked to artificial intelligence (Cao, 2024; Kang et al., 2023; Nogueira et al., 2024; Radanliev, 2024; Sarupuri et al., 2024; Wang, 2024; Wallace et al., 2023; Zhou, 2023).

From the point of view of neuromotricity and body percussion there is only one academic publication, but it is not of high impact (Mazzella & Ambretti, 2023) and it has numerous errors and lacks academicism. Neuromotricity and Body percussion is a discipline that should be analyzed with great caution because it should be based mainly on all the publications on this subject in Web of Science and Scopus. For this reason, as a first step it is mandatory to take as a basis the various bibliometric articles that summarize everything published worldwide both in high impact engines and at secondary level (Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2024), in addition to the existing Review on this subject (Romero-Naranjo, 2013). The publication of Mazzella & Ambretti (2023) lacks any academic rigor as it is not based on high impact publications such as WOS / Scopus, the proposals of authors such as Ciro Paduano, Salvo Russo do not have any quantitative study that demonstrates with validated tests any cognitive improvement, Web of Science and Scopus show it; they are activities created without any academic criteria. We recall that at the scientific level, precise activities are evaluated with a control and experimental group and using validated tests. The publication of Mazzella & Ambretti (2023) allude to embodied cognition with body percussion without any point of union since the above mentioned activities do not have any evidence from a cognitive point of view. Moreover, this aspect was already published and substantiated by the BAPNE Method research group in 2013 establishing the points of union between both disciplines (Vicente-Nicolás & Alonso-Sanz).

Exploring the potential of AI to generate new rhythms and body patterns.

2.A. What can artificial intelligence contribute in relation to neuromotricity and body percussion?

Having seen the 12 fields of action of neuromotricity and body percussion, we can offer a range of possible actions of artificial intelligence based on these twelve major thematic blocks. Artificial intelligence (AI) is opening up new avenues of research and application that promise to expand the possibilities of body percussion. Some future prospects and potential applications are explored below: The convergence between Artificial Intelligence (AI) and body percussion opens up a fascinating range of possibilities that transcend the traditional applications of this discipline. The ability of AI to autonomously and adaptively process, analyze and generate information offers transformative potential for the teaching, research and artistic practice of body percussion.

Engineering prompts: the key to accuracy

Optimizing interaction with AI relies heavily on the ability to formulate clear, precise, and well-structured questions. Prompt engineering, which involves carefully crafting the instructions provided to the AI,

stands as an essential tool for obtaining relevant and useful responses. The inclusion of specific details about the task, context and desired goals allows the AI to better understand the user's intent and generate more appropriate responses. The use of prompt templates can be particularly helpful in guiding the interaction and obtaining consistent results.

AI offers a wide range of possibilities in the field of higher education in neuromotricity and body percussion. For teachers, AI can assist in the creation of customized course materials, the design of formative and summative assessments, and individualized feedback to students. For researchers, AI can facilitate complex data analysis, comprehensive literature review, and identification of new areas of research. AI can also play a crucial role in promoting accessibility and inclusion by providing support for students with special educational needs. In the following, we explore in depth and in a classified manner some of its possible applications, as well as the challenges and ethical considerations that its implementation entails.

1. Rhythmic pattern recognition and analysis:

AI, especially through deep learning, can be trained to discern and analyze complex rhythmic patterns in neuromotricity and body percussion, surpassing human capabilities in terms of speed and accuracy (Mas-Mas et al., 2023; Romero Naranjo & Andreu Cabrera, 2023). This ability has applications in objective performance assessment, identifying rhythmic subtleties and providing detailed feedback to students. In addition, AI can assist in musical composition, suggesting rhythmic variations, generating accompaniments or even creating original compositions based on pre-existing styles.

2. Human-machine interfaces:

The combination of motion sensors, gesture recognition and AI algorithms can lead to revolutionary human-machine interfaces (HMIs) in the field of body percussion, including through robots such as Pepper. These HMIs would enable a more fluid and intuitive interaction with music, translating body movements into sounds and rhythms in a precise and expressive way. This technology could facilitate the participation of people with motor or sensory disabilities, opening new avenues for inclusion and therapy through music.

3. Generation of adaptive accompaniments:

AI can analyze in real time the rhythmic patterns performed by the percussionist and generate musical accompaniments that adapt and respond dynamically to their performance. This would create richer and more collaborative musical improvisation experiences, encouraging creativity and sonic exploration (Navarro-Maciá, & Romero-Naranjo, 2023a, 2023b). AI could also be used to generate customized backing tracks for individual or group practice, adapting to each student's skill level and learning objectives. An example is music for band with body percussion as analyzed by Salvatore di Russo (Di Russo et al., 2021, 2022, 2023, 2024a, 2024b.).

4. Motion analysis and biomechanics:

AI, in combination with motion capture technologies, can accurately analyze body movements during neuromotricity and body percussion performance. This would allow identifying efficient movement patterns, detecting possible muscle imbalances or technical errors, and providing recommendations to improve technique, prevent injuries and optimize performance (Alonso-Marco & Romero-Naranjo, 2022; Morales-Martín et al., 2024). This information would be of great value to both students and professionals of body percussion.

5. Personalization of teaching:

AI can revolutionize the teaching of neuromotricity and body percussion by enabling the creation of intelligent tutoring systems that adapt to the needs and learning pace of each student. These systems can provide personalized feedback, adjust the difficulty of tasks based on student progress, and provide additional resources to address areas of difficulty. AI can also help identify learning patterns and teaching styles, making it easier to tailor instruction to individual preferences.

6. Algorithmic composition:

AI's ability to process and analyze large amounts of musical data can be harnessed to generate new neuromotricity and body percussion compositions. AI algorithms can learn from existing styles and rhythmic patterns, and then generate variations or completely new compositions, thus expanding the repertoire and creative possibilities of this discipline. This tool could be of great use to composers and performers alike, inspiring new forms of artistic expression.

7. Neuroscientific research:

Combining neuroimaging techniques, such as functional magnetic resonance imaging (fMRI) or electroencephalography (EEG), with AI analysis can provide a deeper understanding of how neuromotricity and body percussion affects the brain. AI can help identify patterns of brain activation associated with different rhythms and movements, as well as assess the long-term effects of body percussion practice on neural plasticity and cognitive function. These findings could have significant implications for the design of music- and movement-based therapeutic interventions.

8. Augmented and virtual reality:

AI can enrich the learning and performance experience in neuromotricity and body percussion by creating augmented reality (AR) or virtual reality (VR) environments. These environments can provide real-time visual and auditory feedback, overlay information about technique and rhythm, and enable collaboration and interaction with other percussionists in shared virtual spaces. AI can also be used to generate virtual avatars that mimic the user's movements, offering a new dimension for artistic expression and performance.

All things considered, AI presents itself as a catalyst for innovation and progress in the field of body percussion. Its ability to recognize patterns, analyze movements, generate adaptive music, and create immersive experiences offers transformative potential for teaching, research, and artistic practice. However, it is crucial to address the ethical and technical challenges associated with its implementation, ensuring responsible and beneficial use of this technology. Collaboration between AI experts, percussionists, educators, and researchers is essential to take full advantage of the opportunities that AI offers and build a future in which technology and human creativity are harmoniously intertwined in the exciting world of body percussion.

Importantly, these potential applications also pose ethical and practical challenges that must be considered. For example, preserving cultural authenticity, protecting the privacy of biometric data, and ensuring equitable accessibility to these technologies are crucial aspects to consider.

In conclusion, the intersection between body percussion and artificial intelligence offers fertile ground for innovation and interdisciplinary research. As these technologies continue to evolve, we are likely to see a significant transformation in the practice, teaching, and understanding of body percussion, with potentially profound implications for music education, therapy (Romero-Naranjo & Romero-Naranjo, 2024), and the performing arts.

The contribution of the main IAs (CHATGPT, GEMINI, CLAUDE).

In relation to the application of body percussion in ChatGPT, Claude, Copy, DeepSeek, Grok, Qwen and Gemini we observe that they provide completely imprecise data, inventing authors, inventing academic bibliography and elaborating meaningless texts. In fact, when we put the same search criteria in CHATHUB we can clearly see the differences of each of them. The only one more reliable to date without the need for so much training is Gemini.

In what aspects should IA be trained in order to obtain a good academic performance? Below, we propose five specific points that may be expandable in the future.

1. Objective assessment and accurate feedback: AI, thanks to its ability to process and analyze large volumes of data, can assess performance in body percussion objectively, identifying rhythmic, dynamic, and postural subtleties that might go unnoticed by the human eye. This would provide accurate and detailed feedback to students, facilitating the identification of areas for improvement and optimization of technique.
2. Inclusion and accessibility: The development of AI-based human-machine interfaces (HMIs) that translate body movements into sounds and rhythms could democratize access to body percussion, enabling the participation of people with functional diversity. AI could be tailored to individual needs, offering personalized control and expression options, and opening up new therapeutic and educational possibilities.
3. Cognitive stimulation and personalized learning: AI can design and adapt body percussion activities that challenge and stimulate the brain's executive functions, such as attention, working memory and cognitive flexibility. In addition, by analyzing individual learning patterns, AI can personalize instruction, adjusting the difficulty of tasks and providing specific feedback to optimize the learning process.
4. Injury prevention and performance optimization: AI, in combination with motion capture technologies, can analyze the biomechanics of body percussion, identifying inefficient or potentially injurious movement patterns. This information would allow the development of preventive and corrective strategies, improving the health and well-being of percussionists, and optimizing their long-term performance.
5. Advanced neuroscience research: AI can enhance neuromotor research by enabling massive analysis of neurophysiological and behavioral data. This would facilitate the identification of correlations between patterns of brain activity, motor performance and emotional responses, deepening the understanding of the neural mechanisms underlying body percussion and its effects on cognition, emotion and health.

Reflection on the ethical and social implications of AI in neuromotoricity.

The use of artificial intelligence combined with body percussion entails a reflection on its ethical and social implications. First of all, it brings with it challenges in the field of education that can be summarized in the following five points:

1. Costs and Access: The implementation of AI technologies can be costly, which could limit their access to institutions and students with limited resources.
2. Digital Divide: Lack of access to the Internet and technological devices can exclude students from marginalized communities from the benefits of AI in education.
3. Data Privacy and Security: The use of AI in education involves the collection and analysis of large amounts of students' personal data, raising concerns about privacy and data security.
4. Algorithmic Bias and Discrimination: AI algorithms may perpetuate or even amplify existing biases in training data, which could result in discrimination and inequality in access to educational opportunities.
5. Dehumanization of Education: Over-reliance on AI in education could reduce human interaction and the importance of interpersonal relationships in the learning process.

- Challenges and concerns

Despite its potential, the implementation of AI in body percussion is not without its challenges. Accurate interpretation of AI-generated responses may require expertise in kinesiology and biomechanics, underscoring the importance of interdisciplinary training. The potential for AI to generate biased or inaccurate information

based on incomplete or biased training data raises a legitimate concern. In addition, the use of AI raises ethical questions regarding data privacy and possible overreliance on this technology to the detriment of critical thinking and human creativity.

- Ethical considerations

The responsible integration of AI into body percussion requires deep ethical reflection. It is essential to educate users about the capabilities and limitations of AI, encouraging a critical and reflective approach. Transparency in the use of AI, informing students about its use in the teaching-learning process, is essential to build trust and avoid misunderstandings. Adopting a "healthy skepticism" towards the answers generated by AI, contrasting them with other sources of information and one's own expert knowledge, is crucial to ensure a responsible and ethical use of this tool. Despite its enormous potential, the implementation of AI in body percussion and the BAPNE method raises challenges and concerns that must be addressed responsibly and ethically:

- Accurate interpretation of AI responses: proper understanding of AI-generated responses requires expertise in body percussion, BAPNE glossary, motor learning, biomechanics, and pedagogy (Romero-Naranjo & Llorca-Garnero, 2023). Continuing education of teachers and students is essential to take full advantage of this technology and avoid misinterpretations.

- Possibility of biased or inaccurate information: AI may generate answers based on incomplete, outdated or biased training data. It is crucial to contrast the information provided by AI with other reliable sources, one's own expert knowledge and practical experience.

- Data privacy: The use of AI involves the collection and analysis of data on learner performance, characteristics, and preferences. It is essential to ensure privacy protection, informed consent and ethical use of this data, complying with current regulations and respecting the rights of individuals.

- Over-reliance on technology: While AI can be a valuable tool to enrich the teaching and learning of body percussion, it is important to avoid over-reliance on this technology. Critical thinking, creativity, human interaction, and direct sensory experience remain fundamental elements in skill development and artistic expression.

- Digital divide: Access to technology and Internet connectivity can be barriers for some students, creating a digital divide that limits their ability to benefit from AI applications in body percussion. It is important to seek solutions that promote equity and inclusion, ensuring that all students have the opportunity to access these tools and resources.

Conclusions and future prospects

AI looms as a powerful resource to drive innovation and efficiency in body percussion. However, its implementation must be accompanied by a strong background in prompts engineering, a thorough understanding of its limitations, and an unwavering commitment to ethics and transparency. Continued research in this field is essential to fully explore the applications of AI in body percussion, develop strategies to maximize its benefits and minimize its risks, and ensure that this technology is used responsibly and for the benefit of the educational and professional community. AI should not be seen as a substitute for human knowledge, but as a complement that enhances our capabilities and allows us to reach new frontiers in the teaching, research and practice of body percussion. Neuromotricity and Body percussion, a form of artistic expression that transforms the body into a musical instrument, has undergone a revolution thanks to the integration of artificial intelligence (AI). In particular, the BAPNE method, a cognitive stimulation method based on neuromotricity using body percussion, has found in AI a powerful ally to take teaching and learning to new dimensions of depth, personalization and precision. The BAPNE research group has more than sixty publications in Web of Science thanks to its group of more than ninety researchers. (Figure 1).

In this context, prompt engineering emerges as a fundamental discipline to take full advantage of AI's potential, enabling users to communicate effectively with the machine and obtain relevant and meaningful results.

Prompt engineering is much more than simply asking AI questions. It is an art that involves understanding the capabilities and limitations of the technology, as well as designing clear, precise, and well-structured instructions that guide the AI toward generating useful and relevant responses. In the context of body percussion and the BAPNE method, prompt engineering becomes an essential tool for:

- Specifying the context: providing the AI with detailed information about the learner's skill level, learning objectives, the body percussion style being explored, and other relevant aspects ensures that the generated responses are relevant and tailored to individual needs.

- Define the task: Clarity in describing the task the AI is expected to perform is crucial. Whether it is generating rhythmic exercises, analyzing an audio or video recording, providing feedback, or any other function, a precise definition of the task allows the AI to focus its capabilities effectively.

- Establish evaluation criteria: Communicating to the AI the specific criteria that will be used to evaluate the student's performance, such as rhythmic accuracy, sound quality, body posture, and musical interpretation, ensures that the feedback provided is relevant and constructive.

- Use clear and concise language: Avoiding ambiguity and using language that the AI can easily understand is critical for optimal results. Prompt engineering involves carefully choosing the words and structure of

instructions to minimize the chances of misunderstanding.

- Iterate and refine: Prompt engineering is an iterative process. As you interact with the AI and observe the results, you can refine the prompts to improve the quality and relevance of the responses generated.

Applications of AI in the academic teaching of Body Percussion.

AI, powered by prompts engineering, offers a wide range of applications in higher education body percussion, transforming the way teachers teach and students learn:

Creation of customized course materials: AI can generate a variety of educational resources tailored to the individual needs of each student, including:

- Progressive rhythmic exercises that challenge and motivate students as they progress in their learning.
- Rhythmic sequences that explore different styles of body percussion, from flamenco and African music to beat box and contemporary percussion.
- Interactive scores that allow students to visualize and practice complex rhythmic patterns using BAPNE notation.
- High-quality audio and video recordings to serve as reference models and sources of inspiration for students.

Designing formative and summative assessments: AI can create assessments that accurately and objectively measure students' progress in different aspects of body percussion, including:

- Performance of rhythmic patterns: AI can assess rhythmic accuracy, tempo consistency, and performance fluency.

- Understanding of BAPNE glossary: AI can assess students' ability to read, write, and interpret sheet music using BAPNE notation.

- Application of specific techniques: The AI can assess the correct execution of body percussion techniques such as clapping, snapping, chest thumping, and others by analyzing sound quality, body posture, and coordination of movements.

- Musical interpretation: The IA can evaluate the students' ability to express emotions and convey a message through body percussion, considering aspects such as dynamics, articulation and expressiveness.

Individualized feedback: The AI can provide detailed, personalized feedback to students by analyzing audio or video recordings of their performances and offering specific suggestions for improvement in areas such as:

- Rhythmic accuracy: AI can identify specific rhythmic errors and suggest exercises to correct them.
- Sound quality: The AI can analyze the clarity, volume and projection of the sound produced by students, offering advice on optimizing technique and body posture.
- Body posture: The AI can evaluate body alignment, muscle relaxation and movement efficiency, suggesting adjustments to improve ergonomics and prevent injuries.
- Music performance: AI can offer suggestions to improve expressiveness, dynamics and musical communication through body percussion.
- Complex data analysis: AI can process large amounts of data on student performance, identifying patterns, trends, and areas for improvement that allow teachers to tailor their instruction in more effective and personalized ways.

- Comprehensive literature review: AI can help researchers keep up with the latest developments in body percussion pedagogy and the BAPNE method by facilitating the search, analysis, and synthesis of relevant publications in different languages and formats.

- Identification of new areas of research: AI can discover connections and relationships between different concepts, techniques and styles of body percussion, opening new avenues for research and innovation in this artistic discipline.

To conclude we consider it important to highlight the promotion of accessibility and inclusion: AI can provide tools and resources that enable students with special educational needs to fully participate in learning body percussion. Some of these tools include:

- Adaptation of course materials: AI can generate exercises and rhythmic sequences that are tailored to the capabilities and needs of each student, offering options for difficulty and complexity.
- Automatic captioning and real-time translation: AI can facilitate the comprehension of verbal instructions and audio or video materials for hearing impaired students.
- Gesture and movement recognition: AI can interpret students' body movements and provide visual or auditory feedback, which can be especially useful for visually impaired students.
- Adaptive user interfaces: AI can customize the interface of educational applications and platforms to facilitate their use by students with different needs and preferences.

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