PROPRIOCEPTION IN PHYSICAL EDUCATION: A PRACTICAL APPROACH BETWEEN ICT AND TRAINING

PROPRIOCETTIVITÀ NELL'EDUCAZIONE FISICA: UN APPROCCIO PRATICO TRA TIC E ALLENAMENTO

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ABSTRACT

In an educational context where physical sciences are integrated into online training, this work explores Information and Communication Technologies (ICT) to enhance learning through the stimulation of proprioception in the training of future online teachers to feel in movement. The study, a Delphi investigation, evaluated how to develop bodily movement sensitivity in students according to the Sincrony model.

In un contesto educativo ove le scienze fisiche sono integrate nella formazione online, questo lavoro esplora le Tecnologie dell'Informazione e della Comunicazione (ICT) per migliorare l'apprendimento attraverso la stimolazione della propriocezione nella formazione dei futuri insegnanti online per *sentirsi* nel movimento. Lo studio, indagine Delphi, ha valutato come sviluppare la sensibilità al movimento corporeo in studenti secondo il modello Sincrony.

KEYWORDS
Information and Communication Technologies, proprioception, teacher training, physical sciences, body awareness.
Tecnologie dell'informazione-comunicazione, propriocezione, formazione degli insegnanti, scienze fisiche, consapevolezza del corpo

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[1] In the collaborative authorship of this work, Ambretti and Fogliata jointly contributed to the conception and literature review. Although their contribution was a joint effort, Ambretti served as the scientific coordinator and supervised the introduction and discussion sections, while Fogliata was primarily responsible for the methodological aspects. Tardini focused on data analysis, and Desideri concentrated on the conclusions references.

Introduction

In the digital age, the integration of Information and Communication Technologies (ICT) in education represents an emerging paradigm, with a particularly significant impact in the field of physical education. The potential of ICT to transform teaching and learning is recognized across various disciplines, sparking interest in the current debate concerning new educational tools (Kirk et al., 2018). This trend also extends to the training of physical education teachers, where the adoption of ICT-based approaches could present new opportunities to enrich motor learning and, specifically, proprioception, an interoceptive sense crucial for self-perception and interaction with the surrounding environment (Shumway-Cook & Woollacott, 2012). Proprioception, defined as the ability to be aware of the body and the movement of body parts in space, is fundamental for the execution, learning, and control of both everyday and technical-sporting movements, influencing balance, coordination, and consequently athletic performance (Proske & Gandevia, 2012). Its importance in physical education is therefore undeniable for various reasons and applications, suggesting that teaching methodologies that facilitate its development and understanding in future motor educators could be of great relevance. Moreover, body awareness is essential to improve the learning capabilities of gestures, hence the ability to teach them (Bastin et al., 2006). If well-directed, targeted ICT integration in motor teacher training could open new possibilities to enrich the educational experience, allowing students to explore and learn also through more practical-body arguments, which are not stalled at the theoretical level but are also expressed at a sensible and applicative level. This exploratory study aims to assess how and if this specific form of ICT can enhance teacher training, developing in them a greater predisposition to proprioceptivity that could lead to an increased sensitivity of the subtle dynamics of body movement, and providing useful tools for transferring such skills to students. This vision, in line with the educational models of Synchrony movement (De Bernardi, 2008) and embodied cognition, which highlight how our cognition is deeply rooted in the experiences of our body in the physical world (Shapiro, 2018), could improve the online learning of motor sciences. The importance of learning that integrates both theory and practice is further supported by Ribeiro and Oliveira (2011), who state that physical education should embrace practical learning to meaningfully connect scientific disciplines with practice. Using technology as a tool to stimulate not only theoretical knowledge through lectures but also the proprioceptive bodily experience, we might be able to make specific online lessons more dynamic and applicable, offering students a more comprehensive understanding of movement. A deep understanding of body movement should indeed be a primary educational goal for every future physical education teacher. Research has also shown that, for practical disciplines, simple imitation of observed movements does not guarantee effective learning of the movement itself. Experimental studies conducted by Bläsing et al. (2012) highlight how the visual perception of movement can differ significantly from the reality of the motor processes involved, emphasizing the complexity of transmitting motor skills through mere observation. Furthermore, the research by Calvo-Merino et al. (2005) deepens this issue by exploring the neural bases of movement observation and imitation. The study demonstrated that simply viewing an action activates areas of the brain involved in planning and executing the movement; however, this simulation can be limited by the motor experience of the individual and the knowledge of the observed movement, implying that the perception of an action can be significantly influenced by subjective factors and the motor competence of the person. These findings underline the importance of integrating teaching methods that go beyond simple visual imitation, promoting learning that involves understanding and direct experience of the movement. The approach proposed by Sigrist et al. (2013) on feedback-augmentation in motor activities provides an example of how technologies can support this process. Through the use of visual, auditory, or tactile feedback that complements the motor experience, learners can acquire greater awareness of the dynamics of movement, facilitating the learning and memorization of motor skills. A key study by Mattar & Gribble (2005) explored the distinction between procedural knowledge and visible outcomes of action, showing that visual perception of movement is not always a reliable indicator of the underlying mechanisms that guide the action. These results suggest that motor learning based exclusively on observation can lead to a superficial understanding of movement, limited by the individual's ability to correctly interpret what is seen. To these considerations must be added that proprioception plays a fundamental role in learning and perfecting motor skills. Without adequate proprioception, it is extremely difficult for individuals to perform complex movements or regulate the force and coordination needed for specific motor tasks, and therefore to teach or understand them. Research by Proske and Gandevia (2012) has indeed emphasized that proprioception itself is crucial for regulating voluntary movements as well as for motor learning, providing essential feedback that contributes to the refinement of motor performances and executive understanding. The importance of proprioception in motor learning is further reinforced when we consider that learning based exclusively on observation may be insufficient. Shadmehr and Krakauer (2008) discussed how motor memory and the motor learning process are based not only on replicating observed movements but also on internal adaptation to the body's sensory responses, including proprioception. This adaptation process is essential for refining motor skills and developing an intuitive sense of movement that goes beyond mere imitation. Similarly, Diersch et al. (2013) highlighted how visual perception can be influenced by a range of subjective factors, including previous motor experiences and individual expectations, which can distort the understanding of observed movement. These studies suggest that mere observation of a movement can lead to erroneous or incomplete interpretations of actions, underscoring the need to integrate visual learning with other forms of sensory feedback. In this innovative educational scenario, the main goal of the authors was to explore and define which features Information and Communication Technologies (ICT) should possess to be effective in facilitating the teaching and learning of proprioception. In particular, it was sought to understand how these technologies could overcome the limitations of learning based exclusively on visual inputs, and how they could be evaluated by students and professionals in the field as relevant tools in the educational process. To achieve these goals, a study was undertaken in two distinct phases: the first involved a group of motor science teachers, while the second involved a group of students. Both phases were structured to collect data on opinions and needs. Specifically, the adopted approach aimed to identify the specific educational needs of the physical education sector, assessing how technologies could effectively be perceived to meet these needs in both theoretical and practical contexts. The results of this survey allowed to outline in detail the educational needs and perceptions related to the use of technologies in online learning. Through the analysis of the information collected, it was possible to contribute to the design of a conceptual prototype for future applications of ICT in the field, outlining guidelines for the development of innovative educational tools that effectively integrate proprioception and new technologies in physical education.

Materials and Methods

Sixty subjects were recruited and divided into two distinct groups: physical education teachers and motor sciences students. These participants were selected to provide a comparative view between the perceptions of education professionals and those of apprentices regarding the use of ICT for learning proprioception. All subjects responded to quantitative questions in an anonymous questionnaire, which differed between the two groups. The only identical question in both groups was as follows:

How could the use of proprioceptive training be defined to facilitate practical learning in motor sciences courses, particularly in subjects more related to movement? The response options were structured on a Likert scale, using terms such as: "strongly agree", "agree", "neutral", "disagree", and "strongly disagree". All participants unanimously expressed "strongly agree" on the issue posed, demonstrating strong cross-sectional consensus regardless of their varied experiences and personal characteristics.

- Group 1: Physical Education Teachers

Participant Selection: For this study, 30 physical education teachers were selected through email invitations, using contact lists provided by sports professional associations and educational institutions. This recruitment methodology was chosen to ensure that participants had significant experience in teaching physical education, essential for an informed evaluation on the use of Information and Communication Technologies (ICT) in educational settings, as discussed by Kirk (2018).

Inclusion Criteria: Participants were required to have at least three years of experience teaching physical education in school or university settings to ensure a deep understanding of the challenges and opportunities associated with teaching proprioception, crucial for the effective integration of ICT according to Tondeur (2018).

Participant Demographics: The selected teachers had an average age of 38 years and came from a variety of educational backgrounds, including online and face-to-face courses, demonstrating a wide range of teaching experiences and skills. This diversity contributed to the richness of the data collected, allowing for an overall assessment of the effectiveness of the teaching practices employed.

This methodological approach ensured that all participants were adequately qualified to provide informed feedback, and no questionnaire was excluded from the analysis.

- Group 2: Students

Number of Participants: This study included 30 university students.

Recruitment Method: Participants were recruited using a combination of broad invitations through social platforms and direct invitations transmitted through teachers and school collaborators. This mixed approach allowed for reaching a broad sample of students actively engaged in physical education courses, increasing the likelihood of selecting motivated and interested candidates.

Inclusion Criteria: The inclusion criteria for students required an age range of 21 to 25 years and active enrollment in physical education courses at specialized schools or universities. These criteria were set to ensure that the participants had an adequate baseline experience and a uniform level of knowledge related to the field of study, as suggested by previous literature (Jones, 2011).

Participant Demographics: The students selected for this group had an average age of 23 years, reflecting the typical demographic of enrollees in physical education degree courses. This age and academic context homogeneity is essential to ensure that baseline variables are controlled, allowing for a more precise analysis of the impact of the educational interventions studied. In this sample, 8 questionnaires were discarded and not analyzed due to the lack of actual enrollment in a motor sciences degree course.

Materials

Data was collected using specific anonymous questionnaires, created and distributed via Google Forms to facilitate remote access and participation. This data collection methodology is widely used in educational research for its efficiency and low cost, as well as the ability to reach a broad sample of participants in different locations (Couper, 2013). The questionnaires were created with different questions for the teacher and student groups.

- Questionnaire Development Methodology

Phase 1: Identification of Key Themes

Focused interviews were conducted with a selected group of representatives from each category (5 teachers and 5 students) to identify key themes influencing their educational experience. The transcriptions of the interviews were subjected to thematic analysis to extract relevant topics. None of the interviewees were invited to participate in the experiment.

Phase 2: Development of Questions

Based on the information gathered, a preliminary set of questions was developed. The questions for teachers investigated teaching methodologies, learning assessment, and interactions with students. Meanwhile, those for students focused on the perception of teaching quality, active participation, and academic support.

Phase 3: Content Validation

Drafts of the questionnaires were reviewed by a panel of experts (3 statisticians, 3 experts in educational research methodologies) to ensure content validity and the relevance of the questions. The feedback collected guided the necessary modifications to refine the questions.

Phase 4: Pre-test of Questionnaires

Before their final administration, the questionnaires were pre-tested on a sample of 30 individuals (15 for each group) to verify the clarity and absence of ambiguity in the questions. The feedback obtained allowed for further adjustments. No participant in this phase was invited to participate in the experimental session.

Additionally, Likert scales and multiple-choice questions from the questionnaires are standardized tools for collecting quantitative data in psychological and social fields. The Likert scale, in particular, was used to assess the attitudes, perceptions, and opinions of participants on a series of statements, allowing them to express their degree of agreement or disagreement (Likert, 1932). Multiple-choice questions were designed to offer fixed options among which participants could choose, simplifying the collection and analysis of data.

Questions numeber one.

Question	Type of Question	Response Options
1. How many years of experience do you have in teaching physical education?	Multiple Choice	0-2 years, 3-5 years, 6-10 years, more than 10 years
2. How confident are you in using ICT in educational contexts?	Likert Scale	1 (not at all) to 5 (very confident)
3. Could ICT be useful for teaching proprioception in online courses?	Multiple Choice	Only if well-designed, I don't know, No, must work on the field
4. To what extent?	Likert Scale	1 (not at all) to 5 (very much)
5. How important do you think proprioception is for teachers?	Likert Scale	1 (not at all) to 5 (very much)

Table 1 - Questionnaire for Group 1 (Physical Education Teachers)

Questions numeber two.

Question	Type of Question	Response Options

1. How familiar are you with the use of ICT in educational contexts?	Likert Scale	1 (not at all) to 5 (very familiar)
2. Would you find it useful to learn proprioception concepts and also try them online?	Multiple Choice	Yes, No, Not possible
3. How much do you think it could help you in learning proprioception as an instructor?	Likert Scale	1 (not at all) to 5 (very much)
4. Do you find ICT effective in helping you understand proprioception?	Likert Scale	1 (not at all effective) to 5 (very effective)
5. Would you prefer a learning approach that also includes proprioception?	Multiple Choice	Yes, No, Not sure

Table 2 - Questionnaire for Group 2 (Students)

Data Analysis

The analysis of the data, as per the questionnaires, focused on exploring the perceptions of teachers and students, first separately.

Descriptive Statistics

For both groups, the averages of the responses provided to the questions on a Likert scale from 1 to 5 were calculated, where 1 indicates "not at all" and 5 "very much." Additionally, for the multiple-choice questions, the percentages of responses were calculated.

- Group 1 - Physical Education Teachers

The average confidence in using ICT was 3.1, indicating moderate confidence in the use of technologies in educational settings.

About 60% of the teachers responded that ICT "could be useful only if well studied" for teaching proprioception online, suggesting caution in adopting such tools without a clear implementation strategy.

The importance of proprioception in teaching was rated high, with an average of 4.2.

- Group 2 - Students

The familiarity with ICT showed an average of 3.5, suggesting a general comfort with the use of technologies.

About 67% of the students indicated that it would be useful to learn concepts of proprioception and also try them online, showing an openness to the digital approach to learning.

The assessment of the effectiveness of ICT in helping to understand proprioception received an average of 3.3, reflecting moderate optimism about the usefulness of such tools.

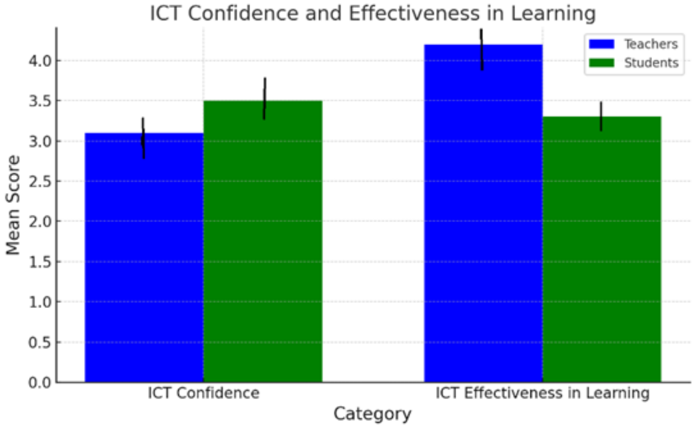
Comparative analyses were conducted using SPSS software.

- ANOVA Analysis

The Analysis of Variance (ANOVA) conducted to examine the effect of years of experience on the use and perception of ICT yielded an F value of 2.375 and a p-value of 0.093. This result indicates that there is no statistically significant difference in confidence in using ICT among different groups of teachers divided by years of experience, at the conventional 5% significance level. However, the p-value suggests a trend that may warrant further investigation with a larger sample or with the addition of other factors that might influence the perception of ICT. This result suggests that, regardless of years of experience, the confidence in using ICT among teachers remains relatively homogeneous, indicating that factors other than experience might play a more significant role in determining confidence in using ICT.

- Post-hoc Analysis

The independent samples t-test revealed that there is no statistically significant difference in the importance attributed to proprioception between teachers ($M = 4.2$, $SD = 0.83$) and students ($M = 3.3$, $SD = 0.96$); $t(58) = 1.22$, $p > 0.05$. This result suggests that, despite differences in the evaluation of the effectiveness of ICT, teachers and students agree on the fundamental importance of proprioception in physical education.



Graphic 1- Group 1 & 2 in using ICT.

Discussion

The analysis of the questionnaires reveals aspects of the perceptions of teachers and students regarding the use of Information and Communication Technologies (ICT) for learning and teaching proprioception in online contexts. The moderate confidence in the use of ICT by physical education teachers (average of 3.1) coupled with their caution in adopting these tools without a clear implementation strategy (60% agreeing that ICT should be "well studied") raises important questions about preparedness and attitudes towards technological integration in the educational curriculum. This contrasts slightly with a higher evaluation of the importance of proprioception (average of 4.2), suggesting an awareness of the value of proprioceptive learning but a certain reluctance towards the means for its remote teaching. On the other hand, the perception of students shows greater openness, with general familiarity with ICT (average of 3.5) and moderate optimism towards their effectiveness in learning proprioception (average of 3.3). This misalignment between the perceptions of teachers and students highlights a potential gap between educational expectations and the reality of technological integration, raising areas of study on the need for more targeted teacher training strategies and an open dialogue on educational technology. Significantly, the Student's t-test result revealed no statistically significant differences in the attribution of the importance of proprioception between teachers and students, indicating a common basis of recognition of its value in physical education. However, the significant positive correlation between familiarity with ICT and its evaluation by students, unlike teachers, underscores how prior experience and exposure to technology can positively influence the perception of its utility. This suggests that the integration of ICT in educational settings might benefit from an incremental approach that builds on existing familiarity and explores concerns and potential resistances from the teaching staff. The absence of statistically significant differences in confidence in using ICT among teachers with different years of experience, while indicating a trend, raises questions about the role of experience in shaping technological perceptions. This could imply that barriers to the adoption of ICT are less about familiarity with technology and more about attitudes, beliefs, and potentially, institutional accessibility or support.

Conclusions

The analyses provide a snapshot of the complex dynamics characterizing the integration of ICT in teaching proprioception in physical education. The results suggest that, despite a general openness towards the use of technologies, there are substantial issues related to confidence, preparedness, and the perception of their educational value. Emerging methodologies like Synchrony highlight the need for targeted strategies for support and training of teachers even in practice. The adoption of ICT in physical education, particularly for learning proprioception, which is a cornerstone of physical experience that goes beyond the principle of motor imitation, represents a fertile field of inquiry that requires ongoing dialogue between research, pedagogical practice, and educational policies.

Ethics and Transparency

This study was conducted in full respect of ethical principles, ensuring compliance with privacy regulations and informed consent. No external funds were used, and there are no conflicts of interest related to the conduct of this research.

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