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SUMARIO / SUMMARY / RESUMO

Editorial

In this new issue 2, 2024, of the MLS Sport Research journal, four new papers are presented, of a multidisciplinary nature, in this case, one focused on the field of sports rehabilitation, another study, which, in the same professional field, incorporates gamification within the teaching and learning processes in physiotherapy students. Thirdly, and also in the university teaching field, another research attempts to analyze the media use behaviors of students in physical activity and health sciences, and finally, a fourth work of validation of a curricular analysis instrument in the context of the theory and methodology of sports training. These four investigations strengthen the open vocation of the MLS Sport Research journal to the different scientific areas that make up the sports sciences, from education, sports performance and health, related to physical activity.

With this new issue, the MLS Sport Research journal maintains its commitment to consolidate this publication as a scientific resource for the multidisciplinary study of physical activity and sport, and invites researchers to send us their studies and papers for the next issue.

Dr. Pedro Ángel Latorre Román
Dr. Álvaro Velarde Sotres
Editors in Chief

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PLAY TO LEARN: HOW GAMIFICATION IMPROVES THE EVALUATION IN PHYSIOTHERAPY STUDENTS

JUEGA PARA APRENDER: CÓMO LA GAMIFICACIÓN MEJORA EL PROCESO DE EVALUACIÓN EN ESTUDIANTES DE FISIOTERAPIA

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gamification, evaluation in physiotherapy, knowledge transfer.

ABSTRACT

The objective of the present study is to define the effectiveness of gamification in the evaluation process within the Physiotherapy career of the Universidad Técnica Particular de Loja (UTPL), for its development the final academic performance was compared in a control group and a group experimental, in order to determine the contribution of gamification in the fixation of knowledge and its implementation, the methodological approach used in the development of this research was based on a combination of quantitative research of descriptive scope and quasi-experimental design , the research consisted of two parts: one of a bibliographic nature and another of a qualitative nature. The students were randomly assigned to one of two groups: an experimental group that was evaluated within their training process using gamification and a control group that received training using traditional methods. Both educational programs lasted 16 weeks. To evaluate the theoretical-practical transfer, the Physiotherapy competency matrix was applied, which included both theoretical and practical sections. The results of the knowledge questionnaire showed that the students in the experimental group achieved significantly higher scores than their peers in the control group, evidencing that the use of gamification as a teaching strategy in the evaluation process in the Physiotherapy degree can be more effective than traditional educational methodologies in terms of theoretical-practical transfer.

Palabras clave:
gamgamificación, evaluación en fisioterapia, transferencia de conocimiento.ification, evaluation in physiotherapy, knowledge transfer.

RESUMEN

El objetivo del presente estudio es definir la efectividad de la gamificación en el proceso de evaluación dentro de la carrera de Fisioterapia de la Universidad Técnica Particular de Loja (UTPL), para su desarrollo se comparó el rendimiento académico final en un grupo control y un grupo experimental, con el fin de determinar el aporte de la gamificación en la fijación del conocimiento y su puesta en práctica, el enfoque metodológico utilizado en el desarrollo de la presente investigación, se basó en una combinación de investigación cuantitativa de alcance descriptivo y diseño cuasi experimental, la

	investigación constó de dos partes: una de carácter bibliográfico y otra de carácter cualitativo. Los estudiantes fueron asignados aleatoriamente a uno de dos grupos: un grupo experimental que dentro de su proceso de formación fue evaluado empleando la gamificación y un grupo control que recibió una formación empleando métodos tradicionales. Ambos programas educativos tuvieron una duración de 16 semanas. Para evaluar la transferencia teórico-práctica, se aplicó la matriz de competencias de Fisioterapia, la cual incluyó tanto apartados teóricos como prácticos. Los resultados del cuestionario de conocimientos demostraron que los estudiantes del grupo experimental alcanzaron puntajes significativamente más elevados que sus pares en el grupo de control, evidenciando que el uso de la gamificación como estrategia de enseñanza en el proceso de evaluacion en la carrera de Fisioterapia puede resultar más efectivo que las metodologías educativas tradicionales en cuanto a la transferencia teórico-práctica se refiere.

Introduction

Gamification

Gamification, consists of the incorporation of game elements and mechanics in non-game contexts in order to make them more attractive and encourage the active participation of users, these principles of game design are applied to different areas, such as education, work, health and environment, among others, in the educational field, gamification is used to make learning more fun and effective, allowing the educator to incorporate game elements in their lessons, such as point systems and rewards, to motivate students and improve their academic performance (Pereira et al, 2020) .

Gamification in the Area of Health Sciences

Currently, one of the main challenges in the acquisition and transfer of knowledge in the health area is the lack of motivation and commitment of students, many times, students can feel overwhelmed by the amount of information presented, having difficulty maintaining attention and retaining information, in addition, the complex and detailed nature of information in the health sciences can be difficult to understand and apply in practice.

Therefore, there is a need to look for new teaching methodologies that are innovative and allow addressing these challenges, ensuring that students acquire solid knowledge that can be effectively applied in the future. A research that reinforces the importance of seeking new strategies in the teaching process is that of Ellis et al. (2016) where he presents a comprehensive study that delves into the benefits of gamification to improve learning and assessment of occupational therapy students in a university setting, the authors conducted extensive research and observed that gamification significantly improved student engagement and satisfaction.

The study described that gamification, properly employed, can help students develop a deeper understanding of complex concepts and theories. The use of game elements, such as challenges, rewards and leaderboards, can motivate students to actively participate in the learning process and develop critical thinking, problem solving and decision making skills in an environment that simulates a real space.

Theory-Practice Transfer Through Gamification as a Way to Promote Meaningful Learning

One of the goals of the university training process is that students develop competencies to apply the knowledge and skills acquired in one situation, to another different situation; that is, to transfer theory to practice, hence, in the professional training of physical therapy, the need for the methods and techniques applied to patients to enjoy not only the technique but also the theory, and through its integration can generate knowledge to improve their professional performance (Tamayo and Borrego, 2018).

This transfer can be of two types: vertical, when knowledge acquired in one teaching situation is applied to a similar practice situation; and horizontal, when knowledge acquired in one teaching situation is applied to a different practice situation (Ortiz et al., 2018).

Theoretical and Practical Transfer in Physiotherapy Students

Theoretical-practical transfer refers to the ability of university students to apply the theoretical knowledge acquired in practical situations and how this can help them in

the real world, the transfer can be of specific skills or general concepts (Michaelsen and Marek, 2018), for example, a Physiotherapy student can apply the theoretical concepts of biomechanics in clinical practice, or an engineering student can apply the theoretical principles of mechanics in the construction of a bridge.

There are several theories on knowledge transfer that have been applied in the field of Physiotherapy according to Lim and Kim (2017) among them, the following stand out:

- The theory of near transfer.
- The theory of distant transference.
- The theory of transfer from training to practice.
- The theory of transfer from practice to training.

In this context, the theories of knowledge transfer in Physiotherapy are an important tool to reflect on the methodological possibilities to generate significant learning, understand and improve the quality of education, the theoretical-practical transfer can be measured in various ways, such as performance evaluation in practical situations, the transfer of theoretical knowledge to practical situations can be influenced by several factors, such as the quality of the theoretical teaching, the relevance of the practices, the motivation and commitment of the student to practical learning (Pereira et al., 2020).

The practical application of theory in education can improve the quality of education and the transferability of theoretical knowledge to practice can be an important factor in this process. According to Michaelsen and Marek (2018), school and teaching internships allow students to apply learned theory in real situations and reflect on their experience, which can enhance their training and positive perceptions of their learning. In addition, Pereira et al. (2020) point out that knowledge transfer can be facilitated through critical reflection and the relationship between theory and practice.

What is Expected to Be Learned Through this Research on the Use of Gamification in the Assessment of Physical Therapy Students?

Through this research, we intend to explore the effectiveness of gamification in the evaluation of Physiotherapy students, specifically to determine the contribution of gamification in improving the transfer of theoretical knowledge to practical skills among students.

The study will focus on identifying the relevance of a gamification strategy and a traditional methodology by comparing their linkage using the Physiotherapy Competency Matrix, thus aiming to develop a framework for the integration of gamification in Physiotherapy education that can be replicated in other settings. This will allow a greater number of students to feel engaged and motivated to learn, which will result in better results not only for the students but also for the performance and relevance as a teacher.

Method

Design

This study used a quantitative methodological approach of descriptive scope with a quasi-experimental design to obtain objective and detailed data on the study phenomenon. The hypothesis put forward in this research developed within the Physiotherapy career at UTPL was: What is the impact of gamification in the process of

evaluation and theory-practice transfer in the development of professional competencies in Physiotherapy students?

Population

The research was based on an official list of students enrolled in the April-August 2023 school year, resulting in a study population of 52 heterogeneous individuals of different genders.

The research was developed within the Pathophysiology component and was divided into two groups: a control group with 26 randomly selected participants and an experimental group with 26 randomly selected participants.

According to Popper (2002) "it is a process of reasoning that starts from a general premise to reach a particular conclusion" (p. 34), in this case the performance of students in a traditional evaluation process versus a process based on the evaluation from gamification was observed in a general way to have a first approximation to the reality of the educational process in the context of the research.

Gamification Strategy to Be Used

The gamification strategy employed consisted in the use of challenges that the students had to face, for which a roadmap was provided, which had to be solved in order for the groups of participants to advance.

Objective: Encourage the active participation of students in the evaluation process through teamwork.

Clues: Ten clues were hidden in different locations around campus, each with a riddle for students to solve.

Group work: Solving the clues required collaborative work among students, fostering communication, cooperation and the exchange of ideas.

Points: Points were assigned for each correctly solved clue, creating a leaderboard with the score achieved.

Instruments

The present study used the competency assessment matrix in Physical Therapy by Quiroz et al. (2012) to assess and measure the competencies of their students in various areas. The matrix is based on a set of standards established by the program and regulatory bodies in Physical Therapy, and features a Likert scale ranging from "Not at all competent" to "Very competent".

The Physical Therapy competency assessment matrix covers a wide range of areas and subcategories, such as clinical assessment, clinical reasoning and therapeutic treatment. Students are evaluated on their ability to demonstrate knowledge and skills in each of these areas, and their level of proficiency is determined by their performance.

Procedure

To carry out the present study, the population was divided into two groups: an experimental and a control group, to evaluate the competencies to be developed, an identical evaluation model was used, in the first group, a traditional practical and written evaluation was applied, while, in the second group, gamification was used as the evaluation method.

To ensure the validity of the criteria within the assessment performed, the competency validation matrix of Quiroz et al. (2012) was used.

Figure 1

Matrix of professional competencies in Physical Therapy

ITEMS	Nothing competent	Poorly competent	Moderately competent	Competent	Very competent
Applies the biological foundations of human body movement as a basis for the analysis of motor activity and its pathokinetic implications, as well as the development of promotion, prevention, assistance and rehabilitation programs in the individual, family and community.					
Integrates the processes of motor control and learning as a basis for the diagnosis and physiotherapeutic approach to the individual, the family and the community in the different stages of the life cycle, taking into account the different areas of performance in the osteomuscular, neuromuscular, cardiopulmonary and vascular domains, and following the bioethical guidelines of the profession and evidence-based practice					
Examines, evaluates and diagnoses osteomuscular, neuromuscular, cardiopulmonary and vascular deficiencies and limitations, based on pathokinetic analysis and the theoretical foundations of human body movement, interacting in disciplinary teams.					
Selects and applies physical, kinetic, pneumatic and/or educational physiotherapeutic intervention modalities for the maintenance and optimization of motor skills, and the improvement of deficiencies and limitations in the osteomuscular, neuromuscular, cardiopulmonary and vascular domains, under bioethical principles, evidence-based practice and the theoretical foundations of the profession, interacting in disciplinary teams					
Designs, executes, directs and controls physiotherapeutic intervention programs necessary for health promotion, prevention, assistance and rehabilitation of human body movement disorders in individuals and communities, interacting in disciplinary teams.					
Plans, organizes, directs and manages services, projects and activities in Physiotherapy according to current legal regulations.					
Describes and argues the epistemological, methodological and conceptual components of the process of scientific knowledge production related to health and human body movement, from a critical and reflective perspective, to provide innovative, timely, effective and efficient professional solutions from the collection and analysis of information, scientific research and evidence-based practice.					

Note. Quiroz, et al. (2012, p.160)

Data Analysis

According to the results obtained in the study, it was demonstrated that the experimental group obtained significantly better results in all areas, except in communication, suggesting that the intervention applied was effective in improving the skills and competencies of the participants of the experimental group.

The differences in performance between the two groups were especially notable in areas such as planning, organization, management, scientific knowledge production and physiotherapeutic intervention. In fact, the experimental group outperformed the control group by a margin of 30% in these areas.

It is important to note that communication was the only area in which the experimental group did not perform better than the control group; however, their performance, although narrowly, was better. This could be due to several factors, such as

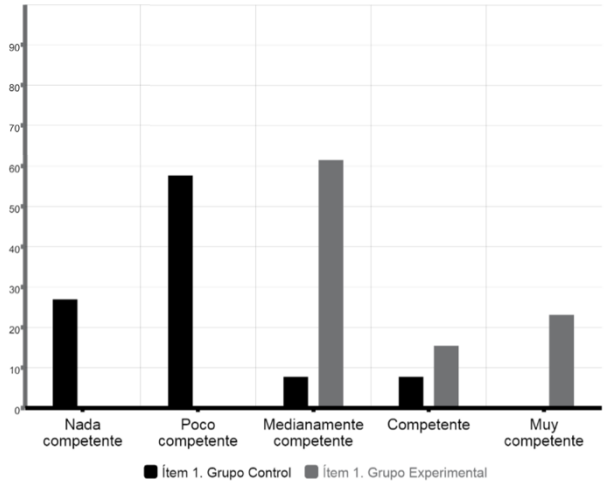
the fact that communication skills are often more difficult to teach and improve than other competencies.

These results suggest that the intervention carried out in the study succeeded in improving the skills and competencies of the participants in the experimental group, the results also highlight the importance of focusing on specific areas of competence when designing interventions aimed at improving performance and achieving specific goals.

Results

Figure 1

Item number one valued within the matrix of professional competencies of Physical Therapy.



Item one of the Physiotherapy professional competency matrix assesses the ability to apply the biological foundations of human body movement in four areas: analysis of motor activity, pathokinetic implications, promotion of motor activity, and prevention, assistance and rehabilitation.

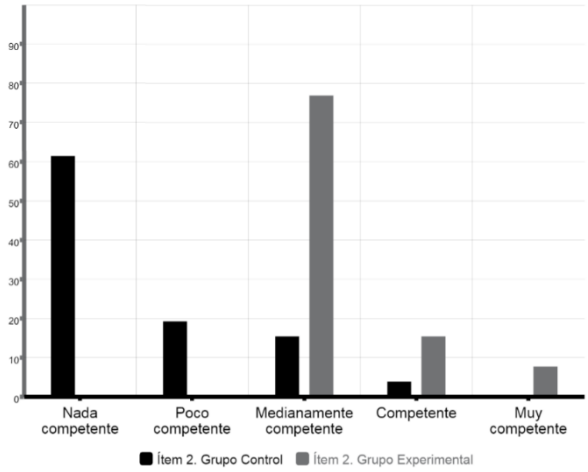
Differences

- An analysis of the aspects considered shows that the experimental group related movement alterations to different pathologies (20% more than the control group).
- Identifies risk factors predisposing to movement pathologies (30% more than the control group).
- It includes mechanisms for the prevention of movement pathologies (40% more than the control group).
- It presents better strategies to promote the regular practice of physical activity (20% more than the control group).
- The experimental group performs better than the control group in the application of the biological fundamentals of human body movement.

The intervention carried out with the experimental group has been effective in improving the knowledge and application of the biological foundations of human body movement.

Figure 2

Item number two valued within the matrix of professional competencies of Physical Therapy.



The second item assesses the ability to integrate motor control and learning processes as the foundation of the physiotherapeutic diagnosis and approach for individuals, families and communities at different stages of the life cycle, this assessment is crucial to determine the effectiveness of the intervention and the overall improvement of patient health outcomes.

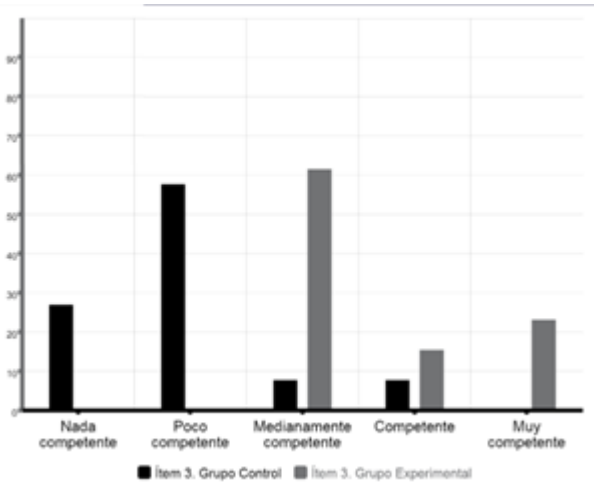
The graphical table presents that the experimental group performs significantly better in the integration of motor control and learning processes in all domains, including musculoskeletal, neuromuscular, cardiopulmonary and vascular, the results indicate the positive impact of the intervention in understanding the overall health and well-being of the patients.

Differences

- The experimental group shows a 40% reduction in the number of participants with no knowledge of the musculoskeletal domain.
- The experimental group has 10% more participants with basic knowledge and 10% more with intermediate knowledge.
- The experimental group presents 20% of participants with advanced knowledge, which is not observed in the control group.
- Differences similar to those in the musculoskeletal domain were observed, with better performance of the experimental group in all levels of knowledge.

Figure 3

Item number three assessed within the matrix of professional competencies of Physical Therapy.



The third item of the assessment measures the ability to examine, evaluate and diagnose musculoskeletal, neuromuscular, cardiopulmonary and vascular impairments and limitations. A comparison of the percentages between the control and experimental groups reveals significant differences in the ability to examine, evaluate and diagnose these conditions.

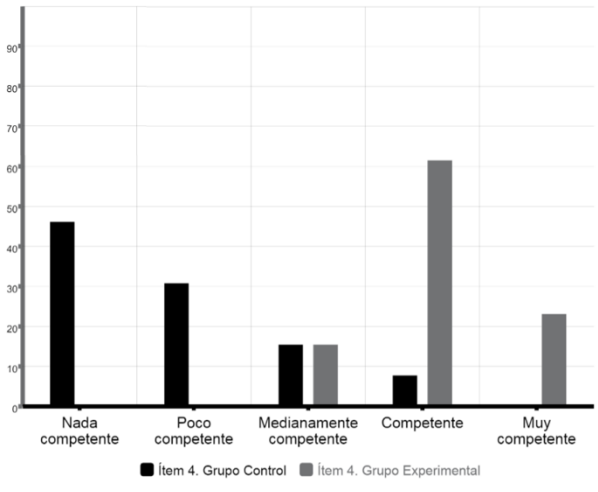
There was a 40% reduction in the number of participants who had no knowledge at all, and a 10% increase in each of the levels of knowledge: basic, intermediate and advanced. The presence of 20% of participants with advanced knowledge in the experimental group indicates the positive impact of the intervention.

Differences

- 40% reduction in the experimental group in the number of participants without knowledge.
- 10% increase in the experimental group in each of the levels of knowledge: basic, intermediate and advanced.
- Presence of 20% of participants with advanced knowledge in the experimental group.

Figure 4

Item number four assessed within the matrix of professional competencies of Physical Therapy.



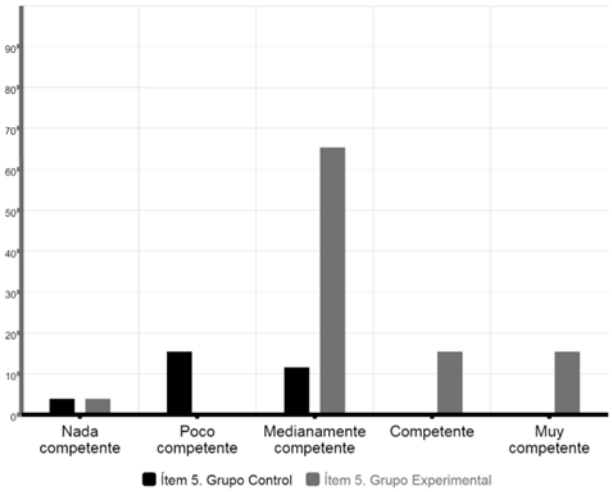
Item 4 assesses the ability to select and apply physical, kinetic, pneumatic and/or educational physiotherapeutic intervention modalities for the maintenance and optimization of motor skills, and the improvement of deficiencies and limitations in the musculoskeletal, neuromuscular, cardiopulmonary and vascular domains. The experimental group performs better than the control group in the selection and application of physiotherapeutic intervention modalities in all domains; the difference in performance between the two groups is greater in the musculoskeletal and neuromuscular domains.

Differences

- 30% reduction in the experimental group in the number of participants who do not apply intervention modalities.
- 10% increase in the experimental group in the application of intermediate intervention modalities.
- 40% increase in the experimental group in the application of advanced intervention modalities.

Figure 5

Item number five assessed within the matrix of professional competencies of Physical Therapy.



Item five evaluates the ability to design, execute, direct and control physiotherapeutic intervention programs for health promotion, prevention, assistance and rehabilitation of human body movement disorders in individuals and communities.

In the experimental group, in which gamification was used, there was a significant improvement in performance compared to the control group, in which traditional methodology was used in all areas, the difference in performance between the two groups was most notable in health promotion, with a 30% increase in performance in this area.

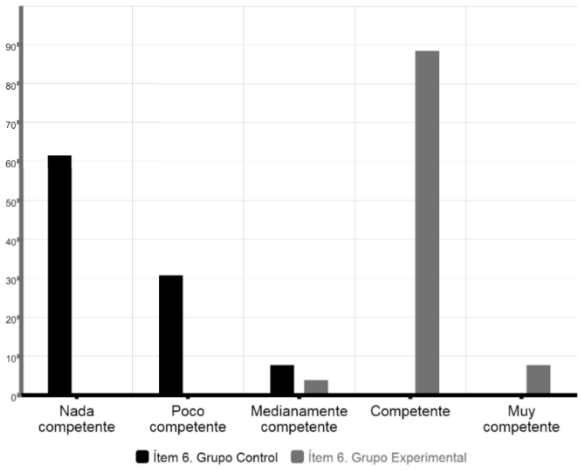
The intervention carried out with the experimental group was effective in improving the participants' ability to design, implement, manage and control physiotherapeutic intervention programs. This was especially evident in the experimental group, where the use of gamification techniques helped to engage and motivate participants, leading to better performance results.

Differences

- Forty percent of the control group has the ability to design, execute, direct and control physiotherapeutic intervention programs for health promotion, this figure increases to 70% in the experimental group.
- 70% of the control group and 95% of the experimental group have the ability to design, implement, manage and control physiotherapeutic intervention programs for rehabilitation

Figure 6

Item number 6 assessed within the matrix of professional competencies of Physical Therapy.



Item six evaluates the ability to plan, organize, direct and manage services, projects and activities in physical therapy in accordance with current legislation. The experimental group performs better than the control group in all areas: planning, organization, leadership and management.

The difference in performance between the two groups is greater in planning (30%), the intervention carried out with the experimental group has been effective in improving the participants' ability to:

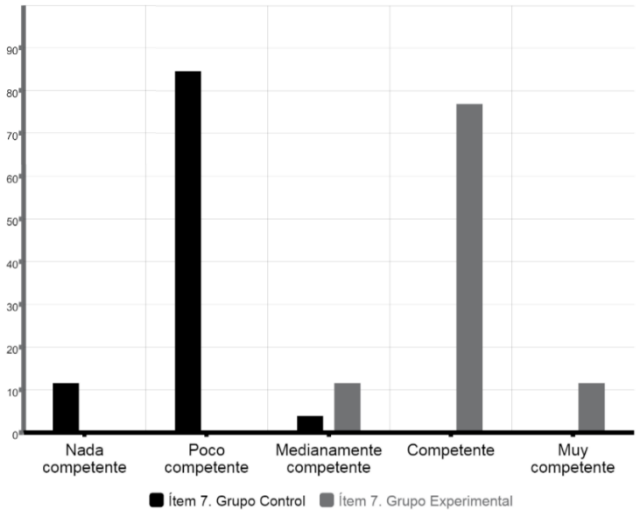
- Planning services, projects and activities in Physical Therapy.
- Organize services, projects and activities in Physiotherapy.
- To direct services, projects and activities in Physiotherapy.
- Manage services, projects and activities in Physiotherapy.

Differences

- 80% of the experimental group and 50% of the control group possess the skills to organize services, projects and activities in Physiotherapy. This 30% difference indicates that the intervention with the experimental group was also effective in improving the participants' ability to organize their work.
- 90% of the experimental group, compared to only 60% of the control group, have the ability to manage services, projects and activities in Physiotherapy. This 30% difference highlights the importance of leadership and management training for Physical Therapy professionals.

Figure 7

Item number seven assessed within the matrix of professional competencies of Physical Therapy.



Item seven evaluates the ability to describe and argue the epistemological, methodological and conceptual components of the scientific knowledge production process related to health and human body movement, from a critical and reflective perspective, to provide innovative, timely, effective and efficient professional solutions based on the collection and analysis of information, scientific research and evidence-based practice.

Differences

- The intervention carried out with the experimental group has been effective in improving their ability to understand and apply the components of the scientific knowledge production process.
- The experimental group performs better than the control group in the description and argumentation of the epistemological, methodological and conceptual components of the scientific knowledge production process.
- The difference in performance between the two groups is greater in epistemology by (30%).

Discussion

Traditional assessment processes have been the norm in academia for many years, but with the advent of technology and the growth of gamification, educators have begun to explore and apply these new training and assessment strategies to their students. It is important to note that gamification should not be considered a substitute for traditional assessment processes; rather, it should be considered a complementary tool that can be used to enhance the learning and assessment experience, allowing educators to create a more dynamic, modern and engaging learning environment that better suits the needs of today's learners.

The study highlights the advantages of using gamification-centered assessment processes in the health sciences, taking advantage of the unique characteristics of gamification, and the ease of creating a learning environment that is more adaptable to changing generational needs. The results identified coincide with the research carried out by López et al. (2018) where it was shown that gamification had a positive impact on motivation and experience, as well as on the understanding and implementation of the conceptual part of the subject.

It is important to highlight that the items that were identified as very competent were achieved exclusively by the experimental group; on the other hand, the items that were identified as not competent at all were only established for the control group, a relationship that points to gamification as positive when pursuing and achieving learning results in students and significant improvement on their competencies.

The findings of this study provide valuable information on the potential of gamification as an effective educational tool in the field of Physiotherapy, it is recommended that educators adopt gamification in their teaching methodologies to improve student learning outcomes, in order that further research in this field can help identify other potential benefits of gamification in education within not only Physiotherapy but also in other health sciences and its direct impact on the development of career-specific competencies.

Gamification is a powerful tool that can be used to motivate and engage students in their learning process, however, it requires meticulous planning and preparation to ensure that the activity is effective in the field of Physiotherapy, the physical space is a key component in the application of gamification, it must be designed in a way that facilitates the activity and encourages interaction between students situation that requires time and effort to ensure that it is promoting learning.

This includes providing the necessary physical space, equipment and technology, as well as promoting and adapting to these new measures of assessment in education within the healthcare setting, ultimately, the success of gamification in the assessment process in Physical Therapy depends on the commitment and collaboration of all parties involved.

Conclusions

Gamification as an assessment strategy is very effective, but it can also be used in the daily teaching process to meet the specific needs required to achieve the objectives in each class, it should not be limited only to health education, but can also be used in other fields of education, incorporating gamification into teaching can facilitate better understanding and learning.

Collaborative learning is enhanced when it is generated between peers versus that which is generated between an authority figure or someone who is not in a situation of equality, in addition, gamification can be an effective tool to motivate students to actively participate in the learning process, by incorporating game elements such as points, challenges and rewards, students are more engaged and motivated to learn.

This strategy is worth considering for any teacher looking to improve their teaching methodology and achieve better learning outcomes for their students, when gamification is used as a teaching strategy, it shifts the focus from a behavioral reinforcement model to a constructivist approach, a situation that is achieved by placing the student at the center of the learning process, encouraging critical thinking and

reflection, through gamification, students can actively participate in their own learning experience, making it more engaging and interactive.

Gamification is an innovative strategy that can revolutionize our approach to education in the area of health sciences, this strategy can create a positive and engaging learning experience that suits the needs of the modern learner, its correct application will help students develop important skills, it should be kept in mind that education today is like a toolbox and gamification is a powerful tool that we can add it box to make it even more effective.

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IMPACT OF VIBRATION PLATFORM TRAINING ON POSTOPERATIVE ANTERIOR CRUCIATE LIGAMENT REHABILITATION. A SYSTEMATIC REVIEW

IMPACTO DEL ENTRENAMIENTO EN PLATAFORMAS VIBRATORIAS EN LA REHABILITACIÓN POST-QUIRÚRGICA DEL LIGAMENTO CRUZADO ANTERIOR. UNA REVISIÓN SISTEMÁTICA

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ABSTRACT

The primary aim of the study was to review the available evidence on the effectiveness of whole-body vibration (WBV) training in comparison with conventional rehabilitation in the postoperative recovery of the anterior cruciate ligament (LCA). Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a systematic search was conducted in the databases PubMed, Cochrane, Scopus, Web of Science and Physiotherapy Evidence Database (PEDro) until July 2024. All randomized clinical trials in which intervention group performed WBV after ACL surgery were included. In order to check the methodological quality of the included studies, the CASPe scale, PEDro scale and the Cochrane bias assessment tool were used. Of the 470 records identified, 7 met the selection criteria. In general, despite there being a trend towards improvement ($p>0,05$) in strength with respect to the control group, no significant increases were observed. On the other hand, the studies found statistically significant ($p<0,05$) increases in balance and the Lysholm Scale compared to the control group. In conclusion, WBV therapy may constitute an effective strategy in the rehabilitation of patients with ACL reconstruction, showing positive results in knee musculature strength, balance, postural control an Lysholm Scale. In addition, WBV has been shown to be superior to conventional rehabilitation in increasing strength, balance and Lysholm Scale. However, there is no consensus on the effectiveness of both therapies on postural control and center of pressure oscillation. Future

clinical trials are needed to substantiate the findings of this systematic review.

RESUMEN

Palabras clave:
plataforma vibratoria, rehabilitación, ligamento cruzado anterior, vibración a cuerpo entero, fuerza.

El objetivo de este estudio fue revisar la evidencia disponible sobre la efectividad del entrenamiento en plataformas de vibración de cuerpo entero (WBV) en comparación con la rehabilitación convencional en la recuperación postquirúrgica del ligamento cruzado anterior (LCA). Siguiendo las directrices "*Prefered Reporting Items for Systematic Review and Meta-anlisis*" (PRISMA) se realizó una búsqueda sistemática en las bases de datos PubMed, Cochrane, Scopus, Web of Science y "*Physiotherapy Evidence Database*" (PEDro) hasta julio de 2024. Se incluyeron todos los ensayos clínicos aleatorizados cuyo grupo intervención realizara WBV postcirugía de LCA. Se comprobó la calidad metodológica mediante la escala CASPe, PEDro y Cochrane. De los 470 registros identificados 7 cumplieron los criterios de selección. En general, a pesar de haber una tendencia a la mejora ($p>0,05$) de la fuerza respecto al grupo control, no se observaron aumentos significativos. Por otro lado, se encontraron incrementos significativos ($p<0,05$) del equilibrio y la Escala Lysholm de funcionalidad de la rodilla respecto al grupo control. En conclusión, la terapia de WBV puede constituir una estrategia efectiva en la rehabilitación de pacientes con reconstrucción de LCA, mostrando resultados positivos en la fuerza de la musculatura de la rodilla, el equilibrio, el control postural y la Escala de Lysholm. Además, la WBV ha demostrado ser superior a la rehabilitación convencional en el aumento de la fuerza, equilibrio y la Escala de Lysholm. Sin embargo, no hay consenso sobre la efectividad de ambas terapias en el control postural y la oscilación del centro de presiones.

Introduction

Anterior cruciate ligament (ACL) injuries represent a challenge in the setting of routine clinical practice in sports medicine and sports physiotherapy (Kakavas et al., 2020). These injuries are common in physically active people, with an approximate incidence of 250,000 injuries annually in the United States (Acevedo et al., 2014). They especially affect people who participate in high-intensity activities and sudden changes of direction (Kakavas et al., 2020). In 70% of cases the injury mechanism is indirect, being damaged during acceleration, deceleration and turning actions in which the foot remains fixed to the ground and the knee undergoes hyperextension, valgus and internal rotation, placing excessive stress on the ACL (Cimino et al., 2010; Kaeding et al., 2017; Letafatkar et al., 2019). ACL injury results in altered knee biomechanics leading to abnormal movement patterns and chronic instability (Lohmander et al., 2007). Over time this biomechanical alteration can lead to meniscal and articular cartilage lesions that will give rise to osteoarthritis after 15-20 years (Kaeding et al., 2017; Lohmander et al., 2007). To avoid these complications, 50% of patients undergo surgical ACL reconstruction to restore knee stability (Acevedo et al., 2014). However, post-surgical rehabilitation is essential to ensure a complete and effective recovery (Diermeier et al., 2021).

Traditionally, conventional physical therapy has been the mainstay of post-surgical ACL rehabilitation. This approach is aimed at restoring joint mobility and stability, strengthening the musculature, improving proprioception and reducing the risk of relapse (Seixas et al., 2020). Despite its good results, the search for other complementary physiotherapy procedures that can accelerate and optimize rehabilitation remains a priority in the research of this injury. In this context, vibration platforms that enable whole-body vibration (WBV) have emerged as a potentially effective tool in musculoskeletal rehabilitation (Van Heuvelen et al., 2021). WBV is an exercise modality in which subjects are exposed to mechanical vibrations by means of a platform, which can be vertical or lateral and alternating or tilting (Oroszi et al., 2020). It has been observed that WBV can improve fast muscle fiber activation and strength of the lower extremity musculature (Annino et al., 2017; Cardinale and Bosco, 2003; Zhang et al., 2021), being essential to recover the strength of the knee extensor musculature after ACL reconstruction (Sogut et al., 2022). Additionally, WBV appears to be beneficial in improving balance, proprioception and joint stability (Sierra-Guzman et al., 2018), particularly important effects for ACL recovery, given that stability and neuromuscular control are imperative for safe return to sporting activities (Kakavas et al., 2020). The properties of WBV are based on the fact that vibration provides a specific sensory stimulus that triggers neuromuscular and musculoskeletal responses, through the stretch reflex (Seixas et al., 2020). Thus, it has been reported that acute changes in motor output are related to an increase in muscle spindle sensitivity (Seixas et al., 2020).

Understanding the effects and application of vibration platforms in ACL rehabilitation could have a significant impact on clinical practice and improve patient outcomes, offering faster and more effective recovery. In addition, it could result in a lower incidence of lesion recurrence, better quality of life and reduced costs associated with prolonged treatment. Therefore, the objective of this research was to systematically review the available scientific evidence on the effectiveness of WBV treatment on strength and neuromuscular parameters in physically active adults in post-surgical ACL rehabilitation. In a complementary manner, the effectiveness of WBV compared to traditional rehabilitation in post-surgical ACL rehabilitation was reviewed.

Method

Search strategy

For the selection of studies, a structured search was carried out using the electronic databases Medline (PubMed), Cochrane, Scopus, Physiotherapy Evidence Database (PEDro) and Web of Science until July 2024. The search was conducted following the methodological guidelines "Preferred Reporting Item Guidelines for Systematic Reviews and Meta-Analyses" (PRISMA) (Page et al., 2021) and the PICOS question model as follows: P (population): physically active adults (≥18 years) undergoing surgery after sustaining an ACL injury. I (intervention): WBV during the postoperative recovery period. C (comparison): conventional rehabilitation or placebo treatment. O (results): strength parameters (peak torque, electromyographic amplitude, isometric and isokinetic strength, peak power and rate of torque development) and neuromuscular parameters (balance, postural control and oscillation of the center of pressures). S (study design): randomized clinical trials.

The search strategy contained a combination of Medical Subject Headings (MeSH) and free words for related key concepts including: ("Anterior Cruciate Ligament" OR "Anterior Cruciate Ligament Reconstruction" OR "Anterior Cruciate Ligament Injuries") AND ("Whole Body Vibration" OR "Whole Body Vibration Training" OR "Whole Body Vibration Exercise" OR "Whole Body Vibration Therapy"). Two authors independently searched the 5 databases and a third reviewer resolved disagreements. All the studies obtained were compared in order to narrow down the search as much as possible and avoid repetition of studies. In addition, the bibliographic references of the included studies and part of the excluded studies were reviewed in order to identify relevant titles that might have been overlooked by the search strategy.

Selection Criteria

The following inclusion criteria were established for the selection of articles: 1) physically active patients (≥18 years) undergoing surgery following ACL injury; 2) treatment with WBV during postoperative rehabilitation; 3) comparison with a group receiving conventional rehabilitation (no vibration) or placebo treatment; 4) original records (meta-analyses, reviews and editorials will not be considered); 5) accurate WBV protocol information (time of use, frequency, vibration etc.); 6) report primary or secondary results related to strength parameters (peak torque, electromyographic amplitude, isometric and isokinetic force, peak power and rate of torque development) and/or neuromuscular parameters (balance, postural control and center of pressures oscillation); 7) score higher than six on the Spanish Critical Appraisal Skills Programme (CASPe) questionnaire (Cabello, 2021) and the PEDro scale (Moseley et al., 2020); 8) publications in Spanish, English, Italian, French and Portuguese.

No criteria were applied regarding the sex of the participants, the duration of the intervention or the age of the studies.

Data Extraction and Synthesis

The following information was extracted from each trial included in the review: Surname of the first author, year of publication, country where the study was carried out, design, sample size, sex, age, height, body weight, losses, intervention in the control group (CG) and in the intervention group (IG), parameters evaluated and results obtained. Two researchers performed the data extraction process using a spreadsheet. In case of disagreements, a third reviewer participated in the process.

Evaluation of Methodological Quality

The selected articles were critically read to assess their methodological quality using the PEDro (Moseley et al., 2020) and CASPe (Cabello, 2021) scales. Additionally, the risk of bias was assessed using the Cochrane tool (Higgins et al., 2011).

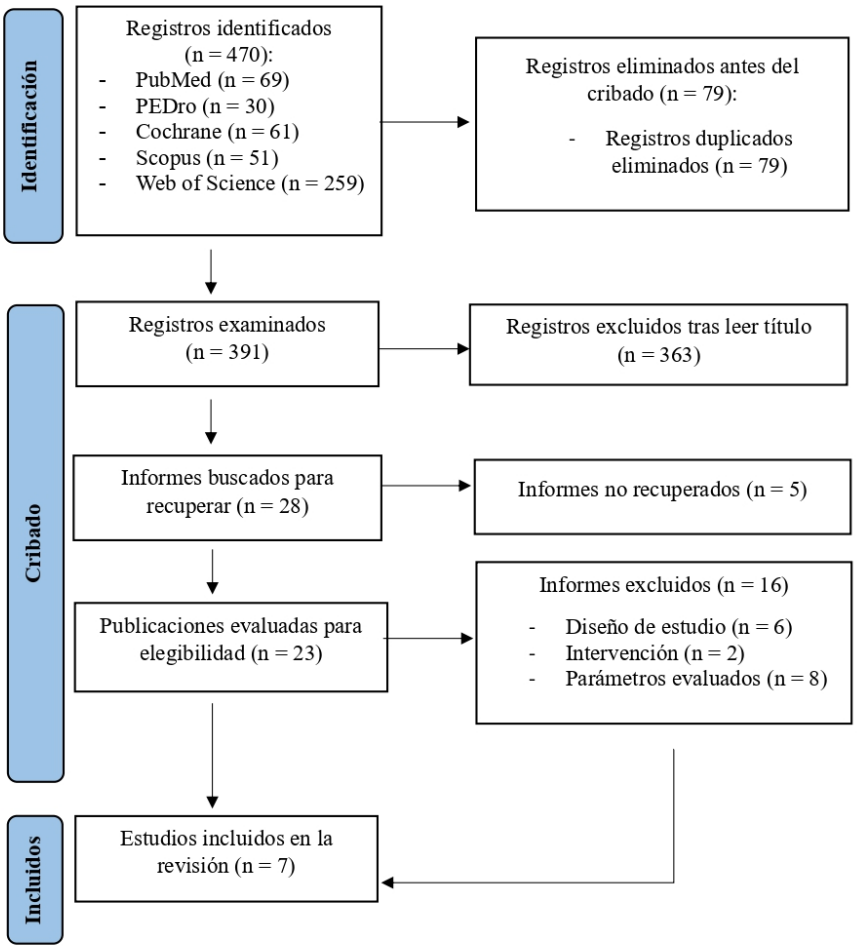
Results

Selection of Studies

The literature search resulted in a total of 470 studies, 69 from Medline (PubMed), 30 from PEDro, 61 from Cochrane, 51 from Scopus and 259 from Web of Science. After eliminating duplicates (n=79), the title and abstract of the remaining 391 studies were analyzed and 363 were eliminated because they did not meet the selection criteria. In a second phase, 28 full-text studies were evaluated, 21 were discarded for not having access to the full text (n=5), not being clinical trials (n=6), not treating ACL injury with WBV (n=2) and not evaluating strength or neuromuscular parameters (n=8). Likewise, the bibliographic references of the included articles and part of the excluded articles were reviewed with the aim of finding additional relevant studies, but there were no results. Therefore, a total of 7 articles (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003) that met all the established selection criteria were included (Figure 1).

Figure 1

Flow chart illustrating the process of identification and selection of studies included in this review, following the guidelines established by "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) (Page et al., 2021)



Evaluation of Methodological Quality

Table 1 shows the scores obtained in the CASPe questionnaire. All studies scored equal to or greater than 9 (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003). Only Costantino et al. (2018) obtained the maximum score. The main shortcomings in terms of methodological quality have been found in blinding items (Berschin et al., 2014; Blackburn et al., 2021; Salvarani et al., 2003), similar groups at baseline (da Costa et al., 2019; Salvarani et al., 2003), large treatment effect (Berschin et al., 2014; da Costa et al., 2019; Pamukoff et al., 2016, 2017) and applicability to your environment or local population (Pamukoff et al., 2016, 2017).

Regarding the PEDro methodological quality questionnaire, all selected articles scored 6 or higher (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003). The highest score was obtained by the study of Costantino et al. (2018) with 11 points, in contrast to Salvarani et al. (2003) who scored the lowest, with 6 points. All studies met the items of randomization, minimum 85% follow-up, intention-to-treat data analysis, statistical comparison between groups, and point and variability measures (Table 2).

Table 1

Methodological quality of the articles included in the systematic review according to the CASPe questionnaire

FIRST AUTHOR, YEAR OF PUBLICATION AND COUNTRY	ITEMS											Total
	1	2	3	4	5	6	7	8	9	10	11	
Berschin et al. (2014), Germany	YES	YES	YES	NO	YES	YES	NO	95% CI $p < 0,05$	YES	YES	YES	9
Costantino et al. (2018), Italy	YES	YES	YES	YES	YES	YES	YES	95% CI $p < 0,05$	YES	YES	YES	11
da Costa et al. (2019), Brazil	YES	YES	YES	YES	NO	YES	NO	95% CI $p < 0,05$	YES	YES	YES	9
Pamukoff et al. (2017), USA	YES	YES	YES	YES	YES	YES	NO	95% CI $p < 0,05$	NO	YES	YES	9
Pamukoff et al. (2016), USA	YES	YES	YES	YES	YES	YES	NO	95% CI $p < 0,05$	NO	YES	YES	9
Salvarani et al. (2003), Italy	YES	YES	YES	NO	NO	YES	YES	95% CI $p < 0,05$	YES	YES	YES	9
Blackburn et al. (2021), USA	YES	YES	YES	NO	YES	YES	YES	95% IC $p < 0,05$	YES	YES	YES	10

Note. CI=Confidence Interval. CASPe questionnaire items: 1=Clearly defined question; 2=Random assignment; 3=Patients considered until the end; 4=Blinding; 5=Similar groups at baseline; 6=Equally treated groups; 7=Large treatment effect; 8=Precision of effect; 9=Applicability to your local environment or population; 10=All outcomes considered; 11=Benefits justify risks and costs.

Table 2

Methodological quality of the articles included in the systematic review according to the PEDro questionnaire

FIRST AUTHOR, YEAR OF PUBLICATION AND COUNTRY	ITEMS											Total
	1	2	3	4	5	6	7	8	9	10	11	
Berschin et al. (2014), Germany	YES	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	8
Costantino et al. (2018), Italy	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	11
da Costa et al. (2019), Brazil	YES	YES	YES	NO	YES	NO	NO	YES	YES	YES	YES	8
Pamukoff et al. (2017), USA	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	9
Pamukoff et al. (2016), USA	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	9
Salvarani et al. (2003), Italy	NO	YES	YES	NO	NO	NO	NO	YES	YES	YES	YES	6
Blackburn et al. (2021), USA	YES	YES	NO	YES	NO	NO	NO	YES	YES	YES	YES	7

Note. Items of the PEDro scale: 1=Choice criteria; 2=Random assignment; 3=Hidden assignment; 4=Similarity of groups at baseline; 5=Participant blinding; 6=Therapist blinding; 7=Evaluator blinding;

8=Minimum 85% follow-up; 9=Analysis of data by intention-to-treat; 10=Statistical comparison between groups; 11=Spot and variability measures.

Bias Risk Assessment

To assess the risk of bias of the selected studies, the Cochrane bias assessment tool (Higgins et al., 2011) was used and is shown in Table 3 and Figure 2. All 7 studies showed low risk on the items of random sequence generation, incomplete follow-up, selective reporting of results, and other biases (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003). However, consistent with what was found in the PEDro and CASPe scales, the risk of participant and rater blinding bias was high in 5 (Berschin et al., 2014; Blackburn et al., 2021; Pamukoff et al., 2016, 2017; Salvarani et al., 2003) and 4 studies respectively (Berschin et al., 2014; Blackburn et al., 2021; da Costa et al., 2019; Salvarani et al., 2003).

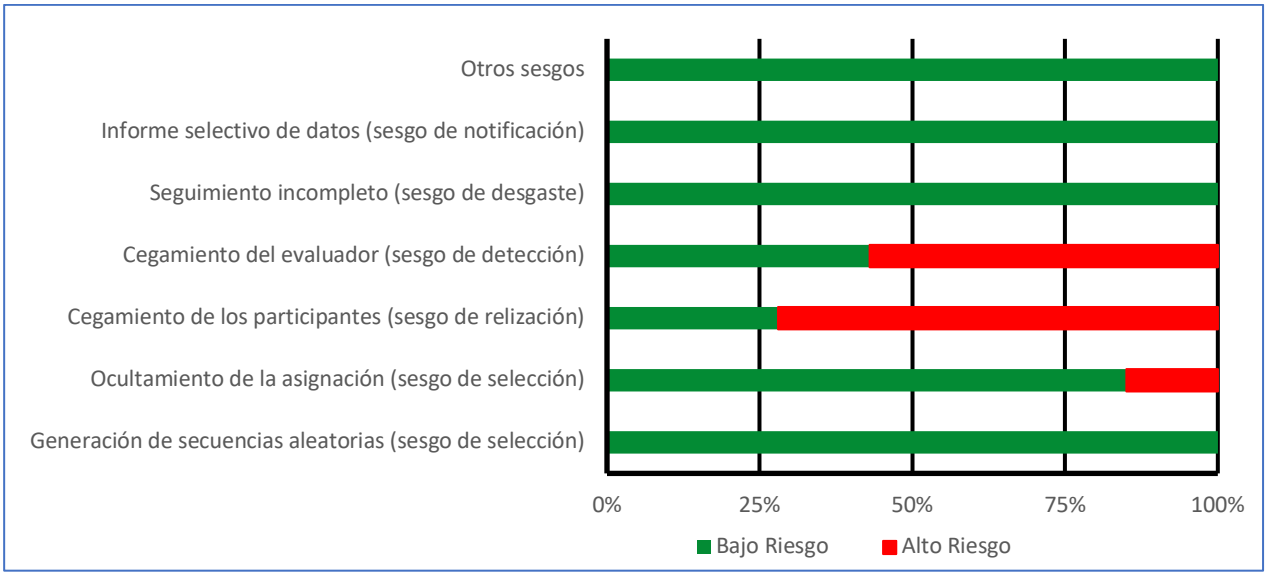
Figure 2

Bias assessment of the articles included in the systematic review according to the Cochrane tool

FIRST AUTHOR, YEAR OF PUBLICATION AND COUNTRY	1	2	3	4	5	6	7
Berschin et al. (2014), Germany	+	+	−	−	+	+	+
Costantino et al. (2018), Italy	+	+	+	+	+	+	+
da Costa et al. (2019), Brazil	+	+	+	−	+	+	+
Pamukoff et al. (2017), USA	+	+	−	+	+	+	+
Pamukoff et al. (2016), USA	+	+	−	+	+	+	+
Salvarani et al. (2003), Italy	+	+	−	−	+	+	+
Blackburn et al. (2021), USA	+	−	−	−	+	+	+

Note. "+": low-risk bias; "-": high risk of bias; "?": uncertainty about the potential for bias or lack of information about it; T: total number of items completed per study. Cochrane tool items: 1=random sequence generation; 2=allocation concealment; 3=participant blinding; 4=evaluator blinding; 5=incomplete follow-up; 6=selective reporting of results; 7=Other biases.

Figure 3
Problems encountered in the risk of bias assessed with the Cochrane tool



Characteristics of Participants and Interventions

A total of 207 participants (111 ♂ y 96 ♀) between 20 and 30 years of age were recruited at the beginning of the study. Only one participant was not evaluated at the end of the study because he did not complete the intervention (Costantino et al., 2018). The participants were physical persons the participants were physically active people who sustained an ACL injury and underwent surgery with an autograft of the ACL tendon (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; Pamukoff et al., 2016, 2017; Salvarani et al., 2003), hamstring (Blackburn et al., 2021; Pamukoff et al., 2016, 2017) or allograft (Blackburn et al., 2021; Pamukoff et al., 2016, 2017). All studies included both women and men, except Costantino et al. (2018) which evaluated only females and da Costa et al. (2019) that studied only men (Table 4).

All studies compared the effect of conventional physical therapy procedures in isolation with the effect of conventional physical therapy combined with WBV (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003). Conventional physical therapy procedures included methods such as passive kinesitherapy, transcutaneous electrical nerve stimulation (TENS), stretching, strengthening of knee and hip flexors and extensors, proprioception and aerobic exercise. In a complementary manner, Pamukoff et al. (2016,2017) and Blackburn et al. (2021) compared with a third group that received localized vibration in the quadricipital tendon area. The duration of the intervention ranged from 11 weeks (Berschin et al., 2014) to 1 week (Blackburn et al., 2021). The weekly frequency ranged from 5 sessions (Salvarani et al., 2003) to 1 session (Blackburn et al., 2021) with a duration of 40 (Berschin et al., 2014) to 10 minutes (Salvarani et al., 2003). Vibration frequencies of 26 Hz (Costantino et al., 2018), 30 Hz (Berschin et al., 2014; Blackburn et al., 2021; Pamukoff et al., 2016, 2017; Salvarani et al., 2003) and 50 Hz (da Costa et al., 2019) were used. The position chosen for vibration was standing (Berschin et al., 2014; Blackburn et al., 2021) and isometric squat (Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003) (Table 5).

Evaluation of Results

The results obtained after the interventions are shown in Table 4.

Force

The changes produced in strength were evaluated by the 7 studies (Berschin et al., 2014; Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017; Salvarani et al., 2003). Isometric (Berschin et al., 2014; Blackburn et al., 2021; da Costa et al., 2019; Pamukoff et al., 2016; Salvarani et al., 2003) and isokinetic (Berschin et al., 2014; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017) strength was analyzed. All 7 studies reported increases in strength over baseline being significant ($p<0.05$) in 4 of them (Berschin et al., 2014; Costantino et al., 2018; Pamukoff et al., 2016; Salvarani et al., 2003). While 5 studies found improvements over GC (Blackburn et al., 2021; Costantino et al., 2018; Pamukoff et al., 2016, 2017; Salvarani et al., 2003) being significant ($p<0.05$) only in 2 of them (Constantino et al., 2018; Pamukoff et al., 2016).

Isokinetic strength of knee extensor muscles increased with respect to baseline in all 5 studies that evaluated it (Berschin et al., 2014; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016, 2017) being statistically significant ($p<0.05$) in 3 of them (Berschin et al., 2014; Costantino et al., 2018; Pamukoff et al., 2016). However, only Costantino et al. (2018) and Pamukoff et al. (2016) reported significant improvements ($p<0.05$) over the GC. On the other hand, all studies that evaluated isometric strength of knee extensors found increases from baseline except da Costa et al. (2019). Regarding GC, only 3 studies reported improvements (Blackburn et al., 2021; Pamukoff et al., 2016; Salvarani et al., 2003) being significant ($p<0.05$) those found by Pamukoff et al. (2016).

Knee flexor strength was evaluated by 4 studies (Berschin et al., 2014; Costantino et al., 2018; Pamukoff et al., 2016; Salvarani et al., 2003). Three reported significant improvements ($p<0.05$) while Pamukoff et al. (2016) found no change from the baseline. Regarding CG, Costantino et al. (2018) and Salvarani et al. (2003) reported increases ($p<0.05$) in isokinetic and isometric strength respectively, while Berschin et al. (2014) and Pamukoff et al. (2016) reported no changes.

Neuromuscular parameters

Only 2 of the 7 studies (Berschin et al., 2014; da Costa et al., 2019) assessed neuromuscular parameters. Berschin et al. (2014) reported significant ($p<0.05$) increases in equilibrium relative to baseline and CG. Da Costa et al. (2019) found non-significant ($p>0.05$) improvements in center-of-pressure oscillation relative to baseline that did not extend to CG.

Other parameters

Berschin et al. (2014) evaluated the effect of WBV on ROM, anterior drawer and Lysholm Scale. They found non-significant improvements ($p>0.05$) with respect to baseline and found no changes with respect to the CG in ROM and anterior drawer. However, they reported significant improvements ($p<0.05$) over baseline and CG on the Lysholm Scale assessing knee functionality.

Table 3
Summary of selected studies

FIRST AUTHOR, YEAR OF PUBLICATION AND COUNTRY	TYPE OF STUDY	PARTICIPANTS (SAMPLE SIZE AND CHARACTERISTICS)	INTERVENTION	PARAMETERS EVALUATED	RESULTS
Berschin et al. (2014), Germany	Randomized clinical trial	$n_{i=40}$ (29 ♂ y 11 ♀), Qx: autograft with patellar T **GC**: n_i= 20 (15 ♂ y 5 ♀); 0 losses → n_f=20 Age (mean ± SD): 28 ± 6.8 years BMI (mean ± SD): 24,3 ± 2,8 Kg/m^2 Days from injury to surgery (mean ± SD): 90.7 ± 47.9 days **GI$_{WBV}$**: n_i= 20 (14 ♂ y 6 ♀); 0 losses → n_f=20 Age (mean ± SD): 27 ± 4.2 years BMI (mean ± SD): 23,2 ± 3,4 Kg/m^2 Days from injury to Qx (mean ± SD): 82.4 ± 39.2 days	**GC**: Rehabilitation protocol after ACL Qx (Exercise program to strengthen the hip and knee muscles. Balance and proprioception work). **GI$_{WBV}$**: WBV standing and squats	**Flexor and extensor strength**: - Isokinetics - Isometric **Neuromuscular**: - Balance **Clinicians**: - Active ROM - Front drawer - Lachman - Lysholm Scale	**GI$_{WBV}$**: changes from the beginning ↑* Isokinetic and isometric strength ↑* Balance ↑ Active ROM ↑ Front drawer ↑* Lysholm **GI$_{WBV}$ vs GC** ↔ Isokinetic and isometric strength ↑* Balance ↔ Active ROM ↔ Front drawer ↔ Lysholm
Costantino et al. (2018), Italy	Randomized clinical trial	n_i = 39 (39 ♀), Qx: patellar T. autograft **GC**: n_i= 19 (19 ♀); 0 losses → n_f=19 Age (mean ± SD): 25.42 ± 2.39 years BMI (mean ± SD): 20,06 ± 1,80 Kg/m^2	**GC**: Rehabilitation protocol after ACL Qx (passive kinesitherapy, TENS, stretching, flexor and extensor strengthening exercises, proprioception, e.g. aerobic). Placebo treatment on vibration platform off.	**Isokinetic strength flexors and extensors**: - Peak torque - Maximum power	**GI$_{WBV}$**: changes from the beginning ↑* Flexor isokinetic strength (peak torque and maximum power) ↑* Isokinetic force extensors (peak torque and peak power)

		GI_{WBV}: n_i= 20 (20 ♀); 1 loss → n_f=19 Age (mean ± SD): 25.47 ± 2.01 years BMI (mean ± SD): 20,29 ± 1,28 Kg/m^2	**GI_{WBV}**: Rehabilitation protocol after Qx of ACL + WBV in squat position and monopodal squat (25º of flexion).		**GI_{WBV} vs GC** ↑* Flexor isokinetic strength (peak torque and maximum power) ↑* Isokinetic force extensors (peak torque and peak power)
da Costa et al. (2019), Brazil	Randomized blinded clinical trial	n_i =44 (44 ♂), Qx: not specified **GC**: n_i= 22 (22 ♂); 0 losses → n_f=22 Age (mean ± SD): 26.8 ± 6.83 years BMI (mean ± SD): 26,5 ± 2,96 Kg/m^2 Postoperative time (mean ± SD): 17 ± 1.26 weeks **GI_{WBV}**: n_i= 22 (22 ♂); 0 losses → n_f=22 Age (mean ± SD): 28 ± 5.52 years BMI (mean ± SD): 27,1 ± 4,49 Kg/m^2 Postoperative time (mean ± SD): 16.8 ± 1.55 weeks	**GC**: Placebo treatment on vibration platform off. **GI_{WBV}**: WBV in monopod squat position (40º flexion).	**Isokinetic strength extensors**: - Peak torque - Total labor **Isometric strength extensors**: - EMG (vastus lateralis and medialis) **Neuromuscular**: - Oscillation of the center of pressures (A-P and lateral)	**GI_{WBV}**: changes from the beginning ↑ Isokinetic force extensors (peak torque and total work) ↔ Isometric strength extensors ↑ A-P center of pressure oscillation ↔ Lateral center of pressure oscillation **GI_{WBV} vs GC** ↔ Isokinetic extensor strength (peak torque and total work) ↔ Isometric strength extensors ↔ Oscillation of the center of pressures A-P ↔ Lateral center of pressure oscillation

Pamukoff et al. (2017), USA	Single-blind randomized clinical trial	n_i=20 (6 ♂ y 14 ♀), Qx: 16 autograft with patellar T., 3 autograft with hamstring T. and 1 allograft; 0 losses → n_f=20 Age (mean ± SD): 21.1 ± 0.5 years Height (mean ± SD): 168.4 ± 4.2 cm Weight (mean ± SD): 68.3 ± 6.5 kg Postoperative time (mean ± SD): 50.6 ± 9.3 months The 20 patients were randomly assigned to the 3 groups (GI_{WBV}, GI_{LV} and GC); after the intervention, a week's rest was allowed and the 20 patients were reassigned to another group and the process was repeated a third time.	**GC**: Isometric squat (60º of flexion) without any vibration **GI_{WBV}**: WBV in squat position (60º of flexion) **GI_{LV}**: Local antero-posterior vibration in the quadricipital tendon in squat position (60º of flexion)	**Isokinetic strength extensors**: - Early RTD - Late RTD **Electromechanical delay**: time difference between the onset of EMG activity and the onset of torque - Vasto lateral - Vast middle - Anterior rectus	**GI_{WBV}**: changes from the beginning ↑* early RTD ↑ Electromechanical delay lateral and medial vastus ↔ Late RTD, electromechanical delay, straight anterior rectum **GI_{WBV} vs GC** ↑ Early RTD ↑ Electromechanical delay lateral and medial vastus ↔ Late RTD, electromechanical delay, straight anterior rectum
Pamukoff et al. (2016), USA	Single-blind randomized clinical trial	$n_{i=20}$ (6 ♂ y 14 ♀), Qx: 16 autograft with patellar t., 3 autograft with hamstring t. and 1 allograft; 0 losses → n_f=20 Age (mean ± SD): 21.1 ± 1.2 years Height (mean ± SD): 168.4 ± 9.5 cm Weight (mean ± SD): 68.3 ± 14.9 Kg Postoperative time (mean ± SD): 50.6 ± 21.3 months The 20 patients were randomly assigned to one of the 3 groups (GI_{WBV}, GI_{LV} and GC) after the intervention a week of rest was left and the 20 patients were again assigned to another group and the process was repeated a third time.	**GC**: Isometric squat (60º of flexion) without any vibration **GI_{WBV}**: WBV in squat position (60º of flexion) **GI_{LV}**: Local antero-posterior vibration in the quadricipital tendon in squat position (60º of flexion)	**Isokinetic extensor strength**: - Peak torque - RTD **Isometric strength extensors**: - Maximum EMG amplitude - CAR (Central Activation Ratio) **Isometric flexor strength**: - EMG amplitude -	**GI_{WBV}**: changes from the beginning ↑* peak torque, EMG amplitude extensors, CAR ↔ RTD, flexor EMG amplitude **GI_{WBV} vs GC** ↑* Peak torque, EMG extensor amplitude, CAR ↔ RTD, flexor EMG amplitude
Salvarani et al. (2003), Italy	Randomized clinical trial	n_i =20 (17 ♂, 3 ♀), Qx: autograft with patellar T.	**GC**:	**Isometric strength extensors and flexors**	**GI_{WBV}**: changes from the beginning

		GC: n_i= 10; 0 losses → n_f=10 Age (mean ± SD): 26.8 ± 5.2 years Height (mean ± SD): 175.2 ± 8.3 cm Weight (mean ± SD): 73.2 ± 7.9 kg Postoperative time: 1 month **GI_{WBV}**: n_i= 10; 0 losses → n_f=10 Age (mean ± SD): 29.7 ± 7.8 years Height (mean ± SD): 174.1 ± 7.7 cm Weight (mean ± SD): 72 ± 7.6 kg Postoperative time: 1 month	Rehabilitation protocol after ACL Qx (passive kinesitherapy, electrostimulation, stretching, cryotherapy, isometric, isotonic and isokinetic exercises, proprioception). Isometric squat (25º of flexion) without any vibration **GI_{WBV}**: Rehabilitation protocol after Qx of ACL + WBV in squat position (25º of flexion).	(EMG vastus medialis, biceps femoris and soleus): - Peak strength - Medium strength - Force during the middle of the first second	↑* Peak strength ↑* Average strength ↑* Force during the middle of the first second **GI_{WBV} vs GC** ↑* Peak strength ↑ Average strength ↑ Force during the middle of the first second
Blackburn et al. (2021), USA	Randomized crossover clinical trial	n_i=24 (9 ♂ y 15 ♀), Qx: 16 autograft with patellar T., 3 autograft with hamstring T. and 1 allograft; 0 losses → n_f=20 Age (mean ± SD): 22 ± 4 years Postoperative time (mean ± SD): 50 ± 41 months The 24 patients were randomly assigned to one of the 3 groups (GI_{WBV}, GI_{LV} and GC) after the intervention a week of rest was left and the 20 patients were reassigned to another group and the process was repeated a third time	**GC**: Standing upright with slight flexion without any vibration **GI_{WBV}**: WBV in standing position with slight flexion **GI_{LV}**: Local anteroposterior vibration in the quadricipital tendon in standing with slight flexion	**Isometric extensor strength** (dynamometry): - Peak torque - RTD - Maximum EMG amplitude (vastus lateralis and medialis)	**GI_{WBV}**: changes from the beginning ↑* Peak torque ↑RTD, vastus medialis EMG amplitude ↔Vastus lateralis EMG amplitude **GI_{WBV} vs GC** ↑* Peak torque ↑ RTD, vastus medialis EMG amplitude ↔ vastus lateralis EMG amplitude

Note. ↑: increase; ↑*: significant increase; ↔: no difference between groups; ♂: male; ♀: female; A-P: anterior-posterior; EMG: electromyography CG: control group; GILV: intervention group with local vibration;GIWBV: full-body vibration intervention group; BMI: body mass index; kg/m2: kilograms divided by meters squared; ACL: anterior cruciate ligament; nf: final sample size; ni: final sample size; ni: final sample sizeñnf: final sample size; ni: initial sample size; Qx: surgeryí; ROM: range of motion; RTD: rate of torque development; SD: standard deviation; t: tendon; TENS: transcutaneous electrical nerve stimulation; tt: treatment.

Table 4

Characteristics of interventions on vibrating platforms

Author, year and country	Exercises	Specific vibration parameters	Volume and intensity	Frequency (days/week)	Time (minutes/session)	Duration (weeks)	Supervision
Berschin et al. (2014), Germany	Sem 2-4: Isometric standing Sem 5-7: Isometric standing Sem 8-11: Squats (load 10% RM)	Sem 2-4: 10-15 Hz Sem 5-7: 30 Hz Sem 8-11: 30 Hz Breadth: 5-9 mm	Sem 2-4: 2-6 reps of 1 min Sem 5-7: 5 reps of 1.5-2 min Sem 8-11: 5-7 reps of 2 min	3-4	40	11	Yes
Costantino et al. (2018), Italy	Isometric squat with 25° of knee flexion Monopodal isometric squat with 25° of knee flexion	Frequency: 26 Hz Breadth: 4mm	6 reps of 1 min 1 min rest between reps and 2 min between exercises	3	Not specified	8	Yes
da Costa et al. (2019), Brazil	Monopodal isometric squat with 40° knee flexion	Frequency: 50 Hz Breadth: 4 mm	10 reps of 30 sec 30 sec rest	Not specified	Not specified	Not specified	Yes
Pamukoff et al. (2017), USA	Isometric squat with 60° knee flexion	Frequency: 30Hz Acceleration: 2g	6 reps of 60 sec 2 min rest between reps	Not specified	20	Not specified	Yes
Pamukoff et al. (2016), USA	Isometric squat with 60° knee flexion	Frequency: 30Hz Acceleration: 2g	6 reps of 60 sec 2 min rest between reps	Not specified	20	Not specified	Yes
Salvarani, et al. (2003), Italy	Isometric squat with 25° of knee flexion	Frequency: 30Hz	5 reps of 60 sec 1 min rest between reps	5	10	2	Yes
Blackburn et al. (2021), USA	Standing upright with slight knee flexion	Frequency: 30Hz Acceleration: 2g	6 reps of 60 sec 2 min rest between reps	1-3 (3 sessions in total with a break of 2-7 days)	20	1-3	Yes

Note: g: acceleration of gravity (9.8m/s2); Hz: hertz; min: minutes; mm: millimeters; RM: repetition maximum; sec: seconds; wk: week.

Discussion and Conclusions

The objective of this systematic review was to critically evaluate the comparative efficacy of vibration platform-based training (GIWBV) with respect to a standard exercise protocol (CG) in improving strength and neuromuscular parameters in physically active adults in post-surgical ACL rehabilitation. Seven studies met the selection criteria and were included in the review. Overall, despite observing a trend towards improvement ($p>0.05$) in strength in participants who used the vibration platforms with respect to the CG, no statistically significant increases were observed (Blackburn et al., 2021; Pamukoff et al., 2017; Salvarani et al., 2003). In relation to balance and the Lysholm Scale of knee functionality, statistically significant ($p<0.05$) increases have been reported with respect to CG (Berschin et al., 2014).

Force Parameters

Strength is one of the main functional abilities that are compromised in patients undergoing ACL reconstruction, so its restoration is a necessity during the rehabilitation process. Gaining strength is essential to improve knee stability, control movements, facilitate return to sporting activity and prevent secondary injuries. It is a key component in the recovery, readaptation process and helps patients regain optimal function and performance for return to sporting activity (Buckthorpe et al., 2019).

Isokinetic dynamometry is considered the gold standard test to objectively assess muscle strength as it allows the measurement of muscle strength at different angles of movement and contraction velocities (Stark et al., 2011). This test provides detailed information about a muscle's ability to generate force in a controlled and precise manner. Isokinetic dynamometry is particularly useful for assessing muscle asymmetry, identifying strength deficits, and monitoring progress in the rehabilitation of muscle and joint injuries (Montejo et al., 2019). In fact, all the articles included in this review evaluated different strength parameters in general. Four studies assessed peak torque or "peak torque" in English (Blackburn et al., 2021; Costantino et al., 2018; da Costa et al., 2019; Pamukoff et al., 2016), i.e., the value of force or torque produced by a muscle or muscle group during a maximal muscle contraction. Torque strength is a key measure in strength assessment and is especially relevant in injury rehabilitation and in assessing progress during a strength training program (Buckthorpe et al., 2019; Simpson et al., 2019). In the study by Costantino et al. (2018) subjects experienced a significant increase in both knee flexors and extensors in this parameter relative to the CG. Similar results were obtained by Pamukoff et al. (2017) and Blackburn et al. (2021), studies in which there was also a non-significant increase in peak torque of the extensor muscles. However, da Costa et al. (2019) obtained no differences with respect to GC, also in extensors, after a WBV session. Variations in the frequency application protocol, from 26 Hz to 50 Hz and the time at which the WBV intervention was applied to the patients, as well as the interindividual response of the subjects could explain the divergence of the results obtained in the different studies.

Electromyography is a procedure used to measure and analyze the bioelectrical activity of muscles through the use of electrodes placed on the surface of the skin or through intramuscular electrodes. This test allows the detection and recording of muscle action potentials, providing information on muscle activation, coordination and function (Gila et al., 2009). This parameter was evaluated in four studies. Salvarani et al. (2003), Pamukoff et al. (2017) and Blackburn et al. (2021) reported an increase in

electromyographic amplitude with respect to CG, while da Costa et al. (2019) reported no differences between groups.

The main difference between these studies (Blackburn et al., 2021; da Costa et al., 2019; Pamukoff et al., 2016; Salvarani et al., 2003) is the time elapsed from ligament reconstruction to intervention, being much shorter in the study by da Costa et al. (2019) (between 15 and 19 weeks), which in the studies of Pamukoff et al. (2016) and Blackburn et al. (2021) ranges from nine to 91 months.

Finally, other parameters such as maximum flexor and extensor power, evaluated by Costantino et al. (2018) found significant ($p<0.05$) increases compared to GC. The rate of torque development was evaluated in three of the selected studies, with improvements obtained by Pamukoff et al. (2017) and Blackburn et al. (2021) especially the rate of early torque development in extensor muscles. However, no significant differences were obtained in the study by Pamukoff et al. (2016).

All these improvements can be explained by the muscular response to vibration, when performing automatic contractions and stretching. The mechanical stimulus generated by the vibrating platform produces a stretch and contraction reflex in the muscles 30 to 60 times per second, resulting in a continuous muscle contraction (Alguacil et al., 2009). The sinusoidal oscillatory movements generated by the vibrating platform are transmitted to the whole body, which increases the gravitational load on the neuromuscular system. This causes the muscles to work to overcome the force of gravity. Upon contact with the vibrating platform, the mechanical stimulus of vibration is transmitted throughout the body, activating various skin and muscle sensory receptors, including muscle spindles. Muscle spindles detect changes in muscle stretch length and velocity and Golgi tendon organs that respond to tension and load on tendons (Albasini et al., 2010; Cardinale and Bosco, 2003; Seixas et al., 2020).

A tonic vibratory reflex is then triggered, which is responsible for muscle contraction and relaxation and involves an automatic response in the muscles, which contract and relax in synchrony with the vibration. This in turn triggers a number of neuromuscular responses, including stimulation of motor units, improvement of muscle coordination and modulation of muscle activation. These responses contribute to muscle strengthening and conditioning, as well as improved stability and balance (Albasini et al., 2010; Alguacil et al., 2009; Cardinale and Bosco, 2003; Seixas et al., 2020).

In other research, no increase in quadriceps strength has been obtained (Pistone et al., 2016; Rowe et al., 2022). In turn, research on athletes aimed at evaluating WBV programs also showed no improvement over conventional strength training (Fernández-Rio et al., 2010).

Neuromuscular Parameters

For balance and postural control (Berschin et al., 2014) and center of pressures oscillation (da Costa et al., 2019) discrepant results were obtained. In terms of balance, a significant improvement was obtained ($p<0.05$). On the other hand, in the oscillation of the center of pressures, the results remained similar with respect to the CG. This difference may be due to the clear variation in frequencies used in both studies, since in Berschin et al. (2014) started treatment at 10 Hz and ascended to 30 Hz; while da Costa et al. (2019) maintained a frequency of 50 Hz throughout the intervention.

Previous studies (Fu et al., 2013; Moezy et al., 2008) observed significant improvements in overall stability and anteroposterior and mediolateral indices. However, the recent meta-analysis by Rowe et al. (2022) states that this type of therapy does not improve anteroposterior stability, but it can improve overall and mediolateral stability.

Improvements in balance and postural control could be attributed to the oscillatory movements provided by the vibration platforms. These mechanical vibrations generate multiple and repetitive instability situations, which stimulates the motor learning process. The application of mechanical vibrations leads to the adaptation of neuromuscular reflexes, resulting in a more efficient control of vibration processes from a mechanical point of view. As individuals are regularly exposed to mechanical vibrations, their peripheral and central nervous and muscular systems adapt and learn to respond more efficiently to maintain balance and stabilize the body (Alguacil et al., 2009).

Limitations

Within the included studies, limitations were found in terms of study design, heterogeneity of WBV protocols, variability in CGs, and cohort characteristics. All of which makes it difficult to compare studies and interpret the effects of WBV, which is why meta-analysis has not been possible. In addition, the included trials had small sample sizes and heterogeneous samples, and in some cases, detailed demographic data were not provided.

In view of these limitations, caution is advised when interpreting the results. Moreover, despite the popularity of WBV as a therapeutic modality, in view of the insufficient scientific evidence currently available in this regard, its efficacy is not yet sufficiently demonstrated due to the lack of standardized protocols (Wang et al., 2020). The approach of protocols customized to individual needs could prove useful in the rehabilitation of musculoskeletal disorders, as well as improve sports performance (Bonanni et al., 2022).

Further research in this area is suggested to gain a more robust understanding of the potential effects and benefits of WBV.

Conclusions

WBV therapy, through the use of vibratory platforms, may constitute an effective strategy in the rehabilitation of patients with ACL reconstruction. WBV has demonstrated positive results in knee musculature strength, balance, postural control and the Lysholm Knee Functionality Scale. In addition, WBV has been shown to be superior to conventional rehabilitation in increasing strength, balance and Lysholm Scale. However, there is no consensus on the effectiveness of both therapies on postural control and center of pressure oscillation. Future clinical trials are needed to support the findings of this systematic review.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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CURRICULAR UPDATE IN THEORY AND METHODOLOGY OF SPORTS TRAINING (TMED): VALIDATION OF A QUESTIONNAIRE USING THE CRONBACH ALPHA COEFFICIENT

ACTUALIZACIÓN CURRICULAR EN TEORÍA Y METODOLOGÍA DEL ENTRENAMIENTO DEPORTIVO (TMED): VALIDACIÓN DE UN CUESTIONARIO MEDIANTE EL COEFICIENTE ALPHA DE CRONBACH

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ABSTRACT

The curricular update study in the subject of Theory and Methodology of Sports Training (TMST) at the Higher Pedagogical School of Bié, aimed to validate, using Cronbach's Alpha coefficient, a questionnaire that evaluates skills and competencies in fifth grade students. year of the degree in Physical Education and Sports at the ESPB, to justify the need for a curricular update at the TMST, for which it was conducted from a quantitative approach. The sample design adopted the census category once all the fifth-year students of the degree in Physical Education and Sports participated, consisting of 29 students, of them 25 male and five (5) female. The fundamental instrument used was the TMST competency questionnaire; the internal consistency of the questionnaire items was validated using Cronbach's Alpha coefficient. The validation results indicated a high level of reliability of ($\alpha = 0.858$), corroborating internal consistency. The results of the measures of central tendency, dispersion and correlation between items, using tools such as the Friedman test and ANOVA, showed significant differences, confirming the existence of several dimensions, strong, moderate and low correlations between items, as well as an understanding of the areas in which students show greater or lesser mastery. Weak correlations between items were found as limitations, which infers the need for a review and corroboration with other methods such as item factor analysis (IFA).

Palabras clave:

RESUMEN

El estudio actualización curricular en la asignatura de Teoría y Metodología del Entrenamiento Deportivo (TMED) en la Escuela Superior Pedagógica de Bié, tuvo como objetivo validar mediante el

Alpha de Cronbach, validez, competencias, actualización curricular, Teoría y Metodología del Entrenamiento Deportivo (TMED)	coeficiente Alpha de Cronbach, un cuestionario, que evalúe las habilidades y competencias, en estudiantes de quinto año de la licenciatura en Educación Física y Deportes en la ESPB, para justificar la necesidad de una actualización curricular en la TMED, para lo cual fue conducido a partir de un enfoque cuantitativo. El diseño de la muestra adoptó la categoría de censo una vez que participaron la totalidad de los estudiantes de quinto año de la licenciatura en Educación Física y Deportes, constituidos por 29 estudiantes, de ellos 25 del sexo masculino y cinco (5) femeninas. El instrumento fundamental empleado fue el cuestionario de competencias en TMED, la consistencia interna de los ítems del cuestionario se validó mediante el coeficiente Alpha de Cronbach. Los resultados de la validación indicaron un alto nivel de confiabilidad de (α = 0.858) corroborando la consistencia interna. Los resultados de las medidas de tendencia central, dispersión y correlación entre ítems, utilizando herramientas como la prueba de Friedman y ANOVA mostró diferencias significativas, confirmando la existencia de varias dimensiones, correlaciones fuertes, moderadas y bajas entre ítems, así como una comprensión de las áreas en que los estudiantes muestran mayor o menor dominio. Se encontraron como limitaciones correlaciones débiles entre ítems lo que infiere la necesidad de una revisión y corroboración con otros métodos como el análisis factorial de ítems (IFA).

Introduction

The integration of theory and practice is crucial in the formation of competencies in Physical Education and Sports, this study emphasizes the role of the Theory and Methodology of Sports Training (TMED), not only as a subject, but as a fundamental learning strategy for those trained in the sphere of sports performance, to be able to organize, structure, plan, regulate and control the sports training process in each of the stages of sporting life. At the Bié Higher Pedagogical School, TMED has gained relevance for the professional practice of future trainers.

The development plan for Angola 2023-2027, Government of Angola (2023) declares the need to strengthen programs to improve the quality of higher education and the development of scientific research, while highlighting the need to create the basis for better competitive performance of the athletes of the national teams in international events, considering the generalization of sports practice and the improvement of high performance sports, with emphasis on the training of sports instructors and agents. In this sense, it is important to explain that, in the Theory of Sports Training, the ideas of several sciences are articulated, such as descriptive anatomy, neurophysiology, biomechanics and experimental psychology (Rodriguez, Leon and de la Paz, 2022), as a whole, characterized by the search for performance and productivity of the body, logically, guided by teachers.

The updating of curricular content is fundamental, especially in higher education, facilitating the design of educational programs aimed at training professionals prepared for contemporary challenges, with relevance in the field of sports. Within the TMED, an update is essential for students in physical education and sports of the ESPB to develop the necessary competencies for a performance in correspondence with the socio-cultural context, also achieving social inclusion, related to the attention to diversity (Oroceno, 2008).

The need to address curricular transformation, and as part of it, the updating of contents, leads to an approach to some assumptions of curriculum theories, of which Malagón et al. (2019) highlight the order, which then transits to the category of method, which was conceived as a teaching approach, a discipline oriented to rigor, respect and compliance with academic commitments, these modified elements can be part of indicators for updating the curriculum gives the TMED in the ESPB. Basantes (2019) for his part highlight the socio-political perspectives of the curriculum and ponders the relationship between pedagogical theory and practice, this author this vision defining the curriculum as an essential tool to transform curricula into teaching programs, facilitating pedagogical implementation. This articulation between method and context can provide a set of principles and indicators to update the contents of the TMED.

An academic program can be considered high quality when students acquire the necessary skills to face the challenges of their environment, likewise it is crucial that the curriculum can reflect the characteristics of the knowledge society, integrating the competency-based approach (Barzaga et al., 2019 and Santiago et al., 2019).

Curricular revision from a theoretical perspective has become a global demand (Paz and Padrón, 2020), in the context of university education in the 21st century, a continuous process of improvement and transformation is observed, related to the demands of the contexts and social realities. The TMED in the ESPB requires an update that responds to these demands, as described in the PDN in Angola 2023-2027, and that the approach also corresponds to the educational and professional context of the region.

This adaptation ensures that TMED contributes to the training of skilled professionals (Government of Angola, 2023) to apply theoretical and practical knowledge.

Considering the above, it is important that the updating of the TMED with support in the theories of curricular transformations, be supported by the pillars of curriculum design, this process involves making decisions that cover the creation, implementation and evaluation of the study plan, based on theoretical foundations, aligned to social demands and institutional circumstances (Paz and Padrón, 2020),

On the other hand, Monasterios et al. (2020) point out that Higher Education Institutions face challenges due to a society in constant transformation, these authors highlight the importance of continuous updates in curriculum formulation, emphasizing the dynamics experienced by the contexts, which is why an evolving curriculum vision is needed. This perspective is relevant for the ESPB where the updating of the TMED curriculum must be in correspondence with the changes and needs of the educational and sports field.

Despite the assumptions found in the scientific literature on curricular transformation, the findings in research related to physical education and sports are limited. The theoretical systematization as part of the secondary data does not reveal that there is any research related to curricular modifications in physical education and sports in general, and in TMED in particular, both in the national and international context, making evident the scientific novelty of this study.

In order to delimit the needs for updating the TMED curriculum at the ESPB, it is crucial to think of instruments that allow the diagnosis of professional skills and competencies, as well as to emphasize that the measurements of the method ensure quality so that areas for improvement can be found. In the perspective of Arias & Sireci (2021) validity is a fundamental concept in the context of educational and psychological tests, once they justify the degree to which theoretical and empirical requirements support the interpretations of the scores obtained in a test, for a specific purpose. Validity is considered the most important aspect in test development and evaluation, reiterating the need for this process to ensure a sound scientific basis for the interpretations the researcher intends to make (AERA, APA, & NCME, 2014).

Considering the above, it can be affirmed that the validation of a questionnaire to diagnose competencies in TMED is an essential step for the measurements made to be accurate, and therefore relevant. It is an inescapable fact that updating the TMED curriculum requires a clear understanding of the knowledge and skills that future professionals must acquire, which demands a rigorous diagnosis of the necessary competencies, trying to cover both classical and contemporary theoretical assumptions. In the context where this study is being developed, a rigorous diagnosis of the necessary competencies is crucial, so the development of a solid questionnaire validated and aligned with the curricular objectives not only allows the identification of gaps in teaching, but also acts as a tool to guide continuous improvements in the training of students. Validation should include, content validity, construct validity and criterion validity, ensuring that the questionnaire items are relevant and representative of the desired skills (AERA, APA, & NCME, 2014).

Reliability is one of the essential psychometric properties in research instruments, especially in classical test theory (CTT). In this sense, Cronbach's Alpha is one of the best known methods for measuring the internal consistency of scales. This coefficient gives a clear indication of how well the items of a questionnaire are related to each other, reflecting the homogeneity of what they are intended to measure (Uyanah & Nsikhe, 2023,

p.17; Passafiume et al., 2024; Prodromidis et al. 2024), these authors state that a high Cronbach's Alpha, generally above seven-eight, suggests that the items measure the same construct, which is considered fundamental for the assessment of skills and competencies in TMED.

It is important to highlight the contributions of Chaves et al. (2024), weighting inter-item variability as an element to be considered, Shoushtari-Moghaddam (2024) highlights the robustness of inter-item correlations, as does Lira et al. (2024) explain the impact of inter-item differences, similarly in the estimates of Doğan et al. (2024) explain intraindividual variability, in which Husebø et al. (2023); Peipert et al. (2018) also highlight benefits and unfavorable criteria of high item-to-item correlation, while Kanbay et al. (2022) make their contributions to the moderate correlations between items, at the same time as Kennedy (2022); Cook and Beckman (2006) elaborate on the negative correlations.

Given the importance of a curriculum that adequately prepares future professionals, the validation of this questionnaire is presented as a relevant initiative to contribute to quality training in the field of sport, both for initiation and high performance, based on the update of the TMED.

Considering all of the above, the purpose is to validate, by means of Cronbach's Alpha coefficient, a questionnaire that evaluates the skills and competencies in fifth year students of the degree in physical education and sports at the ESPB, in order to justify the need for a curricular update in the TMED.

Method

This study with the objective of diagnosing the skills and competencies of students in their fifth year of training in the degree in physical education and sport of the ESPB, adopted a quantitative approach considering the way of approaching the problem (Prodanov and Freitas, 2013), this criterion is efficient in studies related to questionnaire or psychometric validation, likewise it is considered descriptive considering its gnoseological and applied objective due to its nature. The IMRyD methodology (Villegas et al. 2023), considering at all times the conceptual management of the variables, which made it possible to contextualize the results obtained with previous studies. [1]

The sample design adopts the census category once the totality of the fifth year students of the degree in Physical Education and Sports, who received the subject Theory and Methodology of Sports Training (TMED) during their formation, constituted by 29 students, 25 of them male and five (5) female, were studied.

The fundamental instrument used was the TMED skills and competencies questionnaire. The internal consistency of the questionnaire items was validated using Cronbach's Alpha coefficient. The application of the instrument was carried out in a single section, after clarifying the research objectives and guaranteeing the reliability of the data. Data analysis was performed using descriptive techniques, such as standard deviation and mean values. Statistical analysis included Friedman's test and ANOVA.

[1] Research where the contents are structured in some way into introduction, methods, result and discussion. https://dialnet.unirioja.es/servlet/articulo?codigo=8632827

Results

The application of Cronbach's Alpha coefficient, to the fifth-year students of the degree in physical education and sports of the ESPB, to evaluate the reliability of the questionnaire applied to diagnose the development of skills and competencies in TMED, which justifies a curricular update, was performed using the statistical software SPSS version 25, the same yielded a value (α = 0.858) indicating a high level of internal consistency. The alpha based on standardized items was (α = 0.877), a result that supports that the questionnaire adequately measures the construct of skills and competencies in TMED. The detailed results extracted from the SPSS version 25 statistical software can be corroborated in Table 1.

Table 1
Reliability statistics of Cronbach's Alpha coefficient

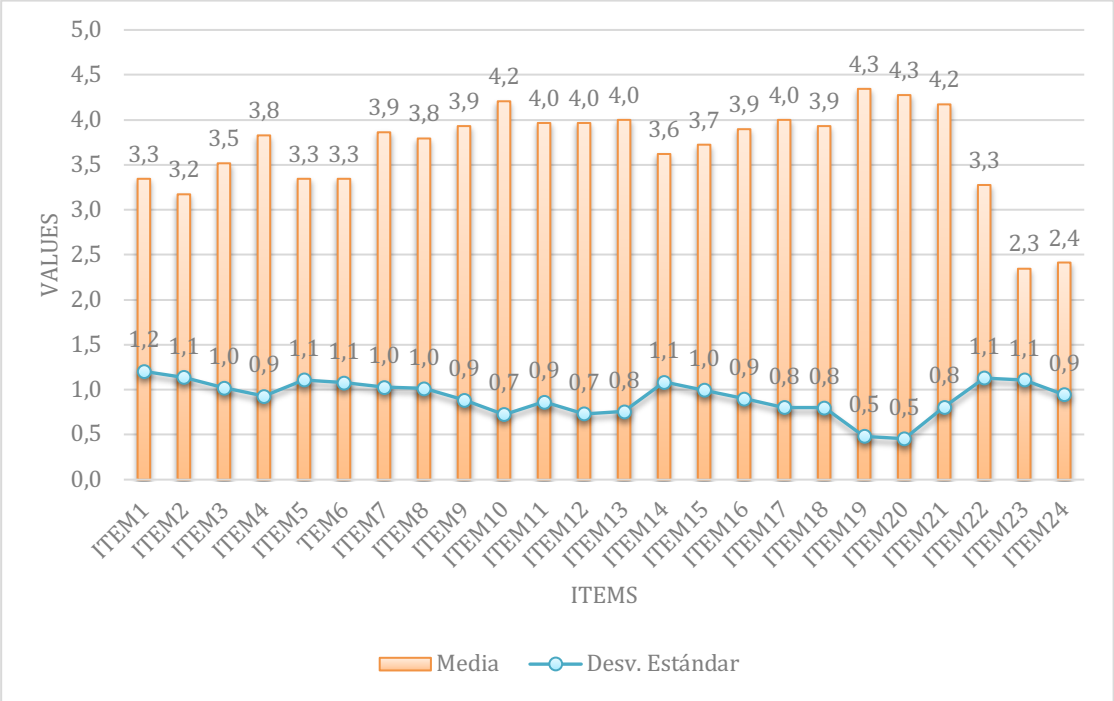
Cronbach's alpha	Cronbach's alpha based on standardized items	N of elements
,858	,877	24

Note. Taken from SPSS software version 21, adapted by Cruz (2024)

The measures of central tendency and dispersion made it possible to place the group studied in a level of difficulty around the data set. In this sense, the item measures range between ($\bar{X}$= 2.3 and $\bar{X}$= 4.3), with an overall mean of (μ= 3.68) on the scale, where the level of difficulty increases as the response values approach five (5). Item 10 ($\bar{X}$= 4.2), which represents the level of difficulty in applying the methods of sports training in correspondence with the time of functional orientation of the load, item 11 ($\bar{X}$=4), which is related to the difficulties in selecting the means and exercises in correspondence with each content of the preparation of the athlete, for its part, item 19 ($\bar{X}$= 4.3) shows high difficulties in elaborating the planning of sports training considering the periodic and cyclic structure of Matveev. The dispersion observed in the standard deviations with ranges between σ = 0.5; σ = 1.2, suggests variability in the perception of difficulty, indicating that some students find some items more difficult than others. Both the results of the measures of central tendency (mean) with the measures of dispersion (standard deviation) can be seen represented in Figure 1.

Figure 1

Measures of central tendency and dispersion



Note. Prepared by Cruz (2024)

On the other hand, the Friedman test with (Chi-square = 188.031, $p < 0.001$) corroborated that there are significant differences between the items of the questionnaire, a result that indicates that students present different levels of difficulty in the competencies evaluated. Similarly, ANOVA shows significant between-subjects variability with a sum of squares (SN= 138.241) and within-subjects (SN= 176.943), confirming differences in perceived difficulty among students. These differences represent the varying degree of challenge experienced by students in relation to the TMED competencies assessed. These results are shown in Table 2.

Table 2
ANOVA results with Friedman's test and Tukey's test for non-additivity

			Sum of squares	gl	Root mean square
Inter subjects			138,241	28	4,937
Intrasubjects	Between elements		176,943[a]	23	7,693
	Waste	Non-additivity	,118[b]	1	,118
		Balance	450,606	643	,701
		Total	450,724	644	,700
	Total		627,667	667	,941
Total			765,908	695	1,102

Note. Taken from SPSS software version 21, adapted by Cruz (2024)

The intraclass correlation coefficient (ICC) for average means is 0.858 with a confidence interval of 0.772 to 0.923, which ensures the stability of the measurement in terms of difficulty. On the other hand, the ICC for individual means is 0.201, which confirms the differences in the perception of item difficulty. The results are confirmed in Table 3.

Table 3
Intraclass correlation coefficient

		95% confidence interval		F test with true value 0	
	Intraclase[b] correlation	Lower limit	Upper limit	Value	gl1
Single measures	,201[a]	,123	,334	7,054	28
Average measurements	,858[c]	,772	,923	7,054	28

Note. Taken from SPSS software version 21, adapted by Cruz (2024)

An analysis of the correlation matrix (Appendix 2), presented between items (Appendix 1), was also carried out, in which strong relationships were observed, but weak relationships were also noted.

Strong positive correlations were confirmed between items 11 and 12 (r = 0.788), items 10 and 11 (r = 0.637). Negative correlations with salience were also found in items 22 and 21 (-0.172); items 22 and 19 (-0.180). Other items indicated low or moderate correlations with others, items 15 with item 9 and with item 23 (0.018 and 0.089) respectively. Another analysis is related to the subgroups and dimensions, as in the case of items 11 to 14, while items 17 to 20 also show high correlations.

Discussion and Conclusions

In the context of the present study, a questionnaire was validated by Cronbach's Alpha coefficient, applied to fifth year students of the ESPB Bachelor's Degree in Physical Education and Sports.

The results show that students face greater difficulty in applied competencies, evidenced mainly in the items that evaluate the difficulties to elaborate training planning considering periodic and cyclic models, as well as the difficulty to apply training methods in relation to the functional orientation of the load. This suggests difficulties in the connection between the theory taught in the corresponding classes and the ability to apply it in practice, which supports the approach of Basantes et al. (2019), authors who reveal the need to articulate theory and practice.

On the other hand, the significant variations among the competencies evaluated reflect that certain aspects of the curriculum do not respond to training needs, coinciding with the perspective of Monasterio et al. (2020), authors who highlight the importance of adapting the curriculum to changing demands.

The validation results from Cronbach's Alpha coefficient indicated a high level of internal consistency supporting the reliability of the questionnaire for assessing TMED competencies. This criterion is important in an educational context, according to Passafiume et al. (2024) reliability allows us to interpret the difficulty in terms of consistency in the students' answers. Cronbach's values above 0.8 in educational questionnaires reflect a solid psychometric structure, especially in contexts where multiple skills are to be assessed simultaneously, these criteria are indicative of robust reliability, which strengthens item cohesion and construct validity.

On the other hand, the value of the standardized items confirms the internal consistency, highlighting that the scale used in the questionnaire is appropriate to assess multiple competencies of students effectively. In this regard, Prodomidis et al. (2024) indicate that high standardized Cronbach's Alpha values confirm stability and absence of significant variations in consistency between subgroups of items.

The application of Friedman's test and the ANOVA reflect significant differences among the items, indicating that students present different levels of difficulty in the competencies evaluated. It should be noted that variability is common in instruments with multiple dimensions (Chaves et al., 2024), as in the case of TMED skills and competencies, which allows for the validation of Friedman's test. The sum of squares between subjects by means of ANOVA showed variability among the students evaluated, as did the intrasubject sum, showing the variability among items. This analysis allowed us to conclude that the items measure different dimensions. Lira et al. (2024) explain that differences between items are common in instruments that span several dimensions.

The results of the intraclass correlation coefficient (ICC) reaffirm that the instrument is suitable for assessing competencies in a stable manner over time. In the educational context, as explained by Doğan et al. (2024) a high ICC for average means, support the use of the difficulty measure as a reliable diagnostic tool, allowing the results to accurately reflect the perception of the group. Shoushtari-Moghaddam (2024) highlights in her study that ICC values close to 0.9 indicate that the instrument can provide reliable measurements, an essential element for the temporal validity of the data, especially in academic contexts.

However, the ICC scores on individual means were low, indicating variability in individual responses, suggesting significant differences in how students perceive the difficulty of each item. Gulliksen's (2013) study highlights that variability may be a reflection of differences in preparation, experience or self-perception of skills and competencies among students, highlighting the need to use averages in the interpretation of perceived difficulty.

The results of the ICC show a limitation found in the study. From these criteria emerges the need to consider personalization, student diversity and inclusion in

curricular updating. "Educational inclusion constitutes an ethical imperative and a complex practical challenge in the context of higher education" (Cedeño et al. 2024, p.70), conceptions that pursue the effective integration of diversity, which leads to the development of a culture of equity in the educational environment (Lewis and Olshansky, 2016), continuing with this line of thought, the characterization of inclusive practices in universities is crucial (Zárate-Rueda, Díaz-Orozco, & Ortiz-Gumán, 2017), once student diversity is recognized and addressed, which transcends individual capabilities, including sociocultural, economic, and ethnic aspects (Pedrero-García, Moreno-Fernández, & Moreno-Crespo, 2017).

The overall mean on the scale suggested a high level of difficulty in the development of skills and competencies in TMED, with some items approaching five, indicating greater difficulty, as in the case of the difficulty of applying training methods related to the load and the challenge to elaborate classical planning models, an important competence in the stage of the athlete's life, related to sports initiation. This coincides with the studies of Lira et al. (2024) who indicate that assessments of complex competencies, measures tend to be related to areas involving greater cognitive effort, this is beneficial since it allows indicating specific needs in the curricula, reinforcing the criteria highlighted, related to inclusion and educational diversity (Cedeño et al. 2024).

Analysis of the inter-item correlation matrix showed both strong and weak correlations, suggesting possible groupings into dimensions, as well as independent items. Positive correlations indicate that the items measured a similar construct; these criteria are consistent with previous studies. Kline (2015) suggests that it is common that in scales assessing several dimensions, positively correlated items suggest underlying factors, whereas negative correlations may indicate opposing dimensions, similarly Husebø et al. (2023), highlight the importance of strong inter-item correlation to strengthen construct validity and psychometric robustness (Peipert et al., 2018).

The results also showed moderate correlations between items of which the study by Kanbay et al. (2022) that moderate correlations provide variety to the construct, contributing to content validity, especially in multivariate questionnaires, which is appropriate for the proposed questionnaire to assess skills and competencies in TMED.

In addition, items with low correlation may require revision in terms of wording or adjustments in order to adequately represent the construct; it is also possible that they are measuring particular aspects that do not necessarily correlate with other more general aspects (Field, 2009) and may even impair the reliability of the scale (Cook and Beckman, 2006).

The presence of negative correlations constitutes a limitation of this study, suggesting a review of the items, in terms of content and structure, which according to Tabachnick and Fidell (2014), these discrepancies may indicate the need for an exploratory factor analysis, to better understand the latent structure of the instrument and adjust items with negative, low or no correlations. Even so, Asún, Rdz-Navarro & Alvarado (2016) in their study explain that for complex scales the use of item factor analysis (IFA) achieves equivalent parameter estimates, preventing biases, and the achievement of a more accurate representation of the constructs evaluated.

This study not only validates an instrument to measure competencies in TMED, but also provides a roadmap to adjust curricula according to the demands of contemporary sport, allows the formation of more competent teachers capable of facing sport challenges, both in initiation and high performance.

The results have significant practical implications for physical education and

sports programs. The high difficulty in training planning suggests the need to include specific methods that simulate real training planning and control scenarios.

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Annexes

Annex 1

Questionnaire Portuguese version

Item	Question	1	2	3	4	5
1	Quão difícil você acha compreender a evolução do treinamento desportivo ao longo do tempo?	◯	◯	◯	◯	◯
2	Avalie sua dificuldade em explicar os principais conceitos relacionados à evolução do treinamento desportivo.	◯	◯	◯	◯	◯
3	Quão desafiador é para você identificar as mudanças no organismo perante os efeitos da carga de treinamento?	◯	◯	◯	◯	◯
4	Avalie sua dificuldade em interpretar a lei de adaptação biológica ou a síndrome de Seyle.	◯	◯	◯	◯	◯
5	Como você classifica sua habilidade em aplicar os princípios pedagógicos dentro da preparação do desportista?	◯	◯	◯	◯	◯
6	Quão complicado é para você aplicar os princípios biológicos dentro da preparação do desportista?	◯	◯	◯	◯	◯
7	Avalie seu nível de dificuldade em identificar os componentes da carga segundo as diferentes teorias clássicas e contemporâneas.	◯	◯	◯	◯	◯
8	Como você classificaria o nível de dificuldade para avaliar sua capacidade de controlar as cargas de treinamento segundo sua orientação funcional?	◯	◯	◯	◯	◯
9	Quão complicado é para você identificar o papel dos métodos na dosificação, regulação e controle da carga de treinamento desportivo?	◯	◯	◯	◯	◯
10	Como você classificaria as dificuldades em aplicar os métodos do treinamento desportivo em correspondência com o tipo de orientação funcional da carga e os meios de treino?	◯	◯	◯	◯	◯

11	Avalie sua dificuldade em determinar os meios (exercícios) da preparação do desportista em correspondência com cada conteúdo.	○	○	○	○	○
12	Quão complicado é para você aplicar os componentes da carga de treinamento a cada conteúdo de preparação?	○	○	○	○	○
13	Quão desafiador é compreender as particularidades da preparação do desportista nas etapas da vida do atleta?	○	○	○	○	○
14	Avalie sua dificuldade em explicar o treino desportivo como processo pedagógico a longo prazo na base.	○	○	○	○	○
15	Quão complicado é para você elaborar a fundamentação teórica de um programa dirigido ao ensino desportivo?	○	○	○	○	○
16	Quão desafiador é elaborar um programa gráfico de ensino desportivo tendo em conta todos seus componentes?	○	○	○	○	○
17	Avalie seu nível de dificuldade em elaborar planos de treino a partir das tendências tradicionais.	○	○	○	○	○
18	Quão complicado é para você elaborar planos de treino a partir das tendências contemporâneas?	○	○	○	○	○
19	Quão desafiador é para você utilizar a metodologia para a elaboração da planificação do treinamento a partir da Estrutura periódica e cíclica de Matveev?	○	○	○	○	○
20	Avalie sua dificuldade em elaborar um plano escrito a partir da Estrutura periódica e cíclica de Matveev.	○	○	○	○	○
21	Quão complicado é para você aplicar os diferentes testes de controle da preparação do desportista?	○	○	○	○	○
22	Avalie sua dificuldade em aplicar os métodos, técnicas e instrumentos da seleção de talentos.	○	○	○	○	○
23	Quão desafiador é para você melhorar a competência pessoal e o controle emocional para orientar o treinamento e a competição de forma adequada?	○	○	○	○	○

24	Como você classificaria sua habilidade para orientar o treinamento e a competição de forma adequada?	◯ ◯ ◯ ◯ ◯

Annex 2

Correlation matrix between elements

	ITEM 1	ITEM 2	ITEM 3	ITEM 4	ITEM 5	TEM6	ITEM 7	ITEM 8
ITEM1	1,000	,451	-,266	,247	,442	-,067	,127	,324
ITEM2	,451	1,000	-,080	,063	,234	-,167	,420	,094
ITEM3	-,266	-,080	1,000	,474	,089	-,006	,479	,004
ITEM4	,247	,063	,474	1,000	,025	,383	,312	,264
ITEM5	,442	,234	,089	,025	1,000	-,312	,169	,383
TEM6	-,067	-,167	-,006	,383	-,312	1,000	,109	,296
ITEM7	,127	,420	,479	,312	,169	,109	1,000	,178
ITEM8	,324	,094	,004	,264	,383	,296	,178	1,000
ITEM9	,325	,261	-,236	,072	,353	,176	,423	,422
ITEM10	,324	,215	,043	,267	,484	-,140	,136	,594
ITEM11	,595	,442	-,302	,081	,384	-,063	-,006	,440
ITEM12	,582	,480	-,310	,044	,279	-,075	,232	,231
ITEM13	,550	,208	-,092	,305	,170	,219	,184	,420
ITEM14	,460	,403	-,139	,039	,350	,024	,209	,349
ITEM15	,410	-,051	,110	,178	,541	-,174	,066	,401
ITEM16	,430	,158	-,095	,234	,430	,185	,023	,485
ITEM17	,407	-,078	-,131	,288	,080	,578	,174	,352
ITEM18	,434	-,026	,089	,561	,310	,153	,380	,511
ITEM19	,279	,148	,277	,535	,236	,380	,459	,442
ITEM20	,407	,181	-,087	,286	,017	,455	,391	,361
ITEM21	,305	,396	,018	,280	,091	-,071	,463	,133
ITEM22	,190	,045	-,282	-,225	,433	-,022	-,243	,239
ITEM23	,095	-,020	-,194	-,010	,219	,315	-,239	,256
ITEM24	,247	,097	-,192	-,038	,301	,205	-,050	,204

	ITEM 9	ITEM 10	ITEM 11	ITEM 12	ITEM 13	ITEM 14	ITEM 15	ITEM 16
ITEM1	,325	,324	,595	,582	,550	,460	,410	,430
ITEM2	,261	,215	,442	,480	,208	,403	-,051	,158
ITEM3	-,236	,043	-,302	-,310	-,092	-,139	,110	-,095
ITEM4	,072	,267	,081	,044	,305	,039	,178	,234
ITEM5	,353	,484	,384	,279	,170	,350	,541	,430
TEM6	,176	-,140	-,063	-,075	,219	,024	-,174	,185
ITEM7	,423	,136	-,006	,232	,184	,209	,066	,023
ITEM8	,422	,594	,440	,231	,420	,349	,401	,485
ITEM9	1,000	,246	,417	,604	,160	,345	,018	,215
ITEM10	,246	1,000	,637	,552	,456	,421	,427	,635
ITEM11	,417	,637	1,000	,788	,546	,519	,320	,637
ITEM12	,604	,552	,788	1,000	,517	,569	,232	,537
ITEM13	,160	,456	,546	,517	1,000	,480	,474	,420
ITEM14	,345	,421	,519	,569	,480	1,000	,264	,288
ITEM15	,018	,427	,320	,232	,474	,264	1,000	,286
ITEM16	,215	,635	,637	,537	,420	,288	,286	1,000
ITEM17	,403	-,061	,103	,183	,530	,370	,000	,247
ITEM18	,347	,395	,203	,240	,473	,134	,604	,337
ITEM19	,308	,400	,285	,338	,781	,327	,353	,331

ITEM20	,493	,037	,297	,459	,519	,510	,253	,159
ITEM21	,319	,303	,368	,557	,587	,160	,418	,124
ITEM22	-,088	,276	,193	,098	,000	,205	,133	,520
ITEM23	-,084	,130	-,061	-,117	,000	,083	,089	,287
ITEM24	,078	,079	-,026	-,030	,000	,159	,125	,094

	ITEM 17	ITEM 18	ITEM 19	ITEM 20	ITEM 21	ITEM 22	ITEM 23	ITEM 24
ITEM1	,407	,434	,279	,407	,305	,190	,095	,247
ITEM2	-,078	-,026	,148	,181	,396	,045	-,020	,097
ITEM3	-,131	,089	,277	-,087	,018	-,282	-,194	-,192
ITEM4	,288	,561	,535	,286	,280	-,225	-,010	-,038
ITEM5	,080	,310	,236	,017	,091	,433	,219	,301
TEM6	,578	,153	,380	,455	-,071	-,022	,315	,205
ITEM7	,174	,380	,459	,391	,463	-,243	-,239	-,050
ITEM8	,352	,511	,442	,361	,133	,239	,256	,204
ITEM9	,403	,347	,308	,493	,319	-,088	-,084	,078
ITEM10	-,061	,395	,400	,037	,303	,276	,130	,079
ITEM11	,103	,203	,285	,297	,368	,193	-,061	-,026
ITEM12	,183	,240	,338	,459	,557	,098	-,117	-,030
ITEM13	,530	,473	,781	,519	,587	,000	,000	,000
ITEM14	,370	,134	,327	,510	,160	,205	,083	,159
ITEM15	,000	,604	,353	,253	,418	,133	,089	,125
ITEM16	,247	,337	,331	,159	,124	,520	,287	,094
ITEM17	1,000	,335	,553	,588	,000	-,039	,160	,141
ITEM18	,335	1,000	,618	,447	,519	-,018	,068	,039
ITEM19	,553	,618	1,000	,526	,576	-,180	-,030	-,089
ITEM20	,588	,447	,526	1,000	,548	-,014	-,124	-,026
ITEM21	,000	,519	,576	,548	1,000	-,172	-,348	-,238
ITEM22	-,039	-,018	-,180	-,014	-,172	1,000	,547	,457
ITEM23	,160	,068	-,030	-,124	-,348	,547	1,000	,879
ITEM24	,141	,039	-,089	-,026	-,238	,457	,879	1,000

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CHARACTERIZATION OF MEDIA CULTURE IN UNIVERSITY STUDENTS FROM THE PHYSICAL ACTIVITY AND HEALTH PROFILE

CARACTERIZACIÓN DE LA CULTURA MEDIÁTICA EN ESTUDIANTES UNIVERSITARIOS DEL PERFIL DE LA ACTIVIDAD FÍSICA Y LA SALUD

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ABSTRACT

This study investigates the development of media culture (MC), which serves as an essential pillar within the framework of higher education. The objective is to characterize MC in university students specializing in physical activity and health. A random sampling of participants was combined with the Bootstrap method, resulting in a final sample of 300 students across first to fourth academic years, including male and female students aged 18 to 21 years. Peer observations were conducted on educational activities that incorporated the use of ICT, and the variables of interest related to MC were recorded using a purpose-built observation guide. The theoretical analysis identified three dimensions aligned with the observation guide: communicative expressiveness, holistic interpretation, and logical achievement of hypermedia content, processes justified by the emergence of hypermedia as a new textual form. Comparisons across academic years for each dimension using the Mann-Whitney test revealed significant differences in all paired comparisons, with the greatest effect sizes observed between extreme academic years (1st vs. 4th and 2nd vs. 4th), favoring the development of MC. Robust regression analysis and comparisons of performance results (insufficient vs. adequate) showed a favorable shift in MC learning during the 3rd academic year.

RESUMEN

El presente estudio tiene como objeto de investigación la formación de la cultura mediática (CM), por constituir esta un pilar esencial en los marcos de la educación superior, en consecuencia, se plantea como objetivo caracterizar la CM en estudiantes universitarios del perfil de la actividad física y la salud. Para llevar a cabo la investigación se realizó una selección

Palabras clave:

formación, cultura mediática, interpretación, expresividad	aleatoria de participantes que se combinó con el método de Bootstrap para conseguir una muestra final de 300 estudiantes de primero a cuarto curso académico, incluyendo hombres y mujeres, de 18 a 21 años de edad. Se les realizó una observación por pares a actividades docentes que incluían el uso de las TIC y se registraron las variables de interés de la CM incluidas en una guía de observación para este propósito. El análisis teórico aporto tres dimensiones en correspondencia con la guía de observación: expresividad comunicativa, interpretación holística y consecución lógica del contenido hipermedia; procesos que se justifican por la aparición de un nuevo texto, el hipermedia. El contraste entre los cursos para cada una de las dimensiones, empleando la prueba de Mann-Whitney mostró diferencias significativas en todos los pares comparados, hallándose mayor magnitud del efecto entre los cursos extremos (1 vs 4) y (2 vs) a favor del desarrollo de la CM. El análisis de regresión robusta y un contraste de comparación de resultados (insuficientes vs bien) mostraron que en el 3er curso se producía un cambio favorable del aprendizaje de la CM.

Introduction

The Cuban University, in its historical development, shows a continuous improvement of its substantive processes in response to the changes occurred in the national and international environment and, consequently, Pedagogy and Didactics of this educational level are developed as a theoretical corpus to objectively direct the training of professionals, with pertinently configured modes of action, in correspondence with the complex and dynamic social context marked by globalization in which contemporary man coexists.

Information and Communication Technologies (ICT), in the referred scenario, constitute an educational support of global scope, bearers of new forms of communicative expressions, which transform the teaching environment by providing new mediations to represent didactic entities that legitimize the apprehension of socio-cultural instances.

In the formative processes, the irruption of a new communicational architecture marked by interactivity and the integration of symbols of different sensorial and documentary nature, resulting in complex textual constructions, is evident.

The above confirms that it is not enough for the student to have the skills to operate information technologies, but that it is necessary to incorporate new knowledge, referring to how to sequence and interact rationally with the media content to appropriate the didactic information, i.e., a media culture is required that consequently favors the training of the professional and his or her development.

Contemporary universities pay special attention to media culture as a form of social awareness that enables students, from their worldview, to assume a critical and selective attitude towards the system of codes that move the discourses of learning environments, from different cultural backgrounds.

Educational organizations in different territorial locations see the development of media culture as an immediate need to be solved, and direct their research in this direction, as shown in the scientific works of the following authors: Dongo-Mejía et al. (2022), Hernando-Gómez et al. (2022), Pérez (2019), Gómez-García et al. (2020), Cabrera (2017), González (2016), Instituto Nacional para la Educación Superior en Latinoamérica y el Caribe (2010), Montero (2006), Cátedra Unesco de Comunicación (2001) and Gómez (2000) among others.

The scientific productions of Ramasubramanian et al. (2020) show that the effects of media culture transcend the critical apprehension of the social and cultural reality expressed in the media, and are projected to the conditioning of the new forms of social relations in which the individual must coexist for his integral development, that is to say, these conditions express new modes of interaction with communicational support and whose management is the responsibility of the subject in his daily "coexistence".

The aforementioned has caused several researchers in Sociology, Semiotics and Pedagogy to agree in promoting, in the field of education, the search for new theories, methods and strategies that favor the construction of the media education of the professional. Consequently, the European Union, taking on board these considerations of the experts, suggests including media education as a subject in the curricula, which is stated in European and American publications, among which we find: Yazon et al. (2019), Law et al. (2018), Pérez Tornero (2010) and Elpaís.com (2008). In accordance with this position, UNESCO, in several of its educational guidelines -Mateus et al. (2022), Alcolea-Díaz et al. (2020), UNESCO (2009) and Cátedra UNESCO de comunicación (2009)- also

establishes such intentionality supported by solid practical and epistemological arguments.

The guiding documents of higher education in Cuba, which regulate the design and implementation of study plans in its different stages - Ministerio de Educación Superior. Cuba (2022), Artola Pimentel et al. (2019), MES (2003) and (Álvarez de Zayas, 1988), declare with incremental emphasis, implicitly in the former and explicitly in the latter, the need for the construction of media culture.

The educational praxis of the university, in its contextual singularity, has promoted the insertion of Information and Communication Technologies in the different professional profiles for more than three decades. Today this practice, based on media culture, is essential in the training of professionals. Didactics, throughout this period, has gone through epistemological steps of ascent to perfect this knowledge and has knotted factual reasons that elevate it to a generalized social need. However, the theoretical foundations and the degree of mastery of the media culture related to these technologies have not been studied in sufficient depth.

For this reason, the present study *aims* to characterize from a holistic approach the media culture in the university context of Granma province in Cuba.

The following two specific objectives are derived from the general objective.

- To analyze, from a theoretical approach, the process of formation of media culture in the university context.
- To empirically diagnose the current state of the level of development of media culture in the university context.

Due to the nature of the objectives, the study is empirical-theoretical and is classified as cross-sectional, observational and descriptive.

Theoretical Analysis of the Media Culture Formation Process in the University Context

The present epigraph responds to the first specific objective, it is focused on revealing the theoretical references that support the methodological and empirical approach to Media Culture, as the main theoretical contribution it is proposed to provide a redefinition of the concept and its dimensions.

Method

The Dialectical Hermeneutic Method was used to *understand* the accumulated theoretical bases of Media Culture, to *explain* the new relationships between its theoretical constituents in the contemporary conditions of socio-technological development and, as a result of the *interpretation*, to provide a synthesis definition of the existing perspectives adjusted to contemporaneity.

Results

Culture is a category whose presence is becoming more and more frequent in the works of Pedagogy and Didactics. Specialists in these branches of knowledge pay special attention to this category because of what it represents for the processes under study in these sciences.

This concept has been approached by different sciences such as Philosophy, Sociology, Psychology, Aesthetics, Linguistics, Anthropology and Semiotics, among others, each one of which has given it meaning from its theoretical referents at different moments of the social historical evolution, which favors a more complete and contextualized elaboration of the referred category. Such contributions have become solid references that complement the theoretical vision of culture as an essential element in the formative process of higher education and make possible its singularized completeness in this

domain of social activity and condition new milestones in its historical development (Macías Reyes et al., 2010; Universidad de Almería, 2010).

Learning within the framework of culture is understood as a dichotomous process, that is, it presents two modes of execution: the first, informal, when it is developed spontaneously, arising from the social subjects themselves due to their needs and interests, and the second is formalized, with the intervention of institutions that regulate and manage the process, as expressed by Heersmink (2023).

Culture is concretized in the social interaction of the subjects, since it is supported by learning; therefore, it is inherent in the communicative activity from which the subjects, by exchanging their ideas in the form of messages, transform each other and in turn contribute to the development of culture as a social product. From this assumption, communication is assumed to be an essential process for culture, considered as a form of social consciousness (Echenique, 2023; Marcuse, 1967).

The research of Montoya Rivera (2005) formalizes this category, for the formative context, by framing it in three spheres: accumulated results, constant creations, and projects and goals, which gives it a dialectical and didactic nuance.

In the referred study, from this consideration, human activity is redefined as a whole constituted by the dialectic relations between the transforming activity and the cognitive one, dynamized and synthesized by the valuative activity and mediation.

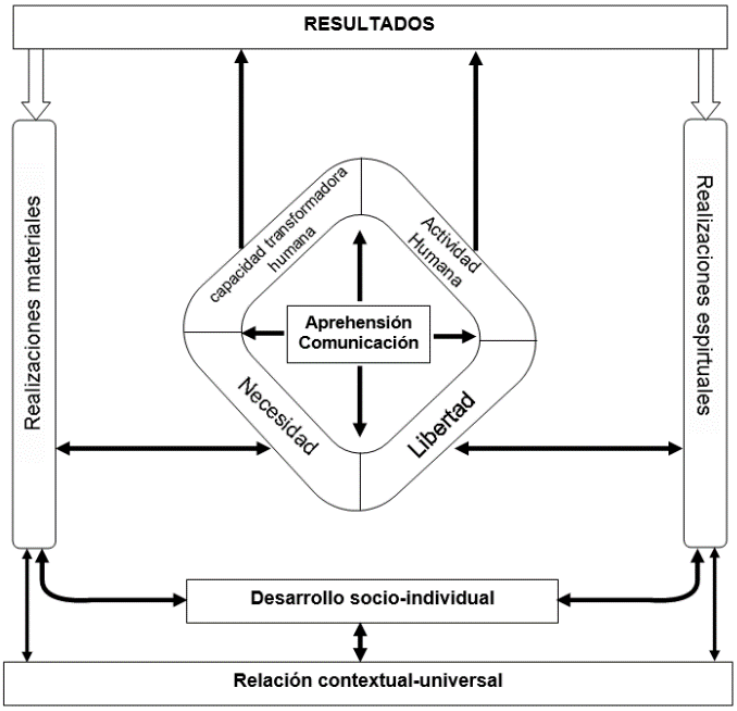
Based on the above references, in this research, culture is understood as:

> A totality of complex character configured by the human transforming capacity in relation to human activity and its results, routed by the need and freedom possessed by the subjects in their material and spiritual realizations, which are expressed in the continuous process of individual and social self-development on the basis of *apprehension* and *communication* in which the contextual and the universal are integrated in a specific historical stage (Pérez Lozada, 2011, p.13).

Communication, in this context (Figure 1), becomes a form of mediation, which allows us to penetrate the interstices of phenomena to find their essence, since it not only exists between subjects, but also occurs as an internal process of the subject (Vygotsky, 1981).

When the theses of the Human and Cultural University, from Fuentes González (2008), are incorporated into the training process, then substantial transformations are generated in its design and projection, in the dynamics, in the evaluation and in the results that as praxis confirm the theory. Such a position implies recognizing that university education is a process that develops human capacities, in which man must be seen as the center, where he acquires an eminently active role that leads him to "prepare himself throughout his life for life". It then suggests a level of greater concreteness of the training process and the adoption of new methods in correspondence with the theoretical corpus, to confer the leading role of the professional at each level of systematicity foreseen with the pertinent mechanisms of regulation and correction.

Figure 1
Relationships of the components of culture in the formative framework



From this theoretical platform, professional training is understood as an essentially cultural and human process, which is conceived in a dialectical relationship with communication by assuming the assumption of "human activity" and the definition of culture provided, which specifies that it contains communication at its core of development (Alsina et al., 2014; Fuentes González, 2010).

This advance in the resignification of the concept of professional training associated with communication is the result of the emergence of new technological communication platforms that transform the traditional forms of human communication, where texts of different types appear, establishing multiple links with other texts as transitional routes between them, and the participation of the social subject as the protagonist of the communicative act emerges through channels that increasingly provide higher quality to the communicative forms and contents.

These new qualities of communication based on ICT make its material carrier acquire a new constitution, which is why the author identifies it with the name of hypermedia text and defines it as a text made up of codes of different formats and sensory nature, containing links that emerge from its structure and that enable relational polymorphism with other texts, media objects and subjects, configuring the gnoseological content as a whole from the relationships that are established between the nodes of communicational information.

Thus, the practices of -reading and reconstruction- have been addressed in different works, among whose authors are Ancízar Narváez (2021), Pérez Tornero (2010) and Orozco Gómez (2001), who agree in referring to them under the name of media culture, pointing to the need for their intentional formation.

This particular culture, by consensus of those who research it, is accepted as an indispensable resource for the critical understanding of nature, society and its associated phenomena, which is conducive to healthy social coexistence and human and professional development. This layer of knowledge is unanimously considered as a pedestal in the

appropriation and development of the rest of the cultures, to the point that it is recognized as literacy in the knowledge society (Frómeta Quintana, 2017; Ricoy Lorenzo, 2006).

From the perspective of the present research, *media culture (MC)* is understood as "the integrated process of communicative practices, supported by Information and Communication Technologies, and its results, expression of the dialectic relationship between *communicative expressiveness*, *holistic interpretation* and *logical consistency* of the hypermedia content that configures, as a whole, a support for continuous human development".

Media training must be understood as a quality, expression of processes and results constituting a whole, that is, as the activities intentionally aimed at the appropriation of this culture and the degree to which it has been internalized as awareness in professionals, which conditions the way in which its professionalizing transforming capacity is expressed and emerges. From this reasoning, both, media training and professionalizing transforming capacity, are identified as dialectical pairs that mutually condition each other in their development and that of the professionals in training.

Empirical Diagnosis of the Current State of the Level of Development of Media Culture in the University Context

Instrument

The observation guide is used to obtain data for the diagnosis of media culture, the dimensions of which are explained below:

Holistic interpretation (HI) of the hypermedia text, process through which the learner identifies the communicative units of each text that participate simultaneously in the discourse, discovers their meaning, finds the relationships between them, totalizing, through successive synthesized reconstructions, a meaning in correspondence with their sociocultural referents.

Communicative expressiveness (CE) is the process by which thought, with intentionality, is translated into a symbolic system that materializes in multiple texts of different nature, interconnected as a coherent whole intended for interaction with other subjects and the support of one's own thought, whose identity emerges from the content-form link mediated by morality.

Logical sequentiality of content (LC) refers to the organized and conscious succession of technological actions, of different levels of complexity, performed by a subject with the elements of a digital communication device or tool to create, express or interact effectively with hypermedia texts.

Method

Participants

The study population was selected from the context of the University province of Granma Province in Cuba, from the profiles of physical activity and health, from the first year to the fourth year. The form of selection was stratified random to achieve a balance among the students of the different courses that participated and among the sex denominations so that it was possible to carry out statistical processing in accordance with the objectives. The sample was initially made up of 30 students, and with the Bootstrap re-sampling process, a total of 300 subjects were finally reached to carry out the study.

Sampling Instrument

The observation guide of Pérez Lozada (2011), designed to explore the level of development of Media Culture in university students, configured from the constructs explained above, was used: *Communicative expressiveness, Interpretation of the hypermedia text* and *Logical sequentiality of the content, structured* in nine observation descriptors that are rated on a 5-level scale, i.e., scores from 1 to 5.

Procedure

Prior to conducting the observation, the subjects were informed of the purpose of the exercise, making it clear that it was a voluntary and completely anonymous act, since no data would be recorded that would serve as a link to identify the participants. In this way, the observation was carried out by two teachers who independently recorded the observed activity data. To mitigate the effects associated with observation bias, strategies were established to reach consensus on discordant scores between observers on the same item.

Statistical Analysis

The data were recorded in Microsoft Excel and a validation process was performed to correct out-of-range and null data. The R language, using RStudio V20224.09.0 -build 375-, was used to complete the sample by means of a Bootstrap algorithm (with the "*boot*" library), the Kolmogórov-Smirnov tests to verify normality, the Mann-Whitney test for the comparison of measurements, the generation of graphs (tidyverse and ggplot2 libraries), the Z test for the comparison of proportions, and the Z test for the comparison of proportions.

Results

General Characteristics of the Sample

Table 1 presents the main demographic characteristics of the sample, designed to explore variations in media literacy constructs according to educational level, i.e., academic years (1st to 4th). In addition, it includes the distribution by sex and age levels of the participants (18-23 years), providing a frame of reference for interpreting the results derived from the statistical analysis.

Table 1

Descriptive variables of the study sample

variables	levels	N	%	Average E	DE	EN
Sex	Woman	139	46,33	20,68	2,297	0,195
	Man	161	53,67	20,74	1,719	0,136
Course	1	71	23,67	18,92	1,565	0,186
	2	74	24,67	19,97	1,158	0,135
	3	83	27,67	21,59	0,733	0,080
	4	72	24,00	22,5	0,839	0,099
	Total	300		20,78	1,760	0,102
Age	18	50	16,70			
	19	30	10,00			
	20	48	16,00			
	21	47	15,60			
	22	59	19,70			
	23	66	22,00			

Note. N: number of cases, ME: mean age, SD: standard deviation, SE: standard error

The selected sample exhibits a balance in the levels corresponding to each of its constituent variables: sex, academic year and age, which allows for the appropriate application of the statistical analysis tests required by the objectives of the study.

Comparison Between Dimensions in Each Academic Year

The assumptions of normality of the dimensions EC, HI, CL by strata -academic courses- are checked, given that the sample in each stratum of the variables is greater than 30, the Kolmogórov-Smirnov normality test is used, in all cases values of $p<0.05$ were obtained, so it is concluded that the sample does not have a normal distribution, consequently, a non-parametric statistical method is selected, the Mann-Whitney test to perform the comparisons.

A comparison of the differences in measures of the dimensions, including media culture, by academic courses was performed as shown in Table 2.

The referred table shows for each course (1st, 2nd, 3rd and 4th) the pairwise comparison of the dimensions (EC vs IH, IH vs CL, CL vs EC), in all cases values of $p>0.005$ were obtained (between 0.200 and 0.994), which means that no significant difference was found between the measures of the dimensions compared, according to the Mann-Whitney test.

Table 2

Comparison of dimensions by course

Year	DIM	N	Median	IQR	U	p-value	r
EC	EC	71	1,67	1,33-2,33	2615,5	0,699	0,032
	IH		1,50	1,25-2,50			
	IH	71	1,50	1,25-2,50	2329,5	0,432	0,066
	CL		1,50	1,25-2,50			
	CL	71	1,50	1,25-2,50	2619,5	0,687	0,034
	EC		1,67	1,33-2,33			
IH	EC	74	2,25	1,83-2,63	2788,5	0,847	0,016
	IH		2,25	1,56-2,50			
	IH	74	2,25	1,56-2,50	2548	0,464	0,06
	CL		2,25	1,75-2,75			
	CL	74	2,25	1,75-2,75	2887	0,568	0,047
	EC		2,25	1,83-2,63			
EC	EC	83	3,00	2,33-3,33	3130,5	0,309	0,079
	IH		3,00	2,38-3,50			
	IH	83	3,00	2,38-3,50	3447,5	0,994	0,001
	CL		3,00	2,25-3,50			
	CL	83	3,00	2,25-3,50	3703,5	0,402	0,065
	EC		3,00	2,33-3,33			

Note. Dim: dimensions, N: number of cases, IQR: quartile range 25-75, U: Mann-Whitney statistic, r: effect size.

Comparison Between Academic Years in Each Dimension

The assumptions of normality of the dimensions in each of the academic years (1st, 2nd, 3rd and 4th) are checked

the Kolmogórov-Smirnov normality test was used, given that the sample in each stratum of the variables is greater than 30. In all cases, values of $p<0.05$ were obtained, so it is concluded that the sample does not have a normal distribution; consequently, a non-parametric statistical method, the Mann-Whitney test, was selected for comparisons.

EC Dimension

Figure 2

Median and interquartile ranges of CD

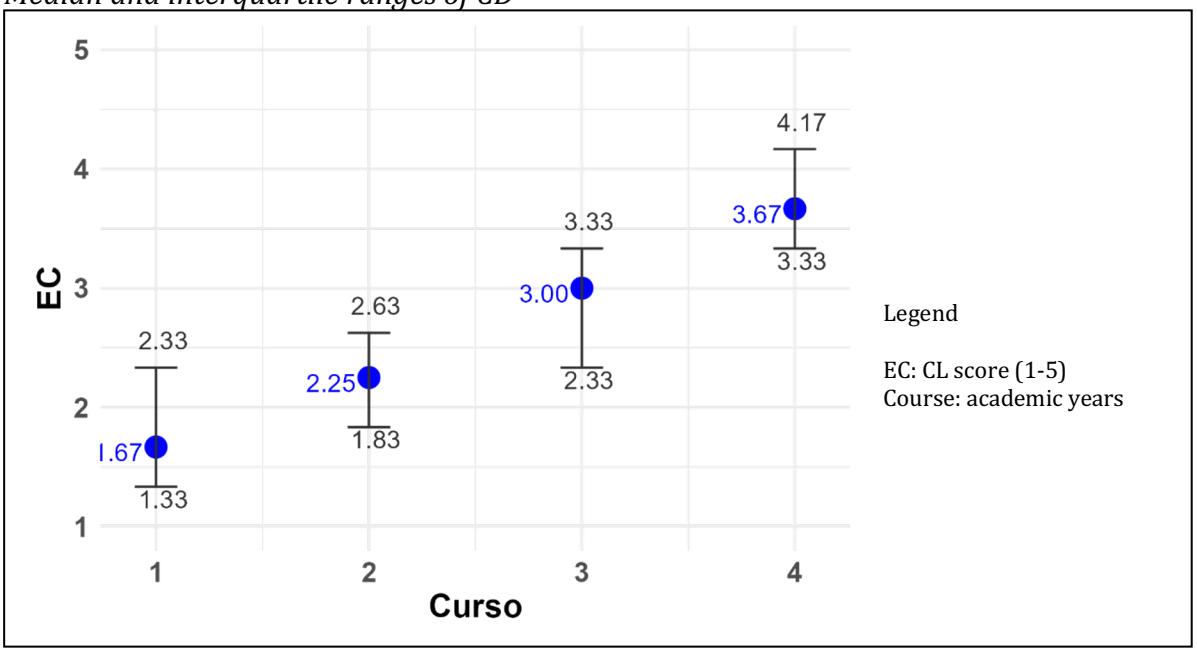


Figure 2 illustrates the median and interquartile ranges (Q1-Q3) of the CE dimension by academic years. It is observed that academic year 1 presented the highest median (4.17), while academic year 1 had the lowest median (1.50). These differences are consistent in all pairwise comparisons, as confirmed by statistical analyses. In courses 1 and 4 there is a shift of the median concentration towards Q1.

Table 3

Comparison of academic courses in EC

Dimension	Comparison	U	p-value	r	rc
EC	Course 1 vs Course 2	1639,00	***	0,326	moderate
	Course 1 vs Course 3	852,00	***	0,613	grande
	Course 1 vs Course 4	218,50	***	0,791	grande
	Course 2 vs Course 3	1431,50	***	0,462	moderate
	Course 2 vs Course 4	301,00	***	0,767	grande
	Course 3 vs Course 4	1166,50	***	0,527	grande

Note. u: Mann-Whitney statistic, r: effect size, rc: qualitative coding of effect size.

The results of the pairwise comparisons are presented in Table 1. All pairs of courses showed statistically significant differences (p<0.001). This indicates that *CE* distributions differ among all courses. Effect sizes (r) ranged from moderate to large, with distinctive values in pairs: Course 1 vs Course 4 (r=0,791) and Course 2 vs Course 4(r=0.767).

IC Dimension

Figure 3
Median and interquartile ranges of CD

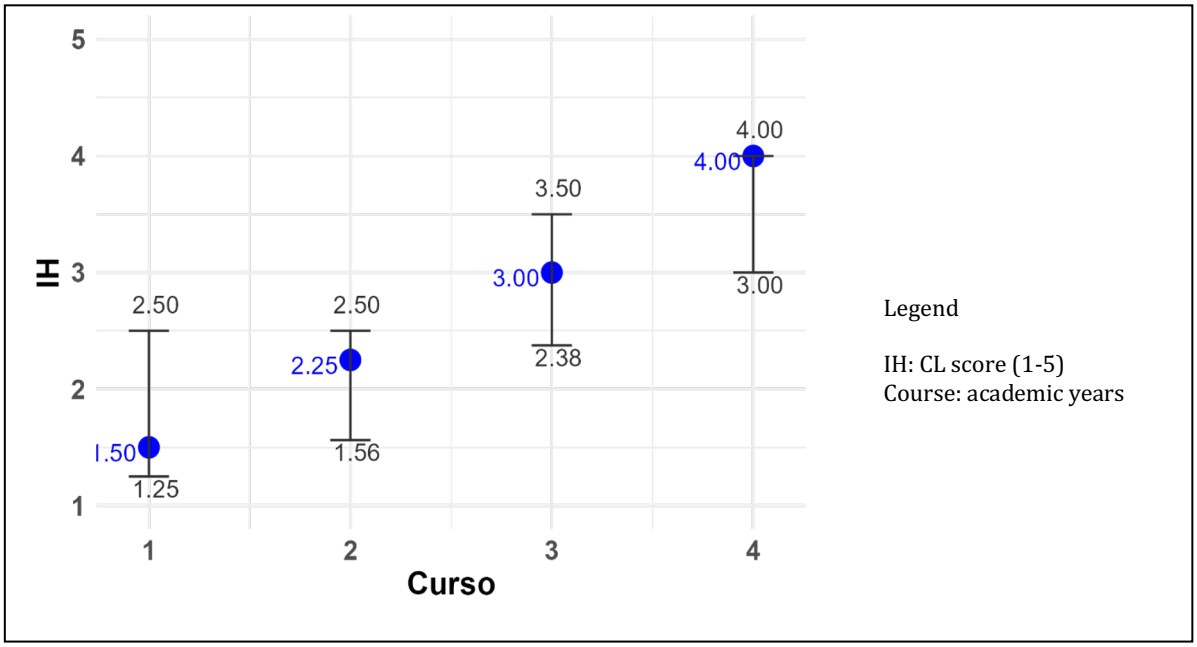


Figure 3 illustrates the median and interquartile ranges (Q1-Q3) of the CE dimension by academic years. It is observed that the 4th academic year presented the highest median (4.00), while the 1st academic year had the lowest median (1.50). These differences are consistent in all pairwise comparisons, as confirmed by statistical analyses. In courses 1 and 4 there is a shift of the median concentration towards Q1 and Q3, respectively.

Table 4
Comparison of academic courses in EC

Dimension	Comparison	U	p-value	r	rc
IH	Course 1 vs Course 2	1748,00	***	0,291	Small
	Course 1 vs Course 3	896,00	***	0,602	Grande
	Course 1 vs Course 4	488,00	***	0,703	Grande
	Course 2 vs Course 3	1463,00	***	0,454	Moderate
	Course 2 vs Course 4	638,00	***	0,662	Grande
	Course 3 vs Course 4	1889,00	***	0,319	Moderate

Note. u: Man Whitney statistic, r: effect size, rc: qualitative coding of effect size.

The results of the pairwise comparisons are presented in Table 4. All pairs of courses showed statistically significant differences (p<0.001). This indicates that *CE* distributions differ among all courses. Effect sizes (r) ranged from small to large, with distinctive values standing out in pairs: Course 1 vs Course 4 (r=0,703) and Course 2 vs Course 4(r=0.662).

IC Dimension

Figure 4
Median and interquartile ranges of CL

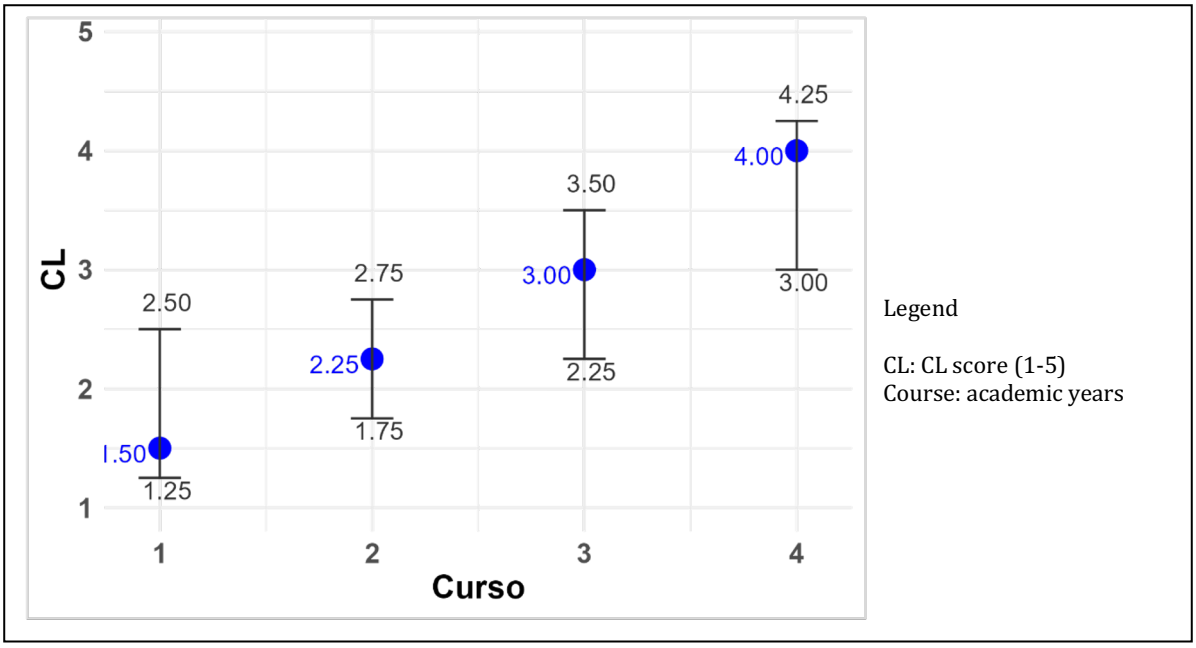


Figure 4 illustrates the median and interquartile ranges (Q1-Q3) of the CE dimension by academic years. It can be seen that the 4th academic year presented the highest median (4.25), while the 1st academic year had the lowest (1.25). These differences are consistent in all pairwise comparisons, as confirmed by statistical analyses. In courses 1 and 4 there is a shift of the median concentration towards Q1 and Q3 respectively.

Table 5
Comparison of academic courses in CL

Dimension	Comparison	U	*p*	*r*	*rc*
CL	Course 1 vs Course 2	1732,50	***	0,295	Small
	Course 1 vs Course 3	996,50	***	0,572	Grande
	Course 1 vs Course 4	493,00	***	0,699	Grande
	Course 2 vs Course 3	1722,00	***	0,380	Moderate
	Course 2 vs Course 4	760,50	***	0,619	Grande
	Course 3 vs Course 4	1833,50	***	0,334	Moderate

Note. u: Man Whitney statistic, ***: p<0.001 r: effect size, rc: qualitative coding of effect size.

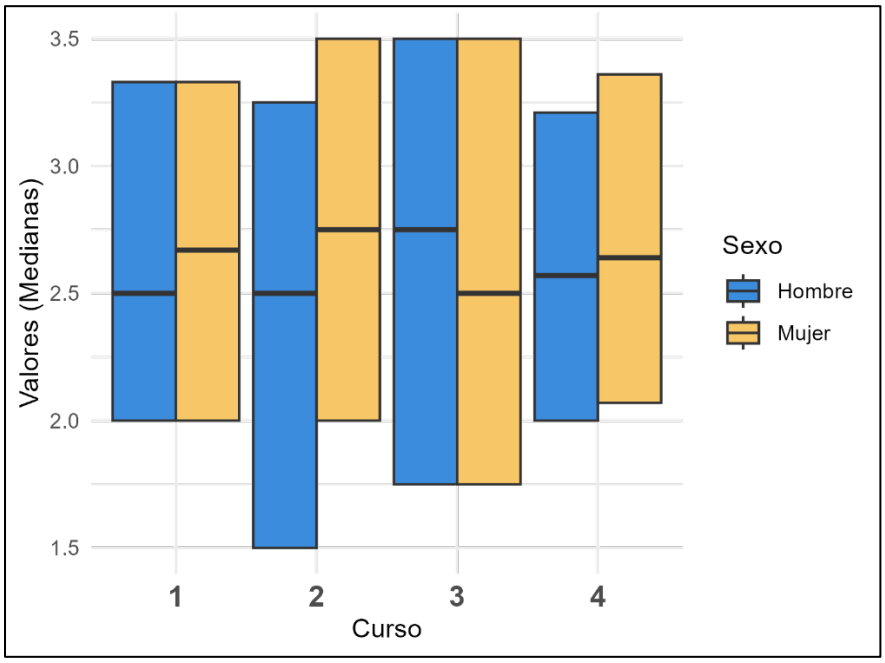
The results of the pairwise comparisons are presented in Table 5. All pairs of courses showed statistically significant differences (p<0.001). This indicates that *CL* distributions differ across courses. Effect sizes (r) ranged from small to large, with distinctive values standing out in pairs: Course 1 vs Course 4 (r=0,699) and Course 2 vs Course 4(r=0.619).

Comparison of Media Culture Measures by Academic Year

We compared the measures of Media Culture, which integrates the values of EC, HI and CL, between men and women in the academic years (1, 2, 3 and 4) using the Mann-Whitney test because the samples violate the assumption of normality (p<0.05) according to the Kolmogórov-Smirnov test.

Figure 5

Medians of media culture by academic year according to sex



Paired medians (Female, Male) were obtained by year: 1st (2.50 vs 2.67), 2nd (2.50 vs 25), 3rd (2.75,259) and 4th (2.57 vs 2.64) with the respective interquartile ranges as shown in Figure 5. The Mann-Whitney test provided *U*-values (10068-11665) and *p*-values (0.535-0.133), since *p>0.05* in all cases indicates that there is not enough statistical evidence to conclude that there are significant differences between the medians of men and women, so it is assumed that the medians of women are equal to those of men.

Association Between Media Literacy and Academic Courses

Given that the Kolmogórov-Smirnov test, in the verification of the normality of the data provided values of p<0.05, then it is assumed that the data do not have a normal distribution. In this situation, robust linear regression methods are chosen to perform a regression analysis, specifically, the MM-estimators due to their excellent response to outliers and non-normal distributions. (Maronna et al., 2019; Smucler, 2016)

In this analysis, CM was chosen as the dependent variable, which was calculated in each case according to the dimensions EC, IH and CL; and *academic year* was taken as the predictor variable.

Using the MM-estimator algorithm method, it presented a robust R^2 of 0.7007, indicating that the model explains approximately 70.07% of the variation of CM, The adjusted R^2 was 0.6997, providing a consistent fit. The quality of the fit was assessed by the residual robust standard error, which was 0.4291, indicating good accuracy in the model predictions. Information on the model's predictor variables is included in Table 6.

Table 6
Model regression coefficients

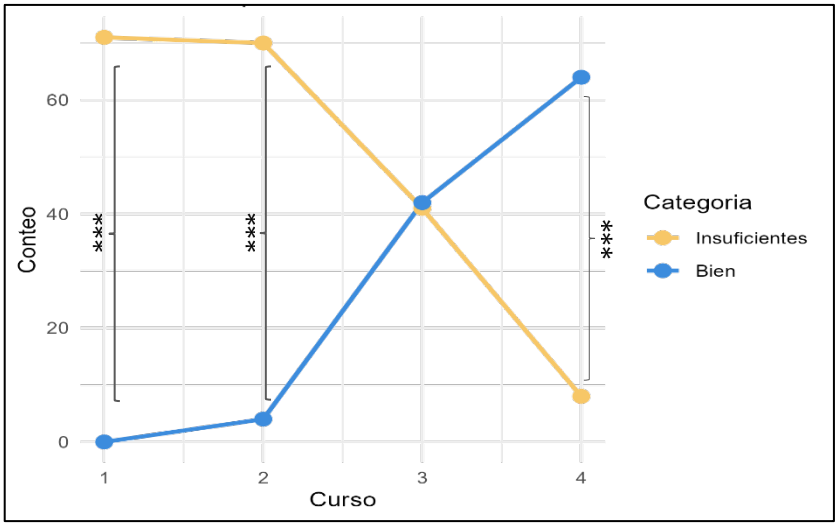
	Estimator	EE	*p*
Interception	1.14301	0.05952	***
Course	0.60600	0.02320	***

Note. EE: standard error, ***: $p<0.001$

General Condition of the CM

In the general study of the state of development of MC, the cut-off points are established according to the Cuban evaluation system, which establishes the following quantitative-qualitative coding: Excellent (5 points), Good (4 points), Pass (3 points), Fail (2 points) (MES. Cuba, 2022).

Figure 6
Behavior of the MC by academic years



Note. ***: pvalue < 0.001

When comparing the proportions (insufficient vs. well) using a Z-test, the count by course, showed significant differences in the MC in the 1st course (0 vs. 71, z=14.01, p < 0.001) in favor of the insufficient count, as well as in the 2nd course (4 vs. 70, z= 12.58, p < 0.0001); however, in the 3rd course the values were similar without significant differences in the count (41 vs. 42) and in the 4th course the differences were significant in favor of the Well status. (8 vs 64, z=-10,92, p<0.001).

Discussion and Conclusions

This study analyzed, from a theoretical approach, the process of formation of media culture in the university context, providing a system of pedagogical categories and the redefinition of the concept of media culture with its constituent dimensions. In addition, an empirical *diagnosis* of the current state of the level of development of media culture in the university context was carried out, which revealed insufficiencies in its development in the first three courses, and in the fourth course, results were recorded that are located in the lowest levels of the satisfactory condition. Thus it is *characterized,* from a holistic approach -theoretical, multidimensional and empirical-, the media culture

in the sampled university context of Granma province in Cuba, revealing that the theoretical dimensions -EC, IH- in their empirical concretion, require immediate attention.

The theoretical approach was based on the contextualization of the category of culture in the framework of higher education, revealing the components that in their interrelation configure it as a totality, highlighting the essential role of communication as a dynamic nucleus of its existence in relation to the process of apprehension. This concept describes the complex web of relationships that link the different forms of human activity with the communicative activity sustained by the complex ecosystem of information and communication technologies that increasingly permeates the social fabric. In the university training process, understood as a cultural process, media culture is identified as a material support for learning and for human development, an expression of the relationship between three processes: communicative expressiveness, holistic interpretation and logical consecutivity of hypermedia content; these processes operate on the hypermedia text, a new type of text that involves new forms of writing, reading and access, of special interest for higher education pedagogy.

The empirical diagnosis was carried out on university students in the profile of physical activity and health, in a cross-sectional sample taken from students from the first to the fourth year of university.

The comparison between the dimensions (EC, IH and CL) of media culture in each course (1,2,3 and 4) did not provide significant differences in the measures, in any case (Table 2), which shows that in the academic courses the students' performance is similar in the dimensions, according to the median. These results and the references obtained from the literature consulted suggest that the formation process of media culture, from its components, is homogeneous and spontaneous, i.e., there are no subjects whose objectives explicitly specify the development of media culture, although it is stated as an intentionality (MES. Cuba, 2014).

On the other hand, performance was compared between years (1,2,3 and 4) for each of the dimensions (EC, HI and CL), as shown in Figures 2, 4 and 4, based on the contrast of the courses (1 vs 2, 1 vs 3, 1 vs 4, 2 vs 3, 2 vs 4, 3 vs), significant statistical differences were found between each of the cases studied (Tables 3, 4 and 5), finding the largest positive effect size in the comparisons (1 vs 4 and 2 vs 4). In light of the training process, the evidence suggests that the appropriation of media culture is favored with the transit of the courses, due to the indirect impact of the tasks oriented to students whose solution is carried out using ICT (MES. Cuba, 2022).

Although statistical tests do not show the development of CL of hypermedia content above the other processes (EC and IH), descriptive data do reveal it, other research also confirms it, since this process has a predominantly technological genesis, which are part of the favorite activities of the subjects of these ages, the constant use of ICT and the motivation to handle it better (Gómez Miguel et al., 2022; Melendro Estefanía et al., 2016).

The comparison of the development of MC by sex in each school year showed no significant differences between men and women, which suggests that there is homogeneity between them, as can be seen in Figure 5.

The linear regression, according to Table 6, provided the following prediction model CM= 0.606*Course+1.14301, in this case studied that defines the passing grade from 3 points (CM=3), it is convenient to know from which course it is obtained, according to the sampled data. To do so, the equation Course=(CM-1.14301) /0.606 is cleared, leaving the equation Course=(CM-1.14301) /0.606; when substituting CM in this

equation, a value of 3.06 is obtained. Which means that the CM performance is satisfactory from the 3rd course onwards.

The comparison of the proportions of CM in students, coded in two states: insufficient and well, as a way to understand the general state of this construct, according to Figure 6, in the form of a scissors, reveals that there is a tendency for students to move from the "insufficient" state to the "well" state as they progress through the academic courses.

According to the data obtained, it is suggested to develop pedagogical interventions that allow students, from the first years, to reach higher levels in CM, which serves as a support for learning the rest of the subjects. It also highlights the need to develop transversal learning strategies throughout the career to ensure the performance of CM from transdisciplinary approaches, due to its relationship with critical thinking, problem solving and professional culture.

Strengths and Limitations

The positive aspects of the present study are: a) the theoretical approach to media culture it favors, by providing an updated reconceptualization in contemporary social and technological frameworks and b) it provides an empirical diagnosis, detailed by dimensions, of the level of development of media culture in students of significant pedagogical usefulness, which, being carried out in R language, can be immediately applied to another data matrix.

However, limitations must be overcome, such as: a) the size of the sample, in order to make statistical inferences towards other similar contexts and b) in the theoretical order, the concept of media culture must be completed by incorporating a dimension of an ethical nature.

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