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Original article

Strategic planning for software learning Geogebra, to apply to sports competitions

Planificación estratégica del aprendizaje del software Geogebra, para aplicar a competencias deportivas

Planejamento estratégico de aprendizagem e conhecimento do Geogebra para matemática aplicada a competições esportivas

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ABSTRACT

In order to achieve success in learning in Physical Education in the current times, it is considered that not only the knowledge of the most trained teachers is sufficient, but also the availability of means to improve the planning of the teaching process and the visualization of movements, techniques and strategic positions. The objective was to develop a set of interdisciplinary workshops, from the application of Geogebra in the Physical Education class, to increase the interest of students in the practice of sports, in its relationship with mathematics and other sciences. In the initial diagnosis, surveys were applied to students and interviews with teachers, where limitations were found that led to the need to design a set of interdisciplinary workshops to train Physical Education teachers, based on the use of this software effectively. After applying a correlational study, it was possible to demonstrate that the planning of PE classes was more significant, as the Geogebra software was used with greater precision and relevance.

Keywords: Physical Education, Geogebra , strategic planning

RESUMEN

Para el lograr éxito del aprendizaje en la Educación Física en los tiempos actuales, se considera que no solo son suficientes los conocimientos de los profesores más entrenados, sino la disponibilidad de medios para mejorar la planificación del proceso de enseñanza y la visualización de movimientos, técnicas y posiciones estratégicas. Se propuso como objetivo elaborar un conjunto de talleres interdisciplinarios, desde la aplicación de la Geogebra en la clase de Educación Física, para el aumento del interés de los estudiantes por la práctica de los deportes, en su relación con las matemáticas y otras ciencias. En el diagnóstico inicial, se aplicaron encuestas a estudiantes y entrevistas a profesores, donde se encontraron limitaciones que condujeron a la necesidad de diseñar un conjunto de talleres interdisciplinarios para capacitar a los profesores de Educación Física, en función de utilizar este software con efectividad. Después de aplicar un estudio correlacional, se pudo demostrar que la planificación de las clases de EF fue más significativa, en tanto se utilizó el software Geogebra con mayor precisión y pertinencia.

Palabras Clave: Educación Física, Geogebra, planificación estratégica

RESUMO

Para alcançar o sucesso no aprendizado da Educação Física nos tempos atuais, não basta apenas o conhecimento dos professores mais capacitados, mas também a disponibilidade de meios para melhorar o planejamento do processo de ensino e a visualização de movimentos, técnicas e posições estratégicas. Ao verificar que esta carência nem sempre está presente, principalmente na concepção destes meios, propõe-se como objetivo: desenvolver um conjunto de oficinas interdisciplinares para aplicar o Geogebra na aula de Educação Física e assim melhorar o interesse dos alunos pela prática do Geogebra. esportes em sua relação com a matemática e outras ciências. Para a realização do diagnóstico inicial, foram aplicados questionários aos alunos e entrevistas aos professores. Nos resultados do diagnóstico, foram encontradas limitações que levaram à necessidade de criação e implantação de um grupo de oficinas interdisciplinares para formação de professores de Educação Física (EF) com base em para usar este software de forma eficaz. Após a aplicação de um estudo correlacional, foi possível demonstrar que o planejamento das aulas de EF é mais significativo quando o software Geogebra é utilizado com maior precisão e relevância.

Palavras-chave: Geogebra, Educação Física, Planejamento Estratégico.

INTRODUCTION

Strategic planning for the academic and sports management of graduates from Regular Basic Education institutions is especially important to ensure that resources are used efficiently and effectively to achieve the development of sports activities in an educational institution.

The contemporary planning model in Physical Education (PE) and sports training does not deny the traditional approach, but rather enriches and complements it. As this model depends on the economic interrelation that sustains society, the financial budget and the

potential offered by science and technology are considered to minimize costs, and to make available to millions of sports practitioners countless digital references that help with orientation, study and improvement in sports terms (Alvites , 2021; González, 2018).

It has been demonstrated that by integrating sports sciences with mathematics, as a discipline of exact sciences, the results can be more predictable, demonstrable, calculable, and become a method to facilitate optimal and sustainable performance (Trillo & Trillo, 2021).

Not only statistical data helps sport when addressing the contributions of this science; also from geometry, when associated with trajectories of objects and phenomena; from arithmetic, when studying the relationship between subjects and objects as arithmetic variables to find average frequency, or probabilities in the occurrence of successes and failures in sport; in addition to other mathematical analyses that are very welcome in biomechanical or purely statistical studies (Trillo & Trillo, 2021).

Mathematical calculations can predict in which movement, position or situation more injuries can be contracted during sports practice; however, the equations achieved to date in this regard only take into account biomechanical and anthropometric variables, thus underestimating variables of interdisciplinary origin such as environmental, situational and psychological variables, which in one way or another significantly affect the athlete (Llamas, 2021).

In the history of mathematics applied to sport, the materials created based on cybernetics are a must-read. Although they originated in the former Soviet Union, they had a significant impact in Europe and later in Latin America, in the 70s and 80s. This precedent promulgated some considerations that must still be highly valued today:

It should be noted that the origin of sports cybernetics is the theory of sports training as a theoretical and practical discipline, based on the application and implementation of mathematical methods, which came to be configured as an independent area of theoretical and practical knowledge about sport. The implementation of this model, as well as its

periodic review towards a qualitatively different level, was linked to a series of circumstances, of which two are especially significant: 1) continuous and accurate information and reliable feedback that acts on changes in the controlled system (athlete) and its direction throughout its process (coach and technical team); 2) rapid and accurate processing of the information received and choosing the most successful option for making adjustments in the next step of the training program. (García et al., 2023, p.13)

Returning to the subject of mathematics, tempered to the area of physical culture sciences, specifically to the plane of PE, dimensions and indicators have been raised that cannot be overlooked in this research such as: thinking and reasoning mathematically explains ideas to solve problems, and expresses arguments to justify actions; modeling and problem solving identifies the aspects that are related to mathematics, the variables to solve it, proposes and uses models, concepts and procedures, to solve it analyzes, provides adjusted solutions, and presents the result; in addition, communicates and represents mathematical ideas with the use of symbolic, formal and technical language to express ideas or procedures (Rodríguez, 2022).

In most of the studies shown in this report, it can be seen how physical education and sport are nourished by mathematics to develop motor skills, intellect and logical thinking. The proposal by Giménez & Teruel (2020) is interesting, where the perspective is the other way around, as it promotes how to make mathematics have a more playful character, with various activities that aim to ensure that a group of primary school students strengthen their knowledge of algebra, geometry, among others, through play.

Among these games, the following stand out: The fastest game, where any reaction speed game is applied; for example, heads and tails, cats and dogs, black and white, with a numerical stimulus or operation. Cat and mouse, where students are grouped in pairs, the mouse must run outside the circle trying not to be caught by the cat, and to do so it is placed next to a pair (odd since there are three). Games with plastic bricks, where different groupings can be made; units, tens and hundreds are worked on. In general, the study proposes several games with a high degree of orientation that require more or less complex mathematical analysis.

On the other hand, Gañan (2020) makes available to sports sciences an analysis, using the Geogebra software that allows professionals in specialties such as volleyball, soccer, and basketball a strategy to predict and study the kinematics of the athlete's movements. This resource mediated by information and communication technologies (ICT), physics, and mathematics turns the strategy into a virtual laboratory where simulation is essential to assess the most effective and most likely actions to ensure success. In this work, values are proposed and variables are calculated to achieve a better understanding of the movements practiced.

Geogebra software occupies a primordial place, due to the attractiveness of the resource, and its interdisciplinary usefulness in the management of sciences, in favor of high performance in sport (Vigo-Soriano, et al., 2023). However, there is still much potential to take advantage of, especially at basic levels of training. That is why the objective of this work was to develop a set of interdisciplinary workshops, from the application of Geogebra in the Physical Education class, to increase students' interest in the practice of sports, in its relationship with mathematics and other sciences.

MATERIAL AND METHODS

This study was applied to students in the last year of Basic Education, Secondary level (population). The sample corresponded to the population, since the total of 68 students was considered for the research. They were willing to collaborate after the authors presented the research project, in order to improve teaching work and the improvement of instructive and educational work in the PE subject. The diagnosis was developed during the third two-month period of the year 2024.

In the research, a survey was applied to the students involved, with the aim of knowing whether in PE classes the teachers presented models or simulations of movements related to sports (MSMD in Spanish), as part of the content of the subject. As other elements to be investigated in the diagnosis, the survey sought to determine whether the students knew the application of any strategy (PEMPD) to improve their performance in sports practice, as

well as the existence of any planning of teaching activities negotiated between teachers and students (EPADNPE).

The interview was conducted with five PE teachers from Regular Basic Education with the objective of knowing their level of use of ICT, to improve the performance of the students. It was also considered necessary to ask about the knowledge of mathematics and physics, to analyze movements, postures and positions, with a view to teaching the characteristics of sports; as well as the management of knowledge in an integrated way to achieve better skills in students.

To corroborate the results of the set of training workshops on the use of Geogebra, a descriptive-correlational study was developed. The mixed approach (qualitative and quantitative) was used in the research. The statistical method was used in the processing of the collected data; and statistical programs such as Excel and SPSS Version 22 were used to process and present the data obtained. The statistician for the hypothesis test was Spearman `s Rho and Using SPSS software, Version 22, data was collected and correlated, following a descriptive analysis of the results.

RESULTS AND DISCUSSION

Table 1 shows the survey data collected from the diagnosis:

Table 1. *Survey results*

Evaluation in Percentage of students surveyed	**MSMD**	**PEMPD**	**EPADNPE**
B	10%	10%	5%
R	30%	10%	5%
M	60%	80%	90%

It was highlighted that the best evaluated indicator was the MSMD, and according to the students' arguments it was not that the professor at some point used some technological material in class to show some simulation or model, but that he himself used it, when

analyzing the movements or positions of an athlete, to achieve a basket in basketball, or a goal in the case of soccer.

The EPADNPE indicator was the one that showed the worst results, since the teacher generally brought all the planned activities, according to his experience and conventional methods; therefore, there were very few opportunities to negotiate which exercise or position the athlete needed, or to explain which technique to apply in more detail, to achieve better learning of the sport, in the context of PE.

In the case of the interview with the selected teachers, the following criteria were argued:

- 50% of teachers did not have sufficient funding to use technological resources in class, such as computers or smartphones to install applications or programs to show models and simulations.
- 60% did not have sufficient preparation to apply skills and knowledge from other areas of knowledge, in order to analyze the peculiarities of each sport.
- 90% were willing to take training courses to operate software and other high-tech instruments to facilitate the visualization of technical movements and positions in sports.

Based on the above, a group of workshops was developed to train teachers to use Geogebra software, specialized in the analysis of kinematics and strategic movements of each sport.

Strengths:

Geogebra software were identified as strengths, which allowed the graphical representation and simulation of mathematical phenomena in real time; it was a powerful tool for teaching mathematics, applied to sports, such as calculating the maximum range of a projectile, shot put or javelin throwing. In addition, the fact that Geogebra is free and easy to install on computers and mobile devices allowed the promotion of interactive learning, making classes more dynamic and attractive.

Opportunities:

The main objective of using this GeoGebra software was to promote meaningful learning of mathematics through practical applications in sport. Specific objectives included:

- Motivate students to understand concepts such as trajectory, speed and angle, through concrete examples such as the analysis of a parabolic shot in basketball or soccer.
- Develop critical and analytical skills in future coaches, to optimize the performance of athletes, through precise mathematical calculations.
- Integrate the use of educational technologies into the PE curriculum to improve the quality of learning.

Weaknesses:

The use of Geogebra software had barriers such as the lack of teacher training in educational technologies, which made its effective implementation difficult. In addition, in institutions with limited resources there may have been restrictions on access to electronic devices and internet connection, which made the software's reach difficult. Finally, some students found the initial Geogebra interface complex, especially if they lacked basic digital skills.

Threats:

Among the most important threats was resistance to change by teachers or institutions that preferred traditional methods. Furthermore, students' excessive reliance on technology sometimes prevented the full development of mental calculation skills. In addition, technical problems, such as software errors or lack of updates, affected the learning experience. There was also a risk that the use of Geogebra was not adequately supported by national educational policies, which limited its integration into the curriculum.

Practical Examples:

- Shot put: Geogebra allowed to simulate the parabolic trajectory, to determine the optimal angle, maximum distance of the throw.
- Free throws in basketball: students were able to model the curve of the ball, from different positions and evaluate the best launch point.
- Football: study of trajectories of shots on goal with different effects (curved or parabolic), to improve accuracy.
- Athletics: analysis of initial speed and angles, in long or high jump to optimize the performance of athletes.
- Cycling: calculation of work performed on slopes, based on mathematical models of the terrain and applied force.

The PE students had to learn how Geogebra software and movement simulation worked, because the maximum range depended on the launch angle of the initial movement; consequently, the lack of training them without the use of the software generated a delay in the quality of the training of the coaches and athletes.

The training of students who graduated from Regular Basic Education was deficient, which is why applicants to EF in several universities showed deficiencies in the use of ICTs in the service of competition. This placed EF students at a disadvantage compared to those who were trained using ICTs.

It was therefore considered necessary to conceive technology as a tool to help be competitive; consequently, in this research it was proposed to use the Geogebra software to awaken interest in calculating the horizontal range of a projectile, as it is a competition practiced in the Olympic games whose prizes accompany the best prepared athletes, with the accompaniment and help of specialists who applied basic knowledge of the Geogebra software to sport.

Geogebra Software to be installed on any portable Smartphone device, using an Android mobile or other similar application, the EF student, during the post-covid-19 period, was

able to acquire expertise in its use, in all situations that he considered pertinent to understand, by analogy, three-dimensional images, which meant the participation of interested parties (Aziz , Haron and Harun , 2020).

Learning through Geogebra software played an important role in the interaction between students and as a response to the difficulties presented; in educational practice, virtual environments or classrooms had to be equipped to meet technological needs, according to Kaplar . et al. (2021).

Table 2. *Correlation between strategic planning and knowledge of applied Geogebra*

			Knowledge of applied Geogebra
Strategic planning	Spearman correlation	1	0.78 **
	Next (bilateral)		0.000
	N	68	136

**The correlation is significant at the 0.01 level (two-tailed)

Geogebra, applied to academic and sports management, was found to be *RS* = 0.78, with experimental significance of p = 0.000, a value lower than that set by the researchers at 0.05.

This correlation of RS=0.78 was approximately equal to the average of the correlations of the dimensions of the variables; therefore the null hypothesis was rejected and the alternative was approved, because there was a relationship between strategic planning and knowledge of Geogebra, with a considerable intermediate relationship between 0.5 and 1.0, which implied the existence of said relationship.

Proposal: Interdisciplinary mathematics workshops, applied to sports through the use of Geogebra software.

Aim: Demonstrate the usefulness of mathematical concepts for understanding and improving sports performance, using Geogebra software in modeling and visualizing the process.

Description:

- Organize workshops where real situations were analyzed, in sports such as soccer, basketball or athletics (maximum range in shot put). For example:
- Using Geogebra to model parabolic trajectories in archery.
- Calculate the average speed of a player in a 100-meter race.
- Maximum range in shot put, depending on the exit angle.
- Using Geogebra software, students were able to create graphical simulations that represented these processes, leading students to adjust parameters such as speed, angles, or force and observe their impact on performance.

As a result, sports practices were better guided during the development of PE, while a greater interest in mathematics was promoted by relating it to sports activities, in a context in which students enjoyed and easily understood.

As a result of this research, it was possible to show that strategic planning for the educational institution of a community was at a high level. This differed from the results obtained by Florez and De la Ossa (2018) who compared two teaching models for learning the concept of density: scientific inquiry and transmission-reception, carried out in eighth grade in a rural school in Colombia, where it was shown that students who participated in the scientific inquiry model obtained better results in a test of understanding of the concept of density, compared to those who participated in the transmission-reception model.

López et al. (2024) explored how personnel management and managerial leadership in sports activities impacted students' mental health, highlighting the importance of effective leadership to promote physical activity and psychological well-being, which favored their comprehensive development.

From this perspective, football required a good command of basic motor skills such as coordination, agility and speed which benefited from the application of teaching strategies, promoted by scientific inquiry in the Geogebra software. For example, coaches were able to design activities that allowed footballers to explore different body movements and their

effects on performance, to help them better understand how their bodies work and how to improve their performance.

Franco et al. (2017) designed a set of activities for the development of scientific competencies in the context of health, based on three key dimensions of scientific competencies: scientific knowledge, understanding of scientific phenomena, and the ability to apply scientific knowledge. The activities, evaluated by a group of experts, were considered appropriate for the development of scientific competencies.

In this sense, the software was used as an instrument in physical and mental training programs, to:

- security and safety tasks, and included activities such as endurance races, self-defense and strength exercises to prevent injuries.
- Stress management training: It was essential to establish a mental health program that included workshops on stress management, meditation, relaxation techniques, and psychology applied to work in risky situations. Psychological training allowed the serenity guards to better handle tense or high-risk situations and improve their performance.
- Drills and Risk Training: Conducting regular drills where graduates were able to practice crisis management, from crowd control to conflict resolution in high-pressure situations, all in a safe environment.

On the other hand, Chávez et al. (2022) analyzed the management of recreational activities in a health institution, highlighting how these activities improved the well-being and job performance of teachers. The research emphasized the relevance of proper management to foster a healthy and productive environment in educational and health institutions.

Accordingly, the software included activities that promoted healthy football practice, being used to help people stay active, reduce the risk of chronic diseases and improve mental health. Along these lines, the activities designed by Franco et al. (2017) were adapted to

promote the health of football players in a rural community, focusing on injury prevention, improving physical condition and promoting healthy habits.

According to González et al. (2012), a study was conducted on the innovative practices of science teachers in secondary education in the Valparaíso region, Chile. The study found that innovative teachers employed a variety of teaching strategies, including scientific inquiry as a strategy that promoted active learning and critical thinking, essential skills for success in soccer that allowed them to solve problems and make decisions on the field of play; they were also able to design activities that allowed soccer players to explore the game and develop their own strategies.

With the use of the software presented, administrative management was facilitated, in line with this, the research by Garay et al. (2021); Rojas (2021) highlighted the importance of emotional balance and conflict resolution strategies in the staff of a municipality, as well as the relevance of administrative management and teaching practice in public educational institutions.

Hernández and Pascual (2018) validated a research instrument for the design of a self-assessment methodology for the environmental management system, based on the principles of scientific inquiry, a useful approach in the football context, to promote sustainability in football; for example, football clubs used scientific inquiry to assess their environmental impact and develop strategies to reduce it.

An important limitation to take into account for future versions of the use of Geogebra software was to reduce the psychological impact and prevent accidents, although no damage was recorded or documented in its use.

CONCLUSIONS

The results of the diagnosis provided data confirming the shortcomings in the application of technological resources and instruments capable of facilitating simulation and modelling of technical and strategic movements and positions in PE classes, as well as their impact on health and other areas.

The results were sufficient arguments to create and establish the use of Geogebra software in PE, to contribute to learning and interaction between teachers and students based on this advanced technology.

By carrying out a correlational study after applying the software, the direct and significant relationship between strategic planning and the knowledge of Geogebra as a mathematical tool, applied to sports competitions, was demonstrated.

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