The Video Game As Practice For Developing Virtual Reality Sports Jumping Skills in Children 5 Years. Case Study of Innovative Practices in Educational Institutions of Bogotá, Colombia

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Abstract — The world of video games is a field of constant development. The possibility of applying video games to learning and developing of bodily skills has permitted deploying this experience; the object of this quasi-experimental research consisted in analyzing the effects of using video games where physical activity and sports practice are exerted, promoting development on locomotor skills like jumping in children 5 years of age, belonging to state educational institutions in Engativá in the city of Bogotá (Colombia) for which 30 children were selected: 15 (control) and 15 (intervention). These children were subjected to the application of tests during continuous weekly sessions during three moments: warm up, interaction and application with the running virtual game, and stretching of the principal muscle groups of lower limbs. Before the applications, anthropometric data (weight, height, and BMI) were collected from the study population. The study found that the motivation induced by the sports practice, upon including the use of virtual reality video games with repetition exercises with bodily extension and elongation movements, influences the locomotor jump pattern in children 5 years of age. These permit broadening the capacities of sports practices as part of the bodily and sports formation process in state educational institutions.

Keywords: Virtual reality video games, locomotor patterns, sports skills, innovative strategies

I. INTRODUCTION

Use of virtual reality games has extended to diverse human activities in populations of all ages. Besides the technological advances, among the reasons why the use of these games has increased are the family dynamics where parents spend their days in working activities and children spend their leisure time on video games, the internet, and television, given that the time to share with the family in outdoor activities has been reduced. This has contributed to the growth of the digital culture throughout the world.

Information and Communication Technologies (ICTs), as well as virtual reality games have become strategic allies in learning processes, given that interactivity increases motivation, a process underlies learning. In this same sense, said games have been used as cognitive and physical rehabilitation methods [1], in neurological pathologies, like strokes and Alzheimer's disease [2].

Therein, the use of video games, by using and developing national standards as pedagogic strategy when employed with child population, may provide an exhaustive framework of interest and investigation and – in relation to quality standards – may be related to the integration of new technologies that, according to the Ministry of Information Technologies and Telecommunications (MINTIC, 2014), must be appropriated from the inclusion of educational strategies that support the teaching practice as of the institutional management and evaluation of their impact upon child populations.

Another important aspect to keep in mind is how mental learning and motor learning are generated in human beings. Thus, mental learning is defined as the acquisition and improvement de knowledge and intellectual capacities and skills [3]; psychomotor learning is the process through which the child relates, is aware of and adapts to his/her surroundings, including aspects like expressive and comprehensive language, visual-motor coordination, gross motor skills, balance, and the social-affective aspect, which is related to self-esteem. Through the manipulation of objects and domain of space by walking, the child acquires sensory-motor experiences that will allow him or her to construct concepts, which will translate into ideas and will develop their thinking and capacity to reason [4,5]. This association is evidenced during the children's early stages when their cognitive processes are produced through their motor activity, by manipulating and moving objects around them, to create significance as a result of the construction of learning through their context, bringing the children to stimulate their motor processes and motor skills. This inter-relation must be reinforced through the combination of the teaching (mental learning) with motor activities like the use of virtual reality games (motor learning).

Motor learning and, thus, significant learning can be influenced by virtual reality games through their influence on the pre-motor cortex. This cortex has direct connections with

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the primary motor area and contributes with 30% of the axons that make up the corticospinal and corticobulbar tracts. The pre-motor cortex is constituted by two components: lateral and medial. The lateral component facilitates development of conditional tasks with visual cues and the medial component participates in the selection and initiation of movements through more internal than external signals, motivation [5]; virtual reality games can influence directly on motor learning processes by providing visual cues and impacting directly on motivation.

This contextualization seeks to apply, through a quasi-experimental design, the development of sports jumping skills in children 5 years of age from the influence of the practice of virtual reality video games. This technology is seen as an innovative learning strategy within educational institutions, promoting, in the area of sports, development of skills appertaining to the human bodily formation that must be developed from early ages, through the stimulus of mental skills concerning processes like attention and memory, generating effects on the performance of coordinated locomotor patterns that must be developed between 5 and 7 years of age and which are fundamental to start the practice of a sports discipline.

Besides the study's principal objective, it sought to highlight that the use of this technology is useful as an innovative pedagogical strategy in the physical education formation field in state institutions as a support tool for the teacher and a complement in conducting outdoor activities. Given the need for surveillance and control by government entities on the prevention of disease related to lack of physical activity or sedentary lifestyles, this type of technology is suggested as a way of staying active at home, propitiating family union and healthy lifestyles.

II. CONCEPTUAL FRAMEWORK

It is important to introduce the basic element of study, the evolution of video games and their transition onto the world of sports education. With this concept, it may be stated that it is an ubiquitous tool in the activities of professors interested in innovating as part of the formation process; concretely, it could be defined as a document containing the organized records of all the data and knowledge that refer to physical education and video games and which serve as foundation for the diagnosis of a useful educational application in this area.

Games have been broadly addressed by different academic disciplines like math, history, philosophy, sociology, motor praxeology, etc. [6]. The importance of games for human beings and for culture is more than a universal consensus; in the end, it fulfills the ludic and socialization needs of all animals, including humans, according to that indicated by Caillois 1958 cited by Bortoleto 2006 [6]. This is why ludic activities in general and the game motor constitute a fundamental content for the educational and/or recreational environment, with this being largely the responsibility of physical education teacher.

Virtual reality games have also been used to maintain active lifestyles [7], [8], [9]. Some authors establish the relationship between the practice of physical activity and motor development [10]. Due to these findings, it may be inferred that a relationship exists between using virtual reality games and the maturity of basic locomotor patterns.

In spite of the benefits derived from using virtual reality games, some studies have observed negative effects from their practice, mainly for the visual system [11] and the musculoskeletal system [12].

Studies recommend increasing research on attention processes and their relationship with the maturity of locomotor patterns implied in the use of these types of video games. Due to this, the objective of this study was to identify the influence of the practice of virtual reality games on attention processes related with the jump motor pattern in children 5 years of age.

A. Virtual Reality Video Games

A videogame is an interactive information technology program destined for entertainment and which can operate in diverse devices: computers, game consoles, mobile phones, etc. It integrates audio and video and permits enjoying experiences that, in many cases, would be difficult to experience in reality.

The characteristics of video games include: the quality of graphics (at the beginning in two dimensions, and currently in 3D), game control must be easy to use and intuitive, and sound (from the speaker to surround sound) [13].

Diverse types of video games exist, among them we could name adventure games (intelligence tests or puzzle solving to advance), arcade (skills activities), sports, strategy (coordinate actions), role playing (players manage a personality and it evolves during the game according to the user's decisions), and simulation (some type of action is simulated like, for example piloting an airplane) [13].

Virtual reality games enter an exclusive range of tools in which users can venture creatively to where the limit of their imagination permits. Therein lays, quite possibly, the biggest attraction, given that imagination and creativity have an opportunity to be executed in an unlimited and artificial "world". The origin of these games is the Department of Defense of the United States, where they were created as material for an aviation class during the 1970s for flight simulations by practicing and not risking lives [14].

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B. Locomotor Patterns

Children progressively develop skills in movements, from the first involuntary reflex movements to highly complex abilities. The early childhood period (2 to 7 years of age) is critical for the development of elemental motor patterns. Children who do not mature motor patterns during this period frequently exhibit difficulties in carrying out more complex motor skills like sports movements.

Locomotor patterns are those movements that allow children to explore space; these include: walking, running, high and long jumping, hopping, galloping, and climbing. These fundamental movements are observable behavioral patterns that can be divided into three stages [15]:

Initial Stage: This stage represents the first guided goal the child tries to execute; its movements are characterized by an inappropriate sequence, restricted use of the body, and poor rhythmic coordination. There is almost no spatial and temporal integration; the two-year-old child's movements of locomotion, manipulation, and balance are typical of this stage.

Elemental Stage: There is greater control and better rhythmic coordination of the fundamental movements. Temporal and spatial elements are more coordinated; however, the pattern is still exaggerated or restricted. Children between 3 and 4 years of age present a great variety of movements during the Elemental Stage.

Mature Stage: It is characterized by mechanical efficiency, coordination, and controlled performance. Children between 5 and 7 years of age can and should be in this Mature Stage.

C. Relationship between Video games and Physical education

Currently, the standards of creating and designing video games from Information and Communication Technologies serve to design learning materials, given that their construction employs cognitive modification elements.

Under this design conception of teaching – learning situations emerge: 1. Speed as greater experience to process information upon designing arcade video games; 2. connectivity, from synchronously and asynchronously operability, which is why it is supported on the capacity to solve problems; 3. constant action in which children and adolescents rarely need manuals to learn the operation of information technology elements; thereby, learning them intuitively [16]. 4. Guidance in solving problems, guided from the approach to the capacity to design in which constant revision of the action exists; 5. Immediate reward in which adolescents request usefulness of contextualized knowledge; 6. Importance of fantasy, which is a primordial element of current video games; 7. Positive vision of technology; without the existence of fears associated to it, which permits its use.

With respect to sports video games reference model, these games reproduce known sports, like: football, basketball, or golf, which are available in 2D and 3D. These games require coordination and strategy, particularly if the player has to manage a team [17] [6]; according to this, age considerations exist, given that activities are associated to the level or age group to which the games are destined. Likewise, the language level used must be adequate for the age group.

The video game's action time must be optimal to complete the challenges, thus, ensuring [17] that students have the necessary time to end the levels of the match and benefit from the educational characteristics.

D. Pedagogic Considerations of Using Video Games

A pedagogic structure based on the structure of video game use within physical education and sports education that has been traditionally used by teachers, without other support than gymnastic artifacts or open spaces centered on rules can be used to emulate conditions of static locomotion. Because of this, which when implementing an evaluation from measuring with learning curves with the arcade game, it is considered necessary to have a simple curve adequate for the age of application – permitting players (boys, girls) to make mistakes and start again.

Every activity designed for use in the educational context must consider using characteristics in said design that promote the pedagogical needs of the population in which these will be employed. These activities must be constructed under ludic concepts, facilitating conceptualization and manipulation by the students to whom they are aimed [6]. Experience in the implementation of video game standards and their use permits enhancement and sufficient maturity on the development of the individual's own processes.

According to the aforementioned, another pedagogic consideration is extracted from the video game's own content, which should illustrate the subject taught, [17] although the content may not be strictly related with the study plan. As it regularly occurs, it may contribute a clear and simplified representation of any of the concepts taught.

Clear objectives. According to this, professors should make sure that the objectives of the game are clearly defined for students to know exactly what is asked of them. Frustrating situations may arise if the instructions are not precise and students could feel blocked because they do not know how to advance in the game.

Clear progress. Professors should check if the player's progress is shown in markers or progress bars and will help students to have a positive attitude with respect to their

provision and will show them that their actions influence their progress, which should motivate players to become responsible for their learning activities.

E. Follow up and Evaluation of Using Video Games and Physical Activity

A standard in designing said activities and themes on virtual reality has opted for working from the evaluation and follow-up systems that permit an adequate follow-up system of the student. For the thematic interest, the child's progress can be measured from the performance and evaluations prior to its use. Said conditions and aspects can be analyzed. This was not included in most video games and simulators; however, some are compatible [17] [6]with sharable content object reference model (SCORM) and can be integrated onto a learning management system (LMS), which permits following the process of students and identifying the points that need more attention.

III. METHODOLOGY

This study was developed through a quasi-experimental design with pre-test, post-test, and a control group; the study was approved by the ethics committee at an educational institution in Bogotá, Colombia. The intervention group was exposed to the use of virtual reality video games from the Nintendo Wii console, during two sessions per week of virtual reality games for one month. Each session was carried out in three parts or moments: a first part for warm up; then, 15 minutes of interaction with the game, and – finally – stretching of the main muscle groups of the lower limbs. The control group was not exposed to any type of interaction with the video game.

La study population fulfilled the following inclusion criteria: children 5 years of age who belonged to educational institutions located in the city of Bogotá, who had never practiced virtual reality sports games, and who had all their physical and mental capacities, whose locomotor jump pattern was at the Initial Stage, and whose parents or legal guardians had signed the informed consent. Informed consent was also obtained from the children.

After signing the paperwork to participate in the study, the study population was evaluated pre- and post-intervention, which contained personal and anthropometric data, as well as data on the stages of their fundamental patterns.

Upon ending the intervention and evaluation processes, the data were used comparatively among the groups and among the evaluations, thus, identifying if any influence existed of the video games on the locomotor jump pattern in 5-year-old children.

IV. RESULTS AND DISCUSSION

The total study population was 30 children of which 15 belonged to the control group and 15 belonged to the intervention group. The anthropometric characteristics of the study population and of the intervention population are shown in Table 1. From these data (weight and height), the body mass index (BMI) was obtained.

Table 1. Anthropometric characteristics of the study population

	Weight	**Height**	**BMI**
Control	19.8 ± 2.39	108.8 ± 7.14	16.7 ± 1.90
Intervention	18.0 ± 2.86	107.8 ± 6.41	15.5 + 1.88

From the table, it may be noted that the BMI in the population is normal, with the presence of low weight, overweight, or obesity conditions.

Figure 1 describes changes in the locomotor jump pattern stage, in the control and intervention groups, that is, children who were in the Elemental Stage and moved on to the Initial Stage or who were in the Initial Stage and moved on to the Mature Stage.

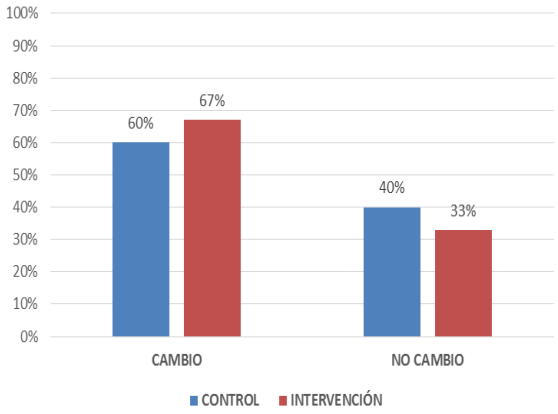

Figure 1. Percentage of change during the stage of the locomotor jump pattern in the control group and intervention group

The start of these types of ludic-motor situations adapted and/or created based on motor skills –locomotor jump pattern – whose percentage was increased from the use of virtual reality video games, making use of the ludic and motivational potential interpreting the action that can be generated when using an arcade video game with educational characteristics for the area of primary physical education.

Development of this measurement permits defining if the increased incursion into the new Information and Communication Technologies from improved strategies of using video games may differ on the motivation of the sports practice.

Although references of studies on the effect of virtual reality games in developing locomotor patterns have been limited, this study agrees with investigations that have found positive

effects of these types of games in learning motor activities in patients with neurological damage, such as: cerebrovascular disease, spinal cord injury, multiple sclerosis, Parkinson's disease, and brain damage due to trauma [18]. Said effect can be attributed to three key elements: repetition, sensory feedback, and the motivation these games provide due to the interaction and immersion in the video game.

Controversy exists about the quality of motor activities learnt. Prior studies consider that the movements are similar or equivalent, this is why they are recommended to learn motor tasks [19]; however, due to the difference in perception less precision has been observed in the movements [20], [21], [22].

Another point of debate is the applicability of motor activities in reality; nevertheless, some investigations have found that virtual reality games provide motor learning in the three dimensions of space, corresponding to the movements made in the real world [16]. The relationship of motor learning with intellectual learning is such that virtual reality systems are used for training in non-medical practices, like aviation, nuclear and industrial systems, and in medical practices like training for endoscopic surgery, general surgery, vascular surgery, orthopedics, and neuro-rehabilitation.

As a Project to include technology in the development of locomotor skills, using virtual reality video games under professional guidance, from teacher support and advice, it permits diminishing displacement to adequate scenarios for sports practices and using space in state educational institutions. Thus, body awareness [6], refers to open spaces as pedagogical elements in which bodily management is part of the expression represented by the game itself as element of formation and not as the sole formation element of the individual who interacts.

Finally, state institutions, from the need to incorporate these types of innovative pedagogical strategies onto infant populations, must permit incorporating technologies in the generation of cognitive processes as in the development of physical skills in a forefront educational system; distancing boys, girls, and later future adolescents from useless activities and waste of time. Said development and design of motivational techniques under the conception of greater physical activity will make useful times of dedication to sports education, development of cognitive skills and, hence, physical skills, contributing to a holistic formation in adolescents in future societies.
The execution of the influence of the use of video games as strategy permits exercising diverse psychomotor coordination skills, while delving into the knowledge of the regulations and strategies of sports. This, applied to the case study for Santa Fé in the city of Bogotá, Colombia will provide the education system a redefinition of its use improvement component in the system of sports education strategies.

V. CONCLUSIONS

This research starts a path where investigations may be conducted to include broader study samples, with more objective tests to evaluate the locomotor pattern, increased amount of video game sessions, and statistical tests to determine the effects of virtual reality games on the development of motor patterns on children. This research found a slight increase in the number of children who moved on to a higher stage in the jump pattern in the group conducting two weekly sessions of virtual reality games for one month (intervention group) with respect to the control group.

Boys and girls five years of age may benefit from using virtual reality video games upon the development of skills and mental agility processes from attention and memory on problem solving processes upon identifying execution errors, verification and repetition as accomplishment process. Said causality is associated to the motor development of extension, flexion, and elongation of lower limbs in boys and girls measured by sports-type arcade video games in Colombian state educational institutions; likewise, they will benefit from their right to recreation and physical activity, which ensures them independent attention and proprioceptive promotion of motivation to sports activities, among them long jump, discus throw, running, and basic gymnastics recognized as having limited access for this population.

The vision created upon using virtual reality video games as of the development of motor patterns through sports applications in education will allow rapid development and engagement to the current educational strategy in basic primary school, and the diagnoses applied to it by professionals in adolescents sports therapy. The theme of sports education has many parts that are quite difficult to address in a single investigation; however, these types of proposals and implementation are necessary from the innovative incorporation of new technologies onto education, which can contribute to the knowledge of this transcendental theme for our country on issues of education and sports health.

Using video games in educational institutions is beginning to gain force in Colombia from the guiding policies by the Ministry of New Technologies (MINTIC); however, given that this research was conducted on state educational entities, the differences from the educational environment and from health prevention permit its implementation in curricular systems to be done gradually and, currently, few have adopted it through their own initiative because this emerges from the skills of the primary physical education teacher, his/her academic competency, and particular openness to using video games as support tools for the teaching tasks.

The link between an adequate low-cost pedagogical strategy, like incorporating video games in the classroom, and integrating innovative non-conventional strategies aimed at

learning attention and memorization processes, make using virtual reality applications into versatile tools and of easy access to state educational institutions, which by developing inclusion processes in curricular plans in the area of sports sciences permit exerting control and improving the development of basic locomotor skills on adolescents population, specifically children between 5 and 7 years of age that enable their future involvement in sports practices.

Given the increasing amount of virtual reality video games in existence or which can be developed, this research focuses an analysis sample of a sports video game on a study group, permitting the analysis of the capacity that can be generated by its use in physical and sports education. Designing arcade sports-type video games broadens the possibility of restructuring objectives on students' performance and greater physical activity, but it is mainly a task of state institutions of primary basic education and professors from primary physical education to contribute to greater performance of locomotor skills by the population of application from the incorporation of pedagogical strategies that include their adequate use and under particular objectives.

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