Virtual reality games about early childhood attention processes

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***Abstract*—** The use of virtual reality games has spread to various human activities in populations of all ages. Information and Communication Technologies (ICTs), as well as virtual reality games, have become strategic allies in the learning processes, since interactivity increases motivation, a process that underlies learning. In the same sense, these games have been used as methods of cognitive and physics in some neurological pathologies such as cerebrovascular accidents and Alzheimer's disease. This research was developed through a quasi-experimental study with a pre-test, post-test and a control group with infants. The study population met the following inclusion criteria: children of educational institutions located in the city of Bogotá, D.C., that have not practiced virtual reality sports games and that have all their physical and mental capacities, and whose parents signed the informed consent. In this study we found a slight increase in the number of students who moved to a higher stage in the jump pattern in the group that performed 2 weekly sessions of virtual reality games during one month (intervention group) with respect to the control group. This research initiates a way in which investigations can be carried out that can include larger sample sizes, with more objective tests for the evaluation of the locomotive pattern, an increase in the number of sessions of the video game, and statistical tests to determine the effects of the games of reality development of motor patterns

***Keywords*—** *videogames, Motor Learning, Meaningful Learning, virtual reality*

I. INTRODUCTION

THE use of virtual reality games has spread to various human activities in populations of all ages. In addition to technological advances, one of the reasons for the increased use of these games are family dynamics where parents occupy their day in work activities and children use free time in video games, internet and television, since the time to share with the family in outdoor activities has been reduced. This has contributed to the growth of digital culture in various countries.

Information and Communication Technologies (ICTs), as well as virtual reality games, have become strategic allies in the learning processes, since interactivity increases motivation, a process that underlies learning. In the same sense, these games have been used as methods of cognitive rehabilitation [1] and physics in some neurological pathologies such as cerebrovascular accidents and Alzheimer's disease [2].

Virtual reality games have also been used for the maintenance of active lifestyles [3], [4], [5]. Some authors establish the relationship between physical activity and motor development [6]. Due to these findings it can be inferred that there is a relationship between the use of virtual reality games and the maturation of the basic locomotors patterns.

Despite the benefits derived from the use of virtual reality games, some studies have observed negative effects derived from their practice, mainly for the visual system [7].

The studies recommend increasing research on the processes of attention and their relation with the maturation of locomotive patterns involved in the use of this type of video games. For this reason, the objective of the present study is to identify the influence of the practice of virtual reality games on the attention processes related to the motor pattern of undergraduate students.

II. THEORETICAL DISCUSSIONS

A. Videogames

A video game is an interactive computer program for entertainment that can work on various devices: computers, consoles, mobile phones, and so on; it integrates audio and video, and allows to enjoy experiences that, in many cases, would be very difficult to live in reality.

In the last decades, ICTs are playing an especially important role in education and in educational systems when proposing new discussions and challenges, such as the possibility of learning through videogames, the title of this monograph. In the report of NMC Horizon Report: 2014 K-12 Edition [8]

It is argued that the games and the so-called gamification will have an important implantation* (consider "implementation") in the educational contexts in two or three

years. The gamification is a method with the purpose of creating a meaningful and motivating experience through the integration of game mechanics in environments and non-ludic applications. [9] It establishes that "gamification is using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems".

With the introduction of videogames, this methodology was renamed learning based on videogames [10]. [11].

In its study on videogame-based learning, it establishes three aspects of the use of this approach in the classroom: a) the use of commercial titles, motivating and attractive games that can be used for educational purposes, but that require trained teachers and precise curricular planning that does not lose sight of the pedagogical approach; b) the so-called serious games, those specially developed to educate, train and inform [12]; and c) the games built by the students themselves and that develop problem solving, programming and game design skills. [13] Add one more**:** d) integration of gamification processes in educational activities mediated by technology.

In spite of the differences between both concepts - gamification and learning based on videogames. "The objectives of both are relatively the same. Serious games and gamification seek to solve a problem, motivate and promote learning through thinking and techniques based on the game »[14].

It is undeniable that video games are a technological instrument that is fully integrated into society [15]. Regarding its incorporation into the classroom, a study by the Spanish Video Game Association of 2012 states that 67% of Europeans and 58% of Spaniards consider the use of entertainment software, in general, and videogames beneficial, in particular, as an educational tool [15].

In large part statistically significant improvements are observed in terms of increased motivation and commitment to tasks, as well as enjoyment around them. [16]. It is underline the importance of the feedback they provide to students, the skills they provide for problem solving and leadership, which allows them to really be part of the learning environment instead of being a passive receiver [17]. In a recent work. [18]. Among the advantages of their integration in all educational levels, they have highlighted: They allow us to develop and exercise creativity, imagination and symbolic play; to work on social skills in the processes of socialization of individuals and the repetition of behaviors to perfection; to promote the increase of attention, the motivation for learning, the change of unhealthy behaviors, learning or doing active learning; to appreciate different cultural values, the development of critical thinking, the construction and reconstruction of knowledge, the creation of processes of reflection (in and for action), collaboration, the ability to react to adverse situations, the ability to solve problems , the development of spatial skills, the effective use of information; to improve attention and memory, verbal and non-verbal language, the ability to work in collaboration and cooperation, the desire to excel, the eye-hand skills, etc. [19].

Computational thinking is a very topical issue [20]. Thanks to the resurgence of the DIY movement (Do It Yourself) together with the generalization of mobile devices, Web 2.0 and the development of videogames [21]. One of the most recognized «Computational thinking involves solving problems, designing systems and understanding human behavior using fundamental computer concepts» [22].

Among the characteristics of video games are: the quality of the graphics (initially in two dimensions, currently in three), the game control, which should be easy and intuitive, and the sound (from the speaker to the surround sound) [23].

There are several types of video games, among them you can name adventure games (intelligence tests or puzzle solving to advance), arcade (dexterity activities), sports, strategy (coordinating actions), role (player manages a character, and evolves during the game according to the decisions of the user) and simulation (some type of action is simulated, for example to fly an airplane) [24].

Virtual reality games enter into an exclusive range of tools, in which the user can enter creatively, as far as the limit of his imagination allows. There lies, quite possibly, the greatest attraction, because imagination and creativity have the opportunity to be executed in an artificial and unlimited "world". The origin of these games is the Department of Defense of the United States, where they were created as material of an aviation class in the 70's to make flight simulations, practicing and avoiding risking lives [25].

B. Motor Learning

Mental and motor learning are two aspects of human learning. Mental learning is defined as the acquisition and improvement of intellectual knowledge, skills and abilities [26]. On the other hand, psychomotor learning is the process by which the child relates, knowns and adapts to the environment that surrounds him/her. It includes aspects such as expressive and comprehensive language, visual-motor coordination, gross motor skills, balance and social-affective aspect, which is related to self-esteem. Through the manipulation of objects and the mastery of space through the march, the child acquires sensorial motor experiences that allow them to construct concepts, which will translate into ideas and develop their thinking and their ability to reason [27].

Motor learning and thus, meaningful learning, can be influenced by virtual reality games through their influence on the premotor cortex. This cortex has direct connections with the primary motor area and contributes with 30% of the axons that make up the corticospinal and corticobulbar pathway. The premotor cortex consists of two components: lateral and medial. Virtual reality games can, also, influence directly on motor learning processes by providing visual cues and directly impacting motivation.

Motor competence implies that a person can adapt and adjust to the demands of the environment to do a good job, it is not only the learning and skills of different nature, but it

also encompasses a set of knowledge (which includes knowing what, how, when and with whom to do) that are used intentionally to deal with the motor tasks that are presented [28]

Motor competence is considered as a set of "knowledge, procedures, attitudes and feelings that intervene in the multiple interactions that he performs in his environment and with others" [29].

In recent decades, research related to motor competence [30]; [31]; they show a decrease in motor competence levels in adolescents. These low levels are of concern to professionals in the motor field, since motor competence not only has great relevance in the overall development of young people, but is also defined as a fundamental element when predicting the practice, understanding the motor competence as a motivator of the desire to practice [32].

C. Meaningful Learning:

The learning process conceived from the constructivist perspective according to some authors [33] there are types of learning that can occur in the classroom: 1) referring to the way in which knowledge is acquired, 2) relating to the way in which the knowledge is incorporated in the structure of knowledge or in the cognitive of learning. Within the first dimension there are in turn two types of possible learning: reception and discovery; and in the second dimension there are two modes: reception and meaningfulness.

According to other researcher [34], the student's learning depends on the previous cognitive structure that is related to the new information. It must be understood by "cognitive structure", a set of concepts and ideas that an individual possesses in a given field of knowledge, as well as its organization.

The learning process as an expression of dynamic construction implies that the subject possesses previous knowledge related to the new learning that will be appropriated from his initial baggage. The most important independent variable for meaningful learning to occur.

Ausubel defines it this way: "If I had to reduce all educational psychology to a single principle, I would say the following: the most important isolated factor that influences learning is what the learner already knows. Find out this and teach yourself accordingly "[35].

The necessary conditions for meaningful learning are: 1)

1) Significant learning attitude (predisposition to relate the new material that will be learned in a substantive and non-arbitrary way, with the knowledge structure)

2) Potentially significant training material (framework and related to particular knowledge structures in a non-arbitrary and substantive way).

Therefore, the significant potential of the new material is not enough if the intention is to memorize it arbitrarily and literally, both in the learning process and in its final product.

Also, although there is a favorable disposition to learn, if the material is not potentially significant, learning can not have this quality. Meaningful learning is, therefore, both the process and the final product of it. The concepts that support the model of meaningful learning are indicated below in a succinct way [36]

Assimilation or anchoring. This process is permanent in the subject that learns. The attributes or criteria of the concepts can be generated as new combinations of concepts and referents already existing in the cognitive structure; In this phase of meaningful learning, cognitive reception in its final form is of cardinal importance.

The assimilation results from the interaction between the existing cognitive structure (previous concepts) and the new meanings, which produces two effects: 1) it can favor the retention of concepts insofar as newly assimilated ideas remain separable from their ideas- anchor; 2) implies the underlying forgetting of meanings, since they tend to be "reduced" to the more stable meanings of established ideas, a phenomenon known as the obliterating stage of assimilation [37].

Subordinate learning

The new concepts obtain meaning through subsubers that are incorporated into the cognitive structure and acquire interdependence and are hierarchized in relation to the level of abstraction, generality and inclusivity of the concepts.

Superordinate Learning

It is defined by a new set of attributes or criteria that encompass those of subordinate ideas; as they are produced, the significant learning, by the elaboration of subsubers, refers that these concepts interact and originate other more encompassing concepts (inductive conceptual learning).

Potentially significant material (logical and psychological).

It has some potential of meaning, which can be of a motivational type and with a disposition for learning; this process is conditioned by:

A logical meaning, that is, understandable and available for the cognitive structure, having clear and specific subsuber in which the material is relatable; and a psychological meaning, which is nothing more than the meanings attributed to potentially significant material in a contextual and cultural way.

Intrinsic motivation. In addition to the extrinsic motivation of the potentially significant material, the knowing subject is required. Intrinsically motivated actions are types of motivation directly influenced by personal interest or pleasure;

the subject feels competence and self-determination when he is able to master challenges that are optimal for him [20] (quite novel to be interesting, difficult enough to be challenging) [38].

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• Progressive differentiation. Deduction of the learning of the recent subordinated concepts through the interaction and anchoring in a new subsuber that, in turn, suffers modifications generating a progressive differentiation or a change and modification of the subsuber concept.

Integrative reconciliation. Induction that produces superordinate or combinatory learning; Thus, ideas established in the cognitive structure can be recognized as related notions when there is new knowledge; then the concepts already existing in the cognitive structure, together with the new information, come to be related and to acquire new meanings.

The conceptual maps and didactic resources are diagrams of meanings, of significant relationships - conceptual hierarchies - considered as the most pertinent instruments to obtain significant learning because the concepts they contain must be connected with an adequate internal coherence and connection. In them, concepts are presented in the form of a hierarchy or levels, from the most general to the most particular. In order to elaborate and interpret a conceptual map, knowledge of the previous basic concepts is required so that they are designed in a way that guarantees understanding with a clarifying presentation of them [40]. Human knowledge is constructed; meaningful learning underlies this construction ... [41].

"Learning is sharing meanings and conceptual maps make these meanings evident, they become instruments to explore and negotiate meanings" [42]. In this context, the humanist idea of Novak [43] .in the framework of meaningful learning, strengthens and integrates the different dimensions of being, which is expressed in the following terms: meaningful learning as an underlying of positive, constructive integration of thoughts feelings and actions; these are always integrated.

The human being thinks, acts and feels in an integrated manner, positively or negatively. This vision of Novak provides, as a novelty, that when this learning is significant, integration is positive and leads to human aggrandizement [44].

III. METHODOLOGY

This research was developed through a quasi-experimental study with a pre-test, post-test and a control group with infants. The intervention group was exposed to two sessions per week of virtual reality game for one month, each session was developed in three phases: a first warm-up part, then 15 minutes of interaction with the virtual race game and finally stretching of the main muscle groups of lower limbs. The control group was not exposed to any treatment.

The study population met the following inclusion criteria: children of educational institutions located in the city of Bogotá, D.C., that have not practiced virtual reality sports games and that have all their physical and mental capacities, and whose parents signed the informed consent.

Subsequently, the posttest data of the control group and the intervention group were compared, identifying if there is any influence of the video games on the locomotor pattern.

IV. RESULTS

The total study population was 30 students, of whom 15 belong to the control group and 15 to the intervention group. The anthropometric characteristics of the study population and the intervention population are presented in Table 1. Based on 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

Figure 1 shows the change in the locomotor pattern stage in the control group as well as in the intervention group, i.e. the students who were in the initial stage and moved to the mature stage.

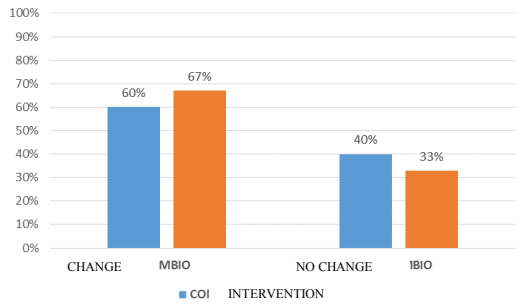

Fig. 1. Percentage change in the locomotor pattern stage in the control and intervention group.

Although there are no studies on the effect of virtual reality games on the development of locomotor patterns, this study is in agreement with those investigations that find positive effects of this type of games in the learning of motor activities in patients with neurological damage, such as: cerebrovascular disease, spinal cord injury, multiple sclerosis, Parkinson's disease and traumatic brain injury [45]. This effect can be attributed to three key elements: the repetition, the sensory feedback and the motivation that these games provide due to the interaction and immersion in the video game.

There is controversy about the quality of motor activities that are learned. Several studies have considered that movements are similar or equivalent, for this reason they are recommended for the learning of motor tasks [46], however, due to the difference in perception, less precision in movement has been observed [46], [47], [48].

Another point of debate is the applicability of motor activities in reality, however, some research has found that virtual reality games provides a motor learning in the three dimensions of space, corresponding to the movement that takes place in the real world [49].

Finally, such is the relationship of motor learning with intellectual learning that virtual reality systems are used for training in non-medical practices such as aviation, nuclear and industrial systems, and in medical practices such as training for endoscopic surgery, general and vascular surgery, orthopedic and neurorehabilitation [45]

Content knowledge can be classified from low to high, as there is learning, memorization, comprehension, application, analysis and synthesis, and evaluation. This criterion refers to the extent to which students have learned. Which highlights the valuation based on a rubric based on the levels of Bloom's taxonomy, the percentages in this sense and detailed in the different scales are highlighted [50]. From this design, the experimental group obtains data and results that allow us to verify elements related to computational concepts.

V. CONCLUSIONS

In this study we found a slight increase in the number of students who moved to a higher stage in the jump pattern in the group that performed 2 weekly sessions of virtual reality games during one month (intervention group) with respect (*consider “regarding”) to the control group. This research initiates a way in which investigations can be carried out that can include larger sample sizes, with more objective tests for the evaluation of the locomotive pattern, an increase in the number of sessions of the video game, and statistical tests to determine the effects of the games of reality development of motor patterns.

The design of the videogame allows the pedagogical to strengthen and potentiate four fundamental dimensions in human development; namely, motor, intellectual, affective and social development.

After the results obtained, it can be concluded that the use of technological tools strengthens skills and attention.

The perspective of generating attention with videogames, knowledge management is clear, emphasizing that they learn with others and for others because they show the ability to work in teams. Additionally, it is necessary to continue building technological tools. This research initiates a path in which research can be carried out that includes broader sample sizes, with more objective tests that may be useful.

If the media develop a role of transmitters of knowledge, video games, for better or for worse, reflect this circumstance a great capacity for entertainment and transmission of training, play is an important part of cognitive and social development.

On the other hand, the attention processes do not seem to suffer any type of deterioration due to the use of video games. On the contrary, it is concluded that the game with video games favors the development of certain aspects of intelligence, especially those of a spatial nature. Finally, it has been demonstrated in a convincing way that video games allow a special help in the treatment and improvement of educational and therapeutic problems, both physical and psychological, as well as multiple utilities in terms of training all kinds of skills.

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