The Impact of Virtual Reality Environments on Body Movement and Concentration Skills

A Successful Attempt at Teaching Novice Computer Users

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ABSTRACT

This research is aimed at investigating the impact of virtual reality technology on body movement and concentration skills by physical education MA students and pupils through action research.

The design and manipulation of virtual reality is based on applying the virtual reality environment to the real world as much as possible by controlling space. The researcher taught the method to 55 MA students majoring in physical education. Such procedures were held among various populations.

The findings showed that the connection between virtual and human movements and the application of this connection in physical education lessons became clear to the students as they practiced the simulation design and manipulation through specific simulative software. The students used their unique disciplinary programs in their teaching work and reported their pupils' improvement in physical activities and concentration skills.

The students were able to integrate theory and practice in their teaching and improved their level of academic writing. The motivation of the students and their pupils to control, design and manipulate virtual environments was also enhanced.

Keywords: Action Research, Concentration Skills, Design, Dynamics, Technology, Body Movement, Simulations, Virtual Manipulation, Virtual Reality Movement.

1. INTRODUCTION

Most physical educators cannot deal with unfocused pupils during the lessons and are not aware of the possibility to improve their body movement and concentration skills by developing their computer design ability. According to Piaget & Inhelder's theory (1), creativity leads to a significant construction of knowledge. Developing control over reality and compatibility with the everyday environment occurs while manipulating virtual simulations.

2. THEORETICAL REVIEW

Since the connection between virtual reality and physical education still seems unlikely, we selected the Tetris software to show this connection by fostering pupils' body movement and concentration skills. Initially, the research of virtual reality focused on science (2), aviation (3), medicine (4) etc. Only during recent years researchers have been dealing with education as well. As it stands, virtual reality is still in its infancy, with each new project often being the first of its kind [5]. But we have not found yet studies dealing with the connection between playing the Tetris game and improving physical performance focusing on concentration skills of pupils during the physical education lessons.

Pazhitnov (6) invented the Tetris game in 1985. Since then, this computer game has been considered the hardest task in problem solving by manipulating virtual reality, while the users race to fit falling blocks together on the screen. In the game, the player sees the objects graphically and tries to organize them before they fall (7). It links the concrete and the symbolic by means of feedback. The manipulations of the shapes over the computer screen (rotating them to the right or to the left side) link the symbolic commands to a sensory-concrete turning action (8). The game exploded in popularity after the Nintendo Co. and other people put it on their popular game machines.

The Tetris Game and the Virtual Reality Environment

The Tetris software is one among a variety of methods by which users can interact with virtual reality technology (9). Weiss, Rand, Katz, & Kizony (10) defined virtual reality as "the use of interactive simulations created with computer hardware and software to present users with opportunities to engage in environments that appear to be and feel similar to real world objects and events." To capture this diversity, authors have coined the term "interactive computer play," defined as "any kind of computer game or virtual reality technique where the child can interact and play with virtual objects in a computer-generated environment" (11). Technology enables presentation of information in three-dimensional formats in real time (12) (13).

Situations which are too complicated to perceive in a regular learning environment can be presented and viewed in many different perspectives in a virtual environment (12) (13).

The simulated world can provide the opportunity to repeatedly practice a skill without the fear of injury or embarrassment. The reported effects on children include: gaining a new perspective [14], increasing participation and access (15) (16), instilling a sense of confidence, competence, self-control and mastery (14) (16).

Thematic analysis of physical activity experiences of 12 age-matched boys with and without the attention deficit hyperactivity disorder (ADHD) (17) revealed the differences that were found between these two groups (See table 1).

Table 1: Examples of Differences between Boys with and without the Attention Deficit Hyperactivity Disorder (ADHD)

Boys with ADHD	Boys without ADHD
They reported playing with friends paid little attention to detail.	They reported playing with friends paid a lot of attention to detail.
They rarely organized opportunities to play or be active with other children.	They frequently organized opportunities to play or be active with other children.
They seemed to enjoy being involved in a variety of different activities, especially individually-oriented sports or leisure activities (18).	They seemed to enjoy being involved in a variety of different activities, in groups.
They experienced limited physical activity experiences and had limited acquired knowledge (19).	They experienced non-limited physical activity experiences and had non- limited acquired knowledge.

Designing, Manipulating and Controlling Virtual Reality Environments

Clements (20) defined successful manipulations as "meaningful to the learner, providing him control and flexibility, having characteristics that mirror, or are consistent with, cognitive and mathematical structures, and assist him in making connections between various pieces and types of knowledge".

Learners actively construct concepts through the process of mediated actions (21). According to the notion of mediated actions, human beings use cultural tools (such as language as well as tangible features of the environment) which fundamentally change the structure of cognitive functioning and activity (22). Kezar (23) believes that faculty instructors can be affected by changes such as integrating technology in their teaching program if only they were actively engaged in creating the change that is taking place.

Education on Computer Training

Research shows that the learning performance of 49 college sophomores was higher for learning software utilizing simulative manipulation and visualization yields than for that lacking simulative manipulation, which suggests that learning performance can be enhanced if visualized learning can appropriately integrate simulative manipulation activities (24).

3. RESEARCH PRESENTATION

Procedure

The research group was composed of 55 MA students majoring in physical education. The tests were conducted for 2 meetings per pupil, a total of 25 minutes per pupil before and after the intervention program, which lasted eight weeks, twice a week. This was a pilot research.

The Research Method

The students planned their study and reported on each stage they completed. The method of training focused on practicing Tetris software.

The Stages of Designing the Virtual Environments and its Applications

We took longitudinal research as our model (25) during one semester (3 months) and included four stages:

Stage 1: Learning the rationale of virtual reality and its impact on physical movements and concentration skills.

Stage 2: Planning research:

- Choosing a pupil diagnosed with ADHD.
- Testing the achievements in the examined skills.
- Learning and training simulative software.

Stage 3: Then testing the achievements in the examined skills.

Stage 4: Writing the research report.

The student writes his/her analysis using a professional PowerPoint presentation, and relates the practice to the theory.

Research Tools

Spatial Intelligence Test

Standard Progressive Matrices test of Raven (26)

Body Movement tests

Media

PowerPoint software was used for writing the research report.

The computer "Tetris Game" software was used to improve physical and concentration skills. The players aimed at filling 2D shapes into rows and a large 3D cube with small blocks of different shapes. During the use of the Tetris task, block-shaped pieces appear at the top of the screen and fall down, while players manipulate them, so that they fit into point-scoring rows. In order to attain a high score, the users need to act both precisely and rapidly. The users have to complete the blank locations on the board according to a rule they had inferred and fit the appropriate shape in the blank locations.

The Tetris software is characterized by the following:

1. Each form appears in the upper part of the game board and is going down at a constant speed.
2. The degrees of difficulty are determined by the speed at which the forms move down.
3. At any time when the line or the surface in the 3-D Tetris game is filled, it is erased and the participant scores points.

The keys for enacting the "Tetris" software are the same: The user can move the form to the right or to the left side, or take it down by using the arrow-keys. The form can be rotated to fit the empty space to be filled by use of the space bar, 90^0 to the right or to the left.

The use of the "Tetris" software trains spatial orientation and visualization, motor skills, hand-eye coordination and time orientation.

The gains in points of the MA students in the Tetris software show a gradual increase during practicing with the software. Observing all the students included in the research group while practicing with Tetris software revealed their progress and interest.

Examples of the connection between the acts performed during training the Tetris software and the ability to analyze motor skill:

Case Presentations (Pre-intervention and intervention)

Case No. 1

Loya's project (27) was aimed at investigating body movement and concentration skills of 8-year-olds learning in a regular 2^{nd} grade class.

- Overall aim: To improve an ADHD child's behavior, improve his physical ability and his level of attention and focus in physical education lessons.
- Secondary aims: To improve his behavior and his level of attention and focus in the various classes, raise his motivation, raise the level of his self-esteem, self-perception, his self-confidence and his confidence in the environment, diligence in carrying out his tasks, improve limb movement and reflex speed.

Description of the intervention program

- Choosing a child diagnosed as having ADHD
- Constructing a dribbling test in basketball.
- Test in matching matrix shapes.
- Practicing Tetris on the computer.

The program checks the progress of the child at the individual level and at the class level, his improvement in motor ability and cognitive ability, and his level of attention and focus. Attention and focus are checked at the outset and at the end of the intervention, and so is the matching of shapes.

Case No. 2

Zelkar's project (28). The subject was a fourth grader with attention and focus issues, discipline problems, disruption of lessons, a history of complaints from other pupils following physical violence. The pupil reached self-fulfillment in physical education. In his physical education lessons he listens to instructions, carries out all the tasks, his achievements improve from lesson to lesson, and he even takes upon himself responsibilities such as organizing teams for sports.

Overall aim: to improve this ADHD pupil's behavior in his physical education lessons.
Secondary aims: to improve the pupil's behavior and his attention and focus span in the other various lessons, to raise his motivation, to improve his self-perception, his self-confidence and his confidence in others, diligence in carrying out his tasks, improve limb movement and reflex speed.

During his participation in the project (to which he came willingly and with high motivation) his attention and focus spans improved significantly. His suspensions from school have stopped and he tries to listen in the other lessons as well.
In the diagnostic matrix test he showed a high level of concentration, attention and patience. Playing the Tetris game, his attention and focuses shown constant progress, indicating an improvement in his focus and attention span. Zelkar added that they should check if it is possible to help this student further in raising his level of attention and focus, and improving his social behavior by using a planned computer program at the beginning of each lesson.
The stages of learning: Use of simulation through computer games.

Case No. 3

Moyal's project (29). The aim of the project was to investigate the question whether it is possible to improve ADHD children in the following areas: cognition, emotional stability, social behavior, and flexibility through computer software.
The subject of the investigation is an eight-year-olds second grader. He was not professionally diagnosed with ADHD, but was reported to suffer from constant restlessness and inability to sit for lengthy periods of time, "a child moving all the time."

The aims of the intervention

The overall aim: To improve the attention and focus span of the child.

Secondary aims:

- To improve cognitive abilities.
- To improve flexibility of the back.
- To improve the level of computer skills.

The child would show impatience with the Tetris game from time to time. He would have a hard time focusing on one single activity and would be restless in his chair.
Computer games did not improve his flexibility to bend forwards.
He could not complete the first matrix test.
In the flexibility exercise, the child reached exactly up to his feet in a sitting position with legs straight.
Regarding the game, initially the child showed very low achievements. His control was bad. He was impulsive and showed no strategic thinking, so that his scores were low. Initially, he played without enthusiasm. He sat on his chair restlessly, and showed signs of wanting to finish the game fast. He did not show control over directions, right or left at first, expressed in his confusion playing the game and verbally.

Evaluation

Evaluations were made on comparing the level of:

- The students' writing of the action research and designing the computerized teaching program.
- The pupils' physical achievements and concentration skills before and after the training.

4. FINDINGS

It was found that the computer-based intervention program increased the achievement level in the examined skills as follows:
The MA students became aware of the connection between the pedagogic-didactic achievements and theoretical scientific approaches they used as the basis of their studies. The students' reports became then clearer and more detailed as well (See table no. 2). Furthermore, the motivation and self-confidence of the MA students and pupils were enhanced.

Table No. 2: Example of Differences between the Level of Research Performance of the Students at the Beginning and the End of the Course

Starting Course	**Ending Course**
Focusing exclusively on theory.	Applying the theory to the teaching work.
Editing the research, in general, without using authentic examples.	Editing the research according to the standards.
Writing long, complex sentences.	Writing brief, structured sentences.
Copying the articles' text.	Writing the text in their own words.
Focusing on some objectives. Having difficulty differentiating between main and sub objectives. Having difficulty formulating the assumptions.	Focusing on the main objectives and assumptions.
Mixing results and discussion.	Differentiating between results and discussion, Summarizing briefly each table showing the results. Then concentrating on the discussion, Analyzing the results according to theory.

All the MA students succeeded in their studies, while their pupils achieved high scores in the post-intervention tests, relatively to those in the pre-intervention tests. This improvement was clearly observed in the pupils' class scores.
The students' reports relating their pupils' improvement strengthen the three cases stated in this paper.
We may highlight the progress noted among the students by demonstrating each one of the projects that they performed.

Case Presentations (Post-intervention)
The data displayed in graphs no. 1, 2, 3 show an improvement in the trained software.

Case No. 1: Loya's case (27).
The pupil's academic level improved at the end of learning. Even the attention and performing attractive math activities led the pupil to invest time and effort, to do his best and have positive experiences through the virtual manipulations.
"Following this, we meet near the computer to practice Tetris after trying it, of course, not a few times at home after encountering it in the computer room at the College. At the beginning, there seems to be no connection between the number of lines and the points accumulated. During the game he says: "Look at all the points, now I am going to do better," "it's beginning to be a cinch," "it's a bit hard, this game," "today I'm going to break the record," "I broke the record. I'm going to write it down."
"At one of the meetings we experienced a problem with the computer, and until we succeeded in clearing it up, there was little time to play. He then surprised himself that he had reached Level 2 so quickly and jumped with joy when he broke the record and reached Level 3, doing 31 lines and scoring 2132 points in four minutes and 57 seconds. At one of the meetings, he waited until I came back from a competition. He did not give up the chance to practice the game, even though there was very little time left. Following many practice sessions with the Tetris game, I again administered to him the matching of shapes test and found that he had made a lot of progress, as it can be in the table below. He also improved in the basketball test – the motor skills test.
The meetings went on a few more times after the project had ended and were gradually reduced to once a week.
" I enjoyed this process very much as teacher of children with issues in attention and focus."

Graph No.1: Points Gained by the Pupil at Every Trial while Training the Tetris Software

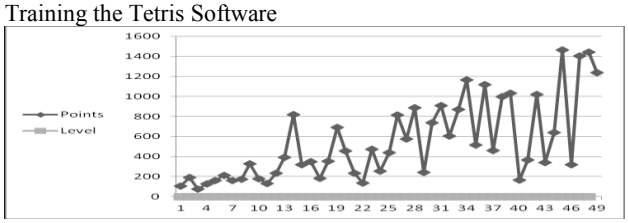


Table No. 3: Child's Activity with Ball before and after the Intervention

The activity	Pre-intervention	Post-intervention
Dribbling 20 meters in straight line with right hand.	Ball fell twice.	Ball did not fall.
Dribbling 20 meters in straight line with left hand.	Ball fell 3 times.	Ball fell once.
Dribbling around conuses.	Ball fell 3 times.	Ball fell once.
Dribbling 20 meters with right and left hand alternating.	Ball fell 4 times.	Ball did not fall.
Dribbling around conuses with right hand.	Ball did not fall.	Ball did not fall.
Dribbling around conuses with left hand.	Ball fell 3 times.	Ball fell twice.

The findings show an improvement in the pupil's attention span and focus, an improvement in computer skills, and an improvement in motor ability.

Case No. 2: Zelkar' case (28)
The pupil acts as counselor for other pupils learning with the teacher how to navigate in the game with the correct control of directions.
The pupil focused throughout the lesson on physical education together with his teacher. She claims he makes a big effort doing this so as to avoid being suspended from school because of his behavior problems and so as to be able to come to her individual instruction lesson to play the Tetris game. It must be stressed that thanks to the pupil's improvement at school and in his ability to focus his attention, the school administration decided that every child who turns violent following an attack of ADHD would be sent to this particular teacher to calm down by playing with the computer instead of being suspended again and again

Graph No. 2: Points Gained by the Pupil at Every Trial while Training the Tetris Software

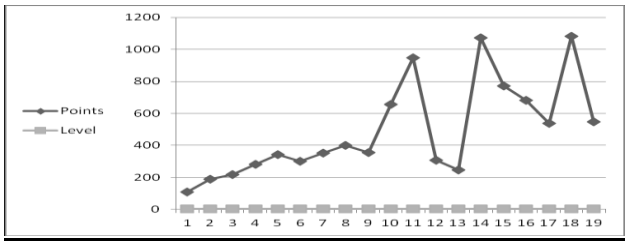
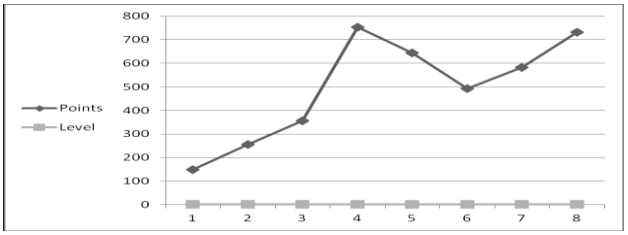


Table No. 4: Child's Activity with Ball before and after the Intervention

The activity	Pre-intervention	Post-intervention
Dribbling 20 meters in straight line with right hand.	Ball fell 4 times.	Ball did not fall.
Dribbling 20 meters in straight line with left hand.	Ball fell 6 times.	Ball fell once.
Dribbling around conuses.	Ball fell10 times	Ball fell 3 times.
Dribbling 20 meters with right and left hand alternating	Ball fell 8 times.	Ball fell twice.
Dribbling around conuses with right hand.	Ball fell 4 times.	Ball did not fall.
Dribbling around conuses with left hand.	Ball fell 8 times.	Ball fell twice.

Case No. 3: Moyal's case (29)
The child did the matrix test showing good behavior, but the results of the test were lower than the first test (a finding for which I found no explanation). He did finish, however, all the questions (60) whereas in his first test he had finished only 30. There was a significant improvement in the child's flexibility: he was able to stretch his hands beyond his feet by 6 cm. His mastery of the computer game is the most conspicuous achievement, expressed by his strategic thinking (stopping the game to check for possibilities), fine motor control, control of impulsive behavior, enthusiastic reaction at scoring every point, self-reinforcement and enjoyment at playing the game.

Graph No. 3: The Average Scores in the Tetris Software at Every meeting



As we can observe, the first two hypotheses were borne out quite clearly. The boy improved his score in the game, and his willingness to sit for a lengthy stretch of time and complete the test shows an improvement in his ability to concentrate. In addition, his cognitive capabilities have also improved. This is expressed in his analysis of the game, in his paying attention to the details, in his planning of the game and in his motor control. The improvement in all these skills contributed in achieving his high score.
The third hypothesis concerns the possibility that playing with the computer would improve the flexibility of the boy's back. The MA student emphasized: "I must admit that regarding this possibility I was skeptical and so I postulated that there would not be any improvement in the boy's back,
but my experience in this study shows that other research and my own research show identical results, and so my hypothesis was disproved.".

Changes in the MA Students

- The action research developed the MA students' awareness of the pupils' capability to improve their computer physical and concentration skills.
- The MA students learned to diagnose the pupils objectively.
- The MA students' self-confidence in using the computer, designing and manipulating simulations was enhanced.
- The MA students improved their academic writing.

The Progress of the Pupils in their Learning Process

- The pupils learned to manipulate virtual simulations.
- The use of computers changed their learning gradually from mechanical to meaningful and relevant to the pupils' everyday environments.
- The spatial intelligence achievements, body movement and concentration skills were improved.

5. DISCUSSION

The question raised in this article is whether training in virtual reality and controlling virtual simulations will affect MA students' awareness of the connection between manipulating virtual reality and physical activities, and improve concentration skills. In spite of the short time of training and the absence of experience in using computers before training, a significant improvement of the participants' PowerPoint presentations was recorded, as a result of the different mode of training.
Learners (students and pupils) can do things that they cannot do with physical manipulations. (30).

Advantages of Computer Manipulations for Teaching and Learning

Certain computer manipulations may be more beneficial than any physical manipulations, and allow students to save configurations and sequences of actions; dynamically link different representations and maintain a close connection between pictured objects and symbols; allow students and teachers to pose and solve their own problems;

Ysseldyke et al. (31) focused on selecting computer manipulations that encourage easy alterations of scale and arrangement, going beyond what can be done with physical manipulations, and demanding increasingly complete and precise specifications.

Virtual Reality and Active Learning

According to Bagley and Hunter (32), students become empowered and spend more time in active construction of knowledge when using technology. Since our knowledge is constantly increasing, and there is now too much information to memorize, students should learn how to access information.

The research exemplifies the effects of the manipulation of forms moving rapidly on the computer's screen. Besides the challenge of the computerized activities, it helps to build physical competence.
Some methods that focus on manipulations allow and even encourage students to choose their own representations material. They can also be used to assess whether students understand the idea or just have learned to use material in a rote manner. Certain computer manipulations encourage easy alterations of scale and arrangement, thus they go beyond what can be done with physical manipulations and demand increasingly complex and precise specifications. Computer manipulating guides students to reflect on their actions and alter them by predicting and explaining (33). The students succeeded in applying physical education theory in their teaching work through the unique software, initiated by their need to understand the meaning of the movements, the relationships between them and how to perform them successfully.

The Connection between Computer Games and Physical Activities

Generally, all or most computer games exercise spatial orientation and visualization, as the player has to orient himself/herself within a rapidly changing environment. Players of the computer game Tetris may elect to preview each upcoming shape in order to plan the next step in playing the game, while manipulating the fast-changing environment over the computer screen. The same skill is needed for performing physical skills. Success in the game, that is to say "gaining points" has its motivating effect on the participants and thus enhances the effect of the training.

The Contribution of Virtual Reality Environment to Thinking

The virtual reality environment is unique in its dynamic representation. Success in designing, manipulating and controlling simulations of the real world has its motivating effect on the participants and thus enhances the effect of the training. In this research, the impact of the computer simulations on body movement and concentration skills was clearly shown.
Moreover, regarding the MA student research works, the findings indicated that the students could integrate theory and teaching work. Such research works enable the MA students to:

- Translate theoretical concepts into practical language,
- Apply them during the teaching work in a variety of educational contexts, and
- Interpret the results of the experiences by looking at them through the perspective of the theoretical approaches he/she has applied. Such courses usually focus on the basics of the use of computers only.

6. SUMMARY AND CONCLUSIONS

The scientific importance of the research lies in the MA students' increased ability to carry out action research and write high-level theoretical reports (34). The research contribution is also observed in the students' awareness of their ability to advance their pupils' body movement and concentration skills by designing, manipulating and controlling virtual learning environments, while technologies are merely tools/or vehicles for delivering instruction (35).

The present study shows that this technology enhanced the theoretical and practical teaching work of 55 MA students majoring in physical education. The design, manipulation and control of computer simulations showed the students that it serves as a mediator for developing physical and concentration skills. As the MA students became more experienced in planning, designing and controlling virtual learning environments, they became more convinced regarding its impact on physical education programs for their pupils in their teaching work, considering the concentration skills too. Consequently, the pupils showed improvement in the trained skills.

According to the MA students' reports about improving their pupils' physical skills, it seems that the virtual simulations serve as a mediator for developing physical skills such as dribbling, gymnastic, ground gymnastics, etc. During the computerized training process, which facilitated the virtual mode, the students learned how to improve their planning physical movements in order to perform them in sequence successfully and fluently. According to the MA students' reports, these improvements were also used to design their teaching programs for their future pupils.

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