Generation and Application of Virtual Dynamic Learning Environments

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ABSTRACT

The generation of virtual dynamic learning environments by mental imagery improved physical education of student teachers. Up-to-date studies showed that training computerized simulations improved spatial abilities, especially visualization of the body's movements in space, and enhanced academic achievements. The main program of the research concentrated on creating teaching units focusing on a variety of physical skills through computerized dynamic presentations. The findings showed that as the student teachers practiced the creation of simulations through the PowerPoint Software, it became clear to them how the computer is related to physical activities. Consequently their presentations became highly animated, and applied to the natural environment. The student teachers applied their presentations in their practical classroom and reported about their pupils' progress in physical skills. Moreover the motivation of the student teachers and pupils to both modes of learning, manipulating virtually and physically, was enhanced.

Keywords: Application, Generation, Simulations, Inter-sensory Coordination, Mental Imagery, Physical Education, Technology, Computer, Virtual Dynamic Learning Environments, Virtual Reality, Visualization in Space.

1. INTRODUCTION

Most physical educators do not yet associate virtual reality and computer simulations with physical activities. Such technologies are mainly used in applied fields such as aviation (1) (2) and medical imaging (3) (4) or science (5), technology-rich industry (6) and computer games (7) (8).
These technologies have begun to edge their way into the primary classroom (9). However, only a few studies concerning the efficacy of virtual reality to physical education were made (see: (10) (11) (12)). The illustration of objects makes learning more straightforward and intuitive for many students, and supports a constructivist approach to learning. Students can learn by doing rather than, for example, by reading. They can also test theories by developing alternative realities. This greatly facilitates the mastery of difficult concepts, for example, the relationships between distance, motion and time (5). The virtual manipulations of the body or the objects help the students to understand the process of performing physical acts consecutively (13). Physical phenomena that are complicated to perceive or measure in usual experiments can be presented in a virtual world and viewed by researchers in many different perspectives in a virtual reality laboratory.

The individual needs his spatial intelligence for his body's movement and computerized activities, for example: while using the computer, he is required to move an object through the maze to a marked target. But in body movement, he must run through the course without bumping into barriers or obstacles.
The integration of physical and virtual movements improves spatial intelligence (13 (14).

The main similarities between computer simulations and physical activities are as follows. Both experiences include initiated motor activities and require inter-sensory coordination; both experiences refer to the basics of the motion: body, space, time, power and flow.

The computer activities also differ from physical activities in some aspects (See Table 1).

Table 1: The Differences between Computerized Activities and Physical Activities

Computerized Activities	**Physical Activities**
Performed by fingers – fine motor.	Done by the whole body – gross motor.
Based on visual perception.	Based on kinesthetic perception.
Can be done individually or communicatively.	Serves usually also as a social event.
Focuses on information appears on the computer screen.	Relates to the environment.

2. THEORETICAL REVIEW

Definitions

Computer Simulations are computer-generated versions of real world objects. They may be presented in two dimensional, text-driven formats, or increasingly, three dimensional multimedia formats. Computer simulations can take many different forms ranging from computer renderings of 2-D geometric shapes to highly interactive 3-dimentional multimedia environments (15).

Virtual reality is a technology that allows students to explore and manipulate computer-generated, three dimensional multimedia environments in real time. The immersion virtual reality environments enable users to fly through space and observe objects from any angle (15). Pantelidis (16) defines virtual reality (VR) as a multimedia interactive environment that is computer based and enables the user to assimilate and to become an active partner in the virtual world. This technology enables presenting information in three dimensional formats in real time. It allows the user to become an active part of the environment and to benefit from interactive communication without using words. Thus virtual reality enables converting the abstract into concrete by giving perspectives on processes that are impossible to visualize in the real world (17) (18).

Spatial Intelligence

Spatial intelligence is based on two main spatial abilities which are differed one from each other: spatial orientation and visualization in space (19) (20) (21). The spatial orientation enables a person to fix the place in space related to the environment and/or other figures around him/her from the personal point of view as an observer immediately. At the same time, visualization in space enables the observer to predict and imagine the changes in space from the others' perspective for a period of time. Both skills, orientation and visualization in space, occur in two patterns of reference: personal space and general space (22). Spatial intelligence refers to movements in space. This intelligence is coming to fruition in sport in high levels and is activated in a motor mode also in imagery of movement (23). All these skills lead to developing navigation in space. The integration of orientation and visualization in space comes to fruition while solving problems in space (22). Virtual reality technology allows the participant multisensory experiences coming from perceptual information: visual, auditory, and tactile stimuli. According to Pizer (as cited in Reingold (24)), the main advantage of Virtual Reality regarding perception is the ability to move and change our view of things as we would do in the real world in order to give us an adequate perception. Visualization enables us to show information that would otherwise not be available (25). Andrew and Ellis (26) remark that "Visualizations of real-world events can be accomplished, and actions might be taken depending on their nature". According to Horwitz (25) visualizations are what we choose to show users, simulations are what we let them do and models are what link the two.

Learning by Computers

Computers serve as symbol-system manipulation tools (26) (27) (28). Advances in computer technology have allowed for the development of real-time three dimensional graphics, auditory and kinesthetic environments in which the learner can be perceptually immersed (29).

Thus, the characteristics of 3-D interactive environments, namely virtual reality, are closely aligned with those of an optimal learning environment. The 3-D interactive environments that are referred to as virtual reality regarding physical activities are described as a computer created, three dimensional environment in which the student is an active participant (30) (31). The perceived advantages of the virtual environment as an instructional tool include whole body experimental learning (32), presence (33) (34) (35), multi-perceptual engagement (36), the opportunity to change perspectives at will (37) and abstract concept representation (38) (39) (40) (41).

Virtual versus Physical Environments

The virtual reality and multimedia are similar since both of them are multi-perceptual. Visual, auditory and haptic senses are engaged to navigate and interact within the environment. It differs from multimedia in three different ways as following:

1. The whole body can be used to navigate and interact within the virtual space.
2. The technology can engender a sense of presence, the perceptual quality of being in the virtual environment, rather than in the physical space.
3. The participant has substantial control over movements and interactions within the environment, rather than navigation by pre-programmed controls.

Virtual reality is as Beardon (42) describes it "a simulation in which we are invited or perhaps persuaded to amend our belief in what is real". It is a tool for experiencing alternate views of both physically real and imagined environments.

The Uniqueness of Generating Virtual Learning Environment for Physical Education

Ainge (43) provides evidence that virtual reality experiences can offer an advantage over more traditional instructional experiences at least within certain contexts. The researcher showed that students who created and investigated 3D solids with a desktop virtual reality programs developed the ability to recognize 3D shapes in everyday contexts, whereas peers who constructed 3D solids out of paper did not. The students who participated in the virtual reality program were more enthusiastic during the course of the study. Barnea & Dori (44) reported that the use of computer simulations improved 3D visualization. Inman & Loge (45) have created virtual reality programs that help physically disabled children operate motorized wheelchairs successfully. Virtual Reality researchers have pioneered the use of VR (Virtual Reality) technology to help training orthopedically impaired and sight-impaired children.

The computer-generated environment simulates a busy street much as in a computer game, and through virtual reality technology, the child has the experience of driving the wheelchair. Zaretsky & Bar's research (46) proved that acting by the computer in virtual reality affected significantly the academic achievements of special education pupils regarding their spatial perception, measured by their ability to solve the Standard Progressive Matrices of Raven (47). The ability of these pupils to read, write and compute was also improved. Zaretsky (48) showed that many participants including students in colleges and pupils in schools, are more active and dynamic during the computerized activity, especially if the activity concerns simulations or movies that they filmed by the Eye Internet camera or by the digital camera and then transferred to the computer. Their actions were enhanced when they created the simulations by themselves and their concentration also increased.

Researchers found that holding a better body image impacts, directly or indirectly, academic skills, especially those of reading and mathematics. When body image with **spatial intelligence** are enacted/activated together by the use of virtual and physical motions, this spatial intelligence expresses itself through the ability to solve problems regarding spatial acts (20). The general ability of solving problems includes also the ability to decode the problem and make the correct decisions appropriate for such action. Spatial intelligence consists of two central skills which differ from one another: spatial orientation (location of objects and the relationships between them), and the visualization of space (20) (21) (49), both of which are developed through virtual reality manipulations (46) (48).

The Space on the Computer Screen and Movement

Computer simulations and virtual reality offer students the unique opportunity to experience and exploring a broad range of environments, objects and phenomena within the walls of the classroom. Students can observe and manipulate normally inaccessible objects, variables and processes in real-time. The ability of these technologies to make what is abstract and intangible concrete and manipulable makes them suitable for the study of natural phenomena and abstract concepts, "Virtual reality bridges the gap between the concrete world of nature and the abstract world of concepts and models" (5, p. 294).

Virtual worlds can be linked to the physical world through telepresence, where distant learning systems could be expanded to allow students and teachers to share worldwide learning environments. Real-time access to a multitude of people and information sources opens the virtual world – and the classroom – to the world. Virtual reality learning environments allow entirely new capabilities and experiences. The users have unique capabilities, such as the ability to fly through the virtual world, to occupy any object as a virtual body. Observing the environment from many perspectives is both a conceptual and social skills: enabling pupils to practice this skill in ways we cannot achieve in the physical world may be an especially valuable attribute of virtual reality. Dynamic programming software enables the addition of viewpoint control, command structures, manipulations of objects, movement constraints, animations and object behaviors. (46).

Table 2: Example of the Connection between the Acts Performed during Training by Computers and the Ability to Analyze a Motor Skill:

Training by Computers	**Analyzing Jumping into the Swimming Pool**
The shape appears on the computer screen.	Standing on the spring board.
Planning the required direction of the shape (planning the next step of the activity).	Choosing the appropriate position and distance from the swimming pool.
Adjusting the shape to the appropriate direction	Adjusting the position of the hands and legs in order to jump correctly.
Navigating the shape down to the right or the left side.	Navigating to the sides, and jumping into the swimming pool, then swimming in the pool.

To sum up, computer-simulated environments are becoming more and more realistic, offering a real-world experience.
This research was aimed at exploring the effect of computer manipulations created by student teachers on their physical performance, and on the application of this experiential method in working with pupils during the student teaching practice.

3. RESEARCH PRESENTATION

Research Group

The research group consisted of 45 students who were majoring in physical education. The investigation was carried out in the mode of a longitudinal qualitative research (50) during one semester (4 months) and included three stages:
Stage 1: Learning the basics of creating PowerPoint presentations (Month 1)
Stage 2: Generating professional simulations through PowerPoint presentations (Months 2-3).
Stage 3: Using the presentations with the pupils in the practical work, having the pupils add their own simulations to the presentations. Afterwards the student teachers write their analysis, while relating the practice to the theory (Month 4).

The research examined student teachers' stated positions about the connection between computers and physical activities, its impact on creating dynamic PowerPoint presentations and its application.

Research Tools

The student teachers created virtual simulations through PowerPoint for training physical skills.
The method of training focused on activating the objects over the computer screen relating to the physical environment. The objects were taken from the everyday environment of the pupils, which enabled them to manipulate everyday situations.

The Stages of Preparing the Units of Curriculum and its Applications

Every student teacher chose a subject, for example: basketball. He/she built a presentation explaining and exemplifying the process of throwing the ball to the basket and prepared exercises for the pupils. Afterwards the pupils performed the exercises and completed the presentation, while adding animation to the objects over the computer screen.
Then the student teachers gave an analysis of the practical work through a professional presentation relating the practical experience to the relevant theory.

Evaluation

Evaluations were made in measuring the improvement of the performance of physical movements that were inspired through computer-based learning by the student teachers and their pupils.

4. FINDINGS

It was found that the computer-based intervention program affects the following:
*Improving the student teachers' planning of their movements,
*Improving the student teachers' physical skills and performance in the physical education lessons which resulted in increasing their motivation for learning.
This was evident, for example, in swimming, ground gymnastics, running etc.
*Improving the physical skills of the pupils in the practical work through the use of computer simulation.
The student teachers' and their pupils' computer skills increased.
Before the course the relationship between the computer and physical education was not clear to the student teachers. But after it:

Samples of Reactions of Student teachers Regarding the Impact of their Use of Computers on their Physical Performance and Ability as Physical Educators
When asked about the relationship between computer use and physical education, their answers indicated that the method enabled the following:

- *Dynamic use of the computer.*
- *Virtual presentation and visualization of positions in ways we can not achieve in the physical world.*
- *Transferring updated international knowledge about various topics of sport.*
- *Increasing motivation and self image.*
- *Introducing the directions in various modes.*
- *Saving and organizing the products for other lessons and subsequent years.*

These reports showed that the students realized the impact of the use of computers on physical performance of movements during the lessons in the college. Simultaneously, the student teachers gradually improved their level of using computers by training them to create simulations of motion in space, which improved their self image as computer users. Consequently, the students' ability to build virtual reality by using the computers improved their training in planning their computer products and body movements and also the exercises they devised for improving physical skills in their own practical classes. The student teachers used their presentations with their pupils and reported about their success.

A comparison of the student teachers' level of using the computer with their answers to the questionnaire indicated that as their use of the computer increased along with the improvement of their computer skills, it brought about the better understanding by the student teachers of the connection between manipulating virtual reality and physical activities. Consequently, the student teachers improved their PowerPoint presentations. They planned the virtual movements over the computer screen, for example: running, swimming, jumping etc.

The Contribution of the Computer Activity to Physical Skills According to the Answers Given through the Open Questionnaire

The student teachers filled out the open questionnaire before and after practicing the creation of computerized simulations.
Before the computer training, the connection between the PowePoint software and physical skills was not clear to them.
But after the training:

Table 3: Samples of Answers Regarding the Impact of Using the Computer on Physical Skills

The Skill	The Answers
Planning	Predicting and planning the next movement/position in space that applies to the given situation.
Thinking	Thinking precisely, Developing spatial and motion thinking, Improvising movements in changing environments.
Orientation in Space	Orienting in narrow spaces, Controlling the directions in space in various environments.
Motor	Developing fine motor.
Body Image	Increasing body balance.
Concentration and Persistence	Improving concentration and persisting on the task until achieving success.

The student teachers' computer literacy was improved by training them to use and create digital simulations of motion in space, and as a consequence when their self-image as computer users was improved, the frequency of their computer use increased. The student teachers' ability to build virtual reality by using the computers improved their planning of the training, and the exercises they made for their practical work in physical education.
Afterwards the student teachers used their presentations with pupils and reported about progress in performing physical activities relating especially jumping, swimming, ground gymnastics, shooting and motion games.

5. DISCUSSION

The question raised in this article is whether the creation of virtual simulations will affect physical education. In spite of the short time of training and the absence of experience in using computers before the training, a significant improvement of the participants' physical skills was recorded, as a result of the different mode of training.

Virtual Reality and Constructivism

According to the constructivist theory, the Immersive Virtual Reality enables first-person experiences by removing the interface that acts as a boundary between the participant and the computer. In this way, each person constructs his/her knowledge of the world visually, from direct experience in the real world, as portrayed by the Computer, without the need for symbolic descriptions of the experience (39).
Constructivism focuses on tools and environments that help learners to interpret the multiple perspectives of the world by creating their own version of it (51). Through making virtual reality tools and environments available to educators, we may discover more regarding the process of learning. By participating in the development of virtual reality, educators can follow the growing use of the technology, and perhaps influence the framework of educational change. Immersive Virtual Reality allows physical and perceptual interactions to occur.

Constructivism and Learning in Technological Environments

An important component of constructivist theory is to focus the child's education on authentic tasks. These are tasks which have "real-world relevance and utility, that integrate those tasks across the curriculum, that provide appropriate levels of difficulty or involvement" (52, p. 29).
According to the constructivist theory, children learn whole to part, not incrementally. Children's ideas and interests lead the learning process. Teachers are flexible; sometimes they are the givers of knowledge, but more often are the facilitators (53). Bagley and Hunter (54) say that active learning leads to greater retention and higher level of thinking. Because our knowledge is constantly increasing, and there is now too much information to memorize, students (pupils) should learn how to access information.

In a technology-rich environment we have to remember that the educational focus is on learning and instructional goals instead of the technology itself, because technology is merely, the tool or vehicle, for delivering instruction (55). We have to focus on the way of using the equipment which makes it relevant to a constructivist classroom (53).
Studies show that in technology-rich classrooms there are many observable changes such as: Students are more actively engaged; they become more cooperative and less competitive; they also learn different things instead of all students learning the same thing; there is an integration of both visual and verbal thinking instead of the primacy of verbal thinking (56).
In one study, student self-esteem and motivation in a technology-rich environment was measured and found to be strong. In addition, student attendance was increased and discipline problems were reduced. Students were also coming in on their own lunch time, recess and after school to work on their projects. They shifted from being competitive to collaborating on projects (57).

Learning by Technological Manipulations of the Real-World

Manipulations must be used in the context of educational tasks to actively engage children's thinking with teacher guidance (58). Different manipulations' methods allow, and even encourage students to choose their own representations' material. Such methods can also be used to assess whether students understand the idea or just have learned to use materials 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 instructs students to reflect on their actions and alter them by predicting and explaining (59). We can add here the improvement of the physical skills, resulting from the student's need to understand the meaning of the movements, the relationships between them and how to perform them successfully.

Gorsky & Finegold (60) reported on the development and application of a series of computer programs which simulate the outcomes of students' perceptions regarding forces acting on objects at rest or in motion. The dissonance-based strategy for achieving conceptual change uses an arrow-based vector language to enable students expressing their conceptual understanding.

According to Mann (61), students in educational settings utilizing new technologies become empowered by gaining access to real data and work on authentic problems. Often, roles are reversed as teacher and student learn from one another.

Strommen & Lincoln (62) stress the importance of the way the technology is used. "The key to success lies in finding the appropriate points for integrating technology into a new pedagogical practice, so that it supports the deeper, more reflective self-directed activity children must use if they are to be competent adults in the future" (62, p. 473), e.g. computers and other technology should be viewed as tools which are an integral part of a child's learning experience.

It has been suggested by LeBaron & Bragg (63) that the role of technology in education is so important, that it will force the issue of didactic versus constructivist teaching. Teachers will no longer have a choice but will be compelled to use a constructivist approach in a technology-rich environment.

The Significance of Virtual Reality for Education and Thinking Skills according to Constructivism

The significance of virtual reality for learning can be better understood if we compare the implications of Constructivism to those of Objectivism. Objectivism and Constructivism represent alternative conceptions of learning and thinking (64). Objectivism assumes that the role of mental activities is to represent the real world and that the role of education to help students to learn about the world and replicate its content and structure in their thinking skills; whereas Constructivism claims that to a certain extent we construct our own reality through interpreting perceptual experiences, that reality is both in the mind of the knower and in the object of their knowing. Constructivists, rather than prescribing learning outcomes, focus on tools and environments to help learners to interpret the multiple perspectives of the world in creating their own view of it (65). We may discover more about the process of learning through making and using virtual reality tools and environments, which are now available to educators. Educators can guide the growth of the use of this technology, and perhaps influence the course of educational change by participating in the development of virtual reality.

Computer assisted manipulations guide students to alter and reflect upon their actions, always predicting and explaining. The virtual reality environment is unique in its dynamic representation. Success in building simulations of the real world has its motivating effect on the participants and thus enhances the effect of the training. In this research the effect of the computer simulations on the improvement of physical skills was shown.

6. SUMMARY AND CONCLUSIONS

The present study showed that the use of the computer enhanced the physical performance of 45 pre-service teachers, especially while performing complex movements. The building of computer dynamic simulations showed the students that it serves as a mediator for developing physical skills, such as running, swimming, using equipment of gymnastic, ground gymnastic etc. During the creation of computer learning sub curriculum, which facilitated the virtual mode, it became clear to the student teachers how they should perform the movements, and which methods they should use for improving the plans of physical movements in order to perform them consecutively successfully and fluently. As the students became more experienced in mastering the computers, they became more convinced regarding the relationship between computer simulations and physical education. These improvements were also used to design their teaching programs for their pupils in their practical work. Consequently, the pupils showed improvement in the trained physical skill.

To summarize:

- The computer enables the translation of the virtual movement to the real world. The software utilizes dynamic simulations of the learners' natural environment.
- This method results in an improved performance of physical activities, of both, the students in the college and their pupils at school.

The contribution of virtual simulations to physical education is thus focusing on the important findings as following:

- Allow the visualization of complex dynamic processes (25)
- Improve 3D visualization and spatial intelligence.
- Develop the ability to recognize 3D shapes (45)
- Assist in decoding problems and improve performance.

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