USE OF VIRTUAL INSTRUMENTATION AS A STRATEGY FOR AN INCLUSIVE EDUCATION

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Abstract:
Can Virtual Instrumentation (VI) be seen as a tool that promotes inclusion? Since virtual learning environments have shown their advantages in order to improve integration among classmates, this paper discusses if this kind of benefits can be extended also to virtual learning objects in general. That is, if the use of VI as a tool for teaching science subjects, has a collateral effect on the achievement of every child learning excellence.
Some case studies will be reviewed to analyze the real situation and to reach some conclusions. We believe that the road to inclusion can be also walked through the didactic use of VI. Some of the characteristics and benefits are common to the use of ICT in the classroom, but others are specific to the VI itself. Simulations and virtual reality bring to our classes a clearer and more effective perception of nature, physics or biology, that can be followed more easily by almost every student, no matter his/her intellectual abilities.

Keywords: Inclusion; virtual reality; virtual environments

1. Introduction

"An inclusive school has a positive view of difference and promotes equality. Diversity is seen as a resource to be celebrated, the individual talents of pupils are supported in achieving their full potential." (Len Barton, Institute of Education, University of London)

Inclusion is not just about including children with disabilities. It's about embracing the idea that diversity is the reality and, therefore, each child is a unique learner. In order for each child to maximally benefit from education, we need to organize our schools, curriculum, and teaching with this reality in mind.

That is, the school must provide answers to the capacities, interests and paces of learning of each student and science subjects are, in part, responsible for enabling the student to live, to experiment, to handle, and to perceive the reality of the things.

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As a result from this point of view, education has undergone some important changes in the last years. As a first idea, there has been a paradigmatic change of undoubted consequences; education has gone from an 'instructional' paradigm that emphasized the roles of education and the teacher to a 'personal' paradigm that emphasized the learning itself and the student who learns. Now, the important thing is that the student learns, and to that process of learning all the elements of the educative system are subordinated, including the teacher and education itself.

And there has been a conceptual change that interprets the learning not like an acquisition, accumulation or reproduction of informative data, but like a construction or mental representation of meanings. This conception of education uses suitable strategies to relate, combine and transform knowledge. It responds to the new model of truth focused on search, investigation, curiosity and imagination. The truth, in this case, is something dynamic; it is rather a question than an answer, a process than a product. This assertion is true in general, but more evident when we are talking about science subjects.

Furthermore, if learning is interpreted from a constructive point of view, virtual materials can play a transcendental and very significant role. It is known that the human brain does not work the same on all the tasks of learning, neither on all the ways of learning nor in all the times of learning. Styles, strategies, preferences, capacities and interests of the students are factors of undoubted importance when programming the educational curricula. In a word, the differentiated, individualized, personalized learning offers excellent opportunities of programming with virtual materials. From this perspective, the main goal is not a question of achieving an education of excellence, but rather of achieving that each student gets in his learning his own level of excellence.

2. Virtual Learning Environments

FIRST CASE STUDY

One of the first and oldest studies about the effectiveness of virtual classes is the one at the California State University at Northridge, which claimed that students leaning in a virtual classroom tested 20 per cent, better across the board than their fellow students in a traditional classroom. [1]

Jerald Schutte at Northridge randomly selected half of his students to be taught through traditional in-class lectures and written assignments while the rest of the class learned through texts, graphics and simulations posted online. Both groups were given identical tests under the same conditions and there were no significant differences between the age, gender and computer experience of the groups involved. What is astonishing about the results was how quickly the students adapted to the virtual classroom and formed peer groups online as compensation for not being able to converse in class. Students in the virtual class spent 50 per cent more time working with each other than their counterparts in the traditional classroom.

These results were quite confounding at the time as little experimental evidence had been generated to demonstrate the effects on student performance in virtual environments versus traditional class formats. The results contradict popular hypotheses that face-to-face teacher-student interaction in a more valuable experience and produces better results. Schutte observed that the traditional classroom could be sometimes an inhibiting environment for students, and its structure can be pressurizing and intimating. Whereas the virtual environment encourages freedom of expression and students are more open to communicate and express opinion and would often thrive in these environments.

Of course, these results support the idea of inclusion since LVE provide dynamic interchange of dialogue, generation of ideas and the formulation and experimentation of opinion as well as interpretation of data. They also promote cooperative learning.

The virtual environment itself, also takes part in knowledge acquisition in a relevant way. The new communities of learning, in which everybody learns and everybody teaches, are trying out educative models that change drastically teacher-student relationship, educative interaction, curricular structure, assessment systems, scholastic environment and learning incentives. Virtual learning environments have been introduced like a third actor within the classic binomial teacher-student, forming a trinomial of actors unknown until now: teacher-technology-student.

A context of this type, would allow to obtain something that is difficult in the conventional school: the socialization of the knowledge, or what others have called to go from the world of the individual construction of the knowledge to the world of the social construction of the knowledge, incorporating the members of that community to the adventure of discovering and exploring knowledge, to develop and to improve the world in which they are living, instead of withholding it for themselves.

But, let us now focus on the specific benefits of Virtual instrumentation as a didactical tool for teaching science subjects.

3. Virtual Reality And Virtual Instrumentation

Virtual instrumentation (as a part of virtual reality) describes a set of technologies that allow users to explore and experience 3-dimensional computer-generated "worlds" or "environments." These virtual environments can contain representations of real or imaginary objects on a small or large scale which act as the real ones. Potential use in education was first considered in the early 1990s, when it was suggested that VI technology could provide powerful learning environments not available through other means. A growing VI research community has since sought to examine the benefits of using this technology in mainstream and special needs education, as well as other learning environments.

Although VR technology has been present for at least one decade, references concerning its use in inclusive schools or even with special needs students are very limited. A search for articles on this topic in the most relevant journals produces very poor results.

C. Sik Lányi and alt. [2] have an excellent article that summarizes the experiences of VR applied to Special needs students. Standen and Brown [3] wrote a paper on general issues of Virtual Reality in the Rehabilitation of People with Intellectual Disabilities. Takacs [4] gave a detailed summary on "Special Education & Rehabilitation" and described their new virtual environment and emotional avatar. Wiencke, W. & Roblyer, M.[5] presented a paper with specifications for the Design of Virtual Reality Learning Spaces for Students with Special Needs. But, in general, this specific field is still "a crawling toddle trying to stand up and walk".

SECOND CASE STUDY

Sánchez and Lumbreras [6] led a research aimed at investigating usability and cognitive issues in a purely aural environment. They focused on the analysis of the creation of mental structures of a navigable object using only spatial audible information and no visual information. Eleven children took part in the six-month project in a Chilean school for blind children. Among the tasks were ones based on cognitive representation, including corporal exercises, acting in a 3D acoustic environment and experiences with concrete representational materials such as clay, sand, Styrofoam, and Lego bricks. The findings of the research showed that 3D sound alone is enough for the construction of mental structures suggesting that spatial imagery is not dependent purely on visual information.

The results of their case study revealed that blind children can achieve the construction of mental structures rendered with only 3D sound and that spatial imagery is not purely visual by nature, but can be constructed and transferred through spatialized sound. Virtual environments provide a link between cognition and experience: abstract concepts are based on bodily experience. "We also conclude that the child possesses both unique skills and pace referred to mental and spatial development, impacting directly on the quality of the topological features obtained in comparison to the ideal reference spatial structure embedded in the software". [7] In addition, it was also shown that the cognition and building of structures in a virtual environment follows the same pattern as its every-day counterpart.

In the light of this second study, Virtual Reality, and thus, Virtual Instrumentation lays clearly on the constructivist approach, providing a link between the learning process and the mental structures we use every day. A basic concept in constructivist teaching "is that a person will have a greater efficiency of learning if he can actually experience a situation as compared with merely reading about it or listening to a lecture." [8] There is a natural linkage between the constructivist learning paradigm and the utilization of educational technology in the classroom. And this linkage can be extended without any kind of doubt to Virtual Reality.

In the same way, the study also reveals that virtual environments provide a link between cognition and experience. That is, one of the basic principles of the constructivist approach.

The other specific advantage shown by the case study is the possibility of personalization of activities for every child, based on the asseveration that the unique response of every student overpasses the ideal answer fostered by the software designer. This specific circumstance shows, from our point of view, the possibilities of VI as a facilitator for those children with less mental abilities, and thus, becomes a valuable tool for building a more inclusive school.

So, the next point in discussion is if Virtual instruments and simulations, as part of a computer based strategy, allow establishing differentiated instructional plans for every student, a quite difficult thing to do for a teacher who does not have the aid of a so versatile tool and with so efficient benefits. If the effectiveness of learning depends on the attention that is lent to the paces, styles and strategies of the students themselves, the use of virtual reality on the computer could be good for adapting the curricular programs to the particular conditions of each one.

4. VI Software Individualization

The VI with its capacity to simulate the reality provides a new window on the vision of the surrounding reality. We can begin by seeing the reality in another way, simply because the work with digital objects produces knowledge in a different way from the traditional analytical instruments. They provide a different view of reality.

Practically all current technology can be accessed by any user, of any ability since interfaces have become easier and easier to use. Students can train and become accustomed to mainstream VI software, working at their own level and can learn and practice skills at their own pace. But, software must be carefully evaluated and trailed with the students before proper assessment can take place. Not all students respond to the same software.

Often, mainstream software proves to be relevant. It is then the teacher's, therapist's or parent's approach in providing, promoting and teaching with the software that requires modification or adaptation. As each student's learning needs are peculiar to the individual, global software attributes often do not always adequately meet a range of learning criteria. We believe that the emerging VI tools enable users who have a disability a better opportunity to experience success

Specifically, the VR allows the students to become familiar with the non-feasible concepts in the physical world, or can immerse them in artificial experiences by reorganizing cognitive habits. The possibilities of simulation of VI provide views that in any other way would be hardly intelligible.

THIRD CASE STUDY

The study, developed by the North Carolina State University Computer Science and Computer Engineering Departments plus two families from the Division for the Treatment and Education of Autistic, was designed to determine if children with autism would tolerate VR equipment and respond to the computer-generated world in a meaningful way. [9]

S. and R. (the two kids) came in separately for approximately 30-minute to 1-hour sessions. During that time both children repeated the work, helmet, play cycle multiple times. S. had twenty-one 3- to 5-minute sessions over a 7-day period, and R. had sessions of shorter duration over a 4-day period. The goal was to teach the children to accept the helmet and pay attention to the images. We initially asked each child to identify cars when they appeared and say the car colour if possible.

After different sessions**,** both autistic children accepted the virtual helmet, repeatedly immersed themselves in the virtual scenes to a degree that they verbally labeled objects and colours of objects and both of them voluntarily took the hand controls at least once and attempted to use them

Study results indicate that the children will identify familiar objects in their environment while using the helmet, and locate and move toward objects in their environment while wearing the helmet. Software was specifically adapted for them.

The properties of VI, in particular its malleability, make it a versatile tool for the development of applications that can be customized to meet the specific needs of children. The characteristics of the VE can be modified to include or exclude certain parts, options and functions depending on the abilities of the child, which determine the aim of the program. This adaptability helps to promote an optimal interaction for children with disabilities. VR allows children with sensory impairments to experience what would normally be difficult or impossible for them by transposing information from the affected sensory modality into information that can be perceived by the senses which are intact.

There are two key concepts concerning inclusive software: Accessibility and Usability.

4.1. Accessibility

The first one, Accessibility, is the ability of a product or system to be perceived and used by people with the widest range of capabilities. To support accessibility, the system should be flexible so that it can be adapted to people with specific needs. Accessible systems also allow a connection to assistive technology for disabled users.

One important advantage of VI is that the need for semantics, symbols or language is virtually eliminated, due to the experiential nature of the learning process. This means that VI is more accessible to different categories of users who may benefit from learning a task in VI without the restrictions of traditional teaching methods.

From the previous case study it is easy to conclude that VI software can be a good candidate to be accessible for people with learning difficulties. Since VR interfaces are as close as possible to natural movements or in the simplest programs very easy to experience, VI software seems to fulfill the first of the needed characteristic. Keep in mind, that we are not talking about designing experiments, but only using them as a learning activity.

4.2. Usability

Usability is concerned with the ability of the users to understand the system, navigate through it, and achieve tasks with few errors. According to authors such as Dix, Finlay, Abowd, and Beale [10], a usable design should be:

- Simple and intuitive
- Consistent with conventions or standards
- Flexible and efficient
- Clear in prompting and giving feedback
- Helpful to the user in avoiding errors as well as supporting error recovery.

Usability can be a strong point for VI software. There is an intrinsic quality of any virtual gadget: it tries to reproduce the behavior, properties and appearance of the real item that simulates. As closer the instrument is to reality, more simple could be to understand and explore the program.

VI also provides immediate feedback on the learner's actions in a VE and allows training to be paused at any time for discussion and correction of performance

From this point of view, the learning process is easy to understand and follow for the most of the students, no matter their intellectual abilities.

5. Conclusion

Virtual environments (VE) and specifically Virtual Instrumentation (VI) can be built to accommodate the needs of children with varying literacy, physical, language and cognitive levels. Even children with disabilities can explore or create new environments or manipulate objects without being limited by their disability, if they are provided with the correct interface. The learning through VI benefits children by giving them a sense of control over their environment. In fact, unlike many real world environments, virtual instruments can be custom-designed to enhance the strengths of an individual rather than allow a disability to limit their interactive capabilities. With VI, all children with or without disabilities can actively participate, focus on their abilities and realize a sense of control and mastery.

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