Virtual Education Seriously Considered

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Abstract: *In recent years the use of computers and related technologies for education purposes has increased exponentially. Organizations from different sectors started to invest in educational software for learning, so did universities and other academic institutions. Research in this area has increased to explore the benefits that are possible through the use of computers to promote education. The paper explores the current practice in using educational software including the use of intelligent tutoring systems, virtual environments, technologies that can be used to develop educational software, authoring tools that can make the development of educational software a task for non-experts, and necessary evaluation procedures to ensure the educational benefits resulting from such software use.*

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1. Introduction

Early computer researchers have sought ways to use the new invention for learning and teaching purposes. Instructional computing at that time took place on mainframes in the form of typing and reading text, but serious efforts were made to further utilize the computer power to serve education. Examples include, the Programmed Logic for Automated Teaching Operations (PLATO) [7] project, that managed to integrate text and graphics, and the Time-shared, Interactive, Computer-Controlled Information Television (TICCIT) [20] project, that introduced the concept of learner-controlled instruction. The invention of microcomputers in the late 70s made it possible for businesses, schools, and homes to enjoy computing. The new small size computers were not restricted to text, but allowed colored graphics, animation and voice. Input became possible through the mouse; touch screens, scanners, and microphones, in addition, to the keyboard. Various forms of output became possible (in addition to the black and white monitor) such as, colored monitors, LCDs, colored printers, and speakers. Although at first, the new computers were stand-alone and information could not be shared, networking solved this problem. In the late 70s and early 80s Apple computers were the first widely available microcomputers that had most of the early courseware, only to be superseded by IBM compatible computers that gained wide popularity and continued to grow its market share up to present day. Network technologies allowed PCs to communicate and share information and processing power. At first, Local Area Networks (LAN) were developed followed by the Wide Area Networks (WAN), and then the Internet made of LANs and WANs started to grow rapidly. Today, millions of people use the Internet to pursue various businesses, pleasure, and learning activities. However, a major setback in computer-based instruction is the unavailability of a single set of tools that make use of the new multimedia technologies to develop the software. Developers tend to glue together various technologies to build the system and struggle to overcome the incompatibilities of software and hardware.

With regard to learning, there is an ongoing debate on the effectiveness of computers to facilitate learning. Research findings vary, some researchers report considerable improvements in learning levels through the use of the computer as a learning medium, while others found little or no improvements. Many researchers believe that the benefits are attributed to the way computer-based instruction is designed. Alessi and Tropllip [5] emphasize that in order to facilitate learning in an efficient way, the process must include: information presentation, learning guidance, practice, and assessment. Information should be presented using verbal, pictorial and/or textual representation. Skills to be learnt must be modeled especially the ones that involve following a certain procedure to carryout a task. Another important approach is the use of examples to illustrate the applications of a concept, rule, skill or a procedure. Learner guidance can be implemented through interaction between the learner and the medium. The learner may answer questions about factual information, apply rules, principles in problem solving activities, or practice procedural skills. The teaching medium observes the learner going through the lesson; correct errors, as well as giving suggestions and hints. Practice sessions can be offered to improve the learners' speed, fluency, and retention. During of which the medium may observe and make short corrective statements. Ending a learning session with tests may prompt the start of a new session. Finally, tests give feedback to the level of learning and quality of teaching. Intelligent programs must assess the learner's knowledge and must decide on the weak areas that need to be enforced. It should offer the learner to continue using parts of the program to improve on those specific areas. Additionally, alternative modes of presentation, examples, and drills could also be useful and may be more suitable to the learner.

An important question we are often faced with is when to use computers to improve learning? Many believe it is more effective when other media have shortcomings. Example situations in which computer-based instruction can be useful are when the use of other means of learning is either expensive or dangerous. Such as in the case of simulators to train pilots; when safety is in concern as in chemistry laboratories; or the need for 3D and other computer effects that are not supported by other media. Other reasons could be intended learners special needs such as visual or auditory disabilities.

In recent years the powers of computers have increased exponentially and the technology related to developing multimedia systems is continually advancing. These advancements coupled with that of network technologies made it possible to build Virtual Learning Environments that can simulate real life situations and provide a safe controlled place to learn. Such environments simulate the real world providing the students with the context for the learning process to take place. It can represent a virtual laboratory in which experiments can be conducted; virtual worlds in any time and place; or virtual office, plant or store for a company. They allow the student to control the learning process; develop an ability to solve high-level problems; make learning a personal experience; model the complexities and uncertainties of working in the real world; and can also accommodate a wide range of student learning styles. Albalooshi [4] reports some of the recent international efforts in the field.

In this paper we look at some important issues related to educational software and their use. In section 2 we look at a small selection of Intelligent Tutoring (IT) systems currently under use to promote learning. Section 3 presents the use of simulations in virtual learning. Section 4 looks into a number of recent technologies that are used to develop educational software, followed by available authoring tools in section 5. Section 6 stresses on evaluation, and analyzes existing methods used to evaluate software followed by concluding remarks in section 7.

2. Intelligent Tutoring Systems

Intelligent Tutoring (IT) systems, offer a great deal of flexibility in control, making them highly adaptable to individual student progress. This makes them excellent candidates to play the role of "Cognitive Tools" [30]. These tools are capable of supporting learners by explicitly representing information. They allow learners to see the structure of the cognitive process by externalizing it and freeing memory for the more important learning task at hand. The simplest form of a tool is pen and a paper, where students can write notes to remind themselves of the numbers involved when performing addition. Therefore it should not be surprising that computer based educational systems impose themselves at the top of the list of Cognitive Tools.

However, the sudden growth of multi-media computer systems necessitated the need for a deeper understanding of the characteristics of each of the different media. Norman [22] indicates that each media has "affordances" and "constraints" that would be either beneficial or counter-active to educational goals. Complexity grows exponentially when the aim of the selection is to include these media into a shell representing an adaptable IT system. The shell itself would be flexible to individual student needs. Therefore, it should not be surprising to see research start off in highly controlled specific cases. For instance, Sharples and du Boulay [26] argue that learning medical concepts is normally acquired through induction. This is done by showing students several scenarios and allowing them to generalize their own models over the possible cases. The problem with this approach is that it leads students to over generalization because they are not always exposed to the extreme possibilities. However, when students are exposed to a controlled set of images through a computer-based tutor then highlighting the extreme cases becomes possible and the problem is alleviated.

In this section we briefly present a number of cases on the use of IT systems for education and training. The first is used to teach university students developmental biology; the second is an IT system for Rocket Training field officers; and the third is a virtual prismaker for children. The systems demonstrate some of the efforts towards the use of IT systems with different age groups and background.

2.1. Advanced Computing for Science Education (ACSE)

Pane, Corbett, and John [23] investigate the impact of movies and simulations on students' understanding of declarative facts about time-varying biological processes. The system uses Multimedia to present textual information, still graphics, movies, and simulations. Students are able to navigate through lessons, viewing the movies, and manipulating and running the simulations. The target course is developmental biology of which two topics were recognized to involve dynamic processes. The first is Sea Urchin Gastrulating and the second titled the Early Development of Drosophilae Melanogaster. Each lesson is about 50 screen pages long and contains multiple high-resolution light microscope images and movies as well as simulations. The lessons also include reviewer questions.

To evaluate the multimedia Learning Environment an alternative learning method is constructed in the form of conventional biology textbook. A textbook version of the ACSE environment is developed. The purpose is to construct an appropriate comparison condition. Two groups of students well matched on class performance were setup. The first group worked through the two ACSE lessons and the second used the textbook version. Both groups were then asked to answer review questions that were graded after that by an independent grader. No significant differences were found between the ACSE condition and control condition on any of the survey questions. The researchers concluded that merely using animation and simulations capabilities of modern computers does not guarantee improvement in students learning. This is a case that highlights the importance of evaluating the impact of the IT systems on students' learning as explained further in the paper in section 6. It must be realized that a particular IT system may not be a successful solution to overcome the learning problems that are encountered.

2.2. IT System for Rocket Training

Wisher, Abramson, and Dees [32] presents the application of an IT system for Rocket Training. The Virtual Sand Table (VST) is designed to replicate the conventional sand table. The conventional sand table exercise is a critical component for a course to prepare field artillery officers. The limit in the number of available tables is the main setback, students are compelled to work in groups of five or six, rather than individually. During an exercise students must prepare a firing plan that is rated by a subject matter expert. The Group receives a score even if some had little contribution to the plan. The VST is a simulation game, where the students' actions are evaluated against a set of expectations governed by a set of operational rules. Terrain maps can be viewed on-line or off-line. The tutoring system simulates instructor coaching for individual students with much expert knowledge, which may not be available for all students at the actual sand table. Soldiers (n-209) who trained on the actual sand table filled a questionnaire before the course and another after. The same was administrated with another group (n=105) who used the VST. The background questionnaire sought demographic and experimental infrastructure on previous field artillery assignments. The post-exercise questionnaire sought feedback on perceived learning on the same topics and, in the case of the VST group, ratings on the usability of the tutoring system. Test results and analysis showed that the VST group outperformed those students trained via the conventional sand table. It became clear that the VST is a more effective training device than the conventional sand table. Other advantages of the VST are reduced training costs and increased accessibility.

2.3. Virtual Prismaker

Gonzalez *et al.* [17] present the Virtual Prismaker. The Virtual Prismaker is a 3D environment that simulates the physical version of the game. It uses different kinds of pieces of prismaker system to develop many different games. The games in the virtual environment are carried in rooms that have different difficulty levels. The environment is designed to stay as far as possible from traditional computer software interfaces. Game instructions can be collected in a virtual book and are presented using text, sounds, images and videos. The games can be played through the Internet to allow for competition and collaboration. The system allows teachers to gather information about the children's reasoning process. It can also evaluate the success or the failure of a performed activity.

3. Virtual Environments for Education

The use of pure virtual environments in which the students interact with a simulated virtual world is becoming increasingly popular [5]. Such environments are perceived as more interesting and motivating than many other methodologies, a better use of computer technology and more like "learning in the real world". They tend to be more motivating, enhance transfer of learning, usually more efficient, flexible, applicable to all phases of learning, and adaptable to different educational philosophies. Learning with a simulated environment has several advantages as compared to using the real world as a learning environment. Simulations can enhance safety, provide experiences not readily available in reality, modify time frames, make rare events more common, control complexity of the learning situation for instructional benefits, and save money.

A typical example of such systems is a range of virtual environments developed by researchers from North Dakota State University that make use of the many advantages such environments provide [27]. Advantages, such as controlling virtual time and virtual distance; creating shared spaces; supporting shared experiences for participants of different physical locations; and supporting multi-user collaborations and competitive play. The environments are designed on the principles of: role playing, goal-oriented, learn by doing, spatially oriented, immersive, exploratory, game-like, interactive, multi-user, unintrusive tutoring, shared courseware tools.

Existing projects include, Geology Explorer, Virtual Cell, Visual Computer Program and Programming Land Museum, Blackwood, and Virtual Polynesia. The Geology Explorer is a virtual world where learners assume the role of a geologist on an expedition to explore the geology of a mythical planet. Learners participate in field-oriented expedition planning, sample collection, and "hands on" scientific problem solving. The Virtual Cell is an interactive, 3-dimensional visualization of a bio-environment. To the students, the Virtual Cell looks like an enormous navigable space populated with 3D organelles. In this environment, experimental goals in the form of question-based assignments promote deductive reasoning and problem solving in an authentic visualized context. The Visual Computer Program and ProgrammingLand Museum is an environment in which students can study and learn programming techniques. Tools are provided to support active learning using visualization of AI programs. This visualization includes animation, fly-through models and more interactive information models. The ProgrammingLand Museum implements an Exploratorium-style museum metaphor to create a hyper-course in computer programming principles aimed at structuring the curriculum as a tour through a virtual museum. Blackwood is an environment under development to simulate a 19th century western town, and Virtual Polynesia is an environment in which the students take the role of an anthropologist on an island in the 19th century western Polynesia.

4. Development Technologies

There are several well-known Software environments to develop multimedia applications that can be connected to the Web such as, Cyberleaf, WebFORCE, and Macromedia Director [15]. In addition to those environments web developers have the prospect of using new languages that can deliver innovative content in new formats. Virtual Reality Modeling Language (VRML) is one such language. It offers the development of three-dimensional representations integrated with Web information. Another such language is Java, a language for providing distributed executable applications, also extends the kinds of information the Web can deliver.

4.1. VRML

VRML started out in the minds of Mark Pesce, Tony Parisi, and others. Pesce and Parisi wanted to create a way to do 3-D over the World Wide Web. They brought their first demo to the World Wide Web conference in 1994 and showed it as part of a "Birds of a Feather session" set up by Tim Berners-Lee, the inventor of HTML and the Web, and Dave Raggett, the man who coined the term VRML (often pronounced *ver-mul).* After the Birds of a Feather session and with time a web-based community for VRML started to grow. Shortly a request for a specification was made and Silicon Graphics released the first version in 1995. Soon after that, VRML became very popular and a number of VRML browsers became available. A request for a new version became a must and SGI, Sony, Mitra, and other members of the community won the proposal

The new version VRML 2.0 brings new capabilities to 3-D on the Internet. These include interactivity, 3-D sound, behaviors, and multi-user worlds. *Behaviors* are algorithms that describe movement and change in 3-D objects. A VRML dog might have behaviors like walking, running, eating, and chasing cats, for example. *Interactivity* means that the user can affect the world by moving around inside it and taking actions like clicking on objects. Sound inside the world can be specialized in 3-D so that sounds are louder when you are closer to them. Some worlds may be multi-user so that you can see and interact with other people's *avatars*-their 3-D representations in cyberspace. Some of these new features use scripting languages, such as Java and JavaScript. Multi-user worlds, for example, can use Java's networking capabilities to communicate the 3-D positions of avatars to everyone in the room. More detailed information on VRML can be found at [1].

4.2. Java

Although the Web's system of hypertext and hypermedia gives users a high degree of selectivity over the information they choose to view, their level of interactivity with that information is typically low. Java, a computer programming language developed by Sun Microsystems, brings this missing interactivity to the Web. With a Java-enabled Web browser, you can encounter animations and interactive applications. Java programmers can make customized media formats and information protocols that can be displayed in any Java-enabled browser. Java's features enrich the communication, information, and interaction on the Web by enabling users to distribute executable content-rather than just HTML pages and multimedia files to Web users. This capability to distribute executable content is the power of Java. Java's origins are in Sun Microsystems' work to create a programming language to create software that can run on many different kinds of devices. Today, Java is a language for distributing executable content through the Web.

What Java makes possible for developers and users is impossible to show in a paper book: animated applications that can be downloaded across the network and operate on multiple platforms on heterogeneous, distributed networks. By giving the browser the capability to download and run executables, developers can create information in many new formats without having to worry about which helper application a user has installed. Instead of requiring helper applications for multimedia display, a smart browser has the capability to learn how to deal with new protocols and data formats dynamically. Information developers therefore can serve data with proprietary protocols because the browser, in essence, can be instructed on how to deal with them. A visit to Java's official web site is a must [28].

4.3. WebFORCE

WebFORCE for authoring provides developers with WebMagic-a graphical user interface for hypermedia development. Bundled with WebMagic are professional-grade tools for multimedia, image, and illustration, such as Adobe Photoshop and Illustrator. WebMagic is intended to be a WYSIWYG interface for HTML document creation. Integrated with Indigo Magic, a user environment for graphical development; the Digital Media Tools Suite for multimedia development; and the InPerson software for group communication; the WebFORCE tools for authoring approach many tasks. The Indigo Magic user environment provides, teleconferencing options using InPerson, audio and video, shared whiteboard, shared files, the multimedia tools for movies, work spaces called *desks*, digital video recording and teleconferencing, movie player, sound editor, video capture, sound filter, and image editor. More details of these tools and others can be found at Silicon Graphics, Inc. web site: www.sgi.com.

5. IT Systems Authoring Environments

Teachers have the skills, knowledge and opportunities to provide learners with rich educational experiences in the classroom. However, existing computer-based environments provide little opportunity for teachers to put this knowledge into practice. One solution to this problem is to provide teachers with tools that they can use to develop their own computer-based learning environments. However, IT systems are estimated to require at least 200 hours of development per hour of instruction, thus too costly to be built [2]. A number of authoring environments exist that allow the creation of computer-based teaching material. Examples are REDEEM, WEAR, and InterBook.

5.1. Reusable Educational Design Environment and Engineering Methodology (REDEEM)

REDEEM [2, 33] is an authoring tool for teachers to develop their own computer-based learning environments. It allows teachers to create IT systems by taking existing computer-based material as a domain model and then overlaying their teaching expertise. Existing course material can be delivered in an adaptive way to meet the needs of different learners. The REDEEM shell uses the domain material together with its own default teaching knowledge, to interpret the courseware in such a way as to deliver adaptive teaching strategies, supplement the course material with additional questions and feedback, support integration into classroom teaching by the use of non-computer-based tasks and reflection points and to provide teachers with detailed feedback on students' performance.

REDEEM consists of three main pieces of software: course catalogues, IT system authoring tools and the IT system shell. The first task by the author is to identify suitable domain material. IT system authoring tools allow teachers to describe courses, to construct teaching strategies to categorize students and to assign different strategies and different material to those student categories. The IT system shell is given the teacher's pedagogic decisions and uses this input in combination with its predetermined defaults to deliver the course material.

Ainsworth, Grimshaw, and Underwood [2] report a formative evaluation of REDEEM that examined whether the tools were usable by authors with no prior experience in developing computer-based learning environments. Overall, it was shown that it was possible for teachers to use these tools to express, represent and assess their teaching knowledge to create an IT system within a feasible time scale.

5.2. Web-based authoring tool for Algebra Related domains (WEAR)

As the title suggests WEAR is a Web-based intelligent Tutoring System authoring tool that is mainly used for Algebra-related domains, but it could also be utilized for the creation of courseware in other domains too [21]. WEAR is based on three models: the domain model, the learner model, and the instructor model. The domain model holds knowledge related to the subject matter and is structured as a network of hierarchically organized topics. The links between the nodes of the network represent relationships such as, is-prerequisite-of and is-related-to. Each topic has an associated difficulty level. Problems and/or tests related to the knowledge to be acquired are also associated with.

The learner's model stores two attribute-values. A read value to indicate if a topic has been visited by the student, and knowledge weight indicating the student's knowledge level on the topic. The second attribute value is calculated based on the student's performance in solving the problems associated with the topic and the test posed to the student determines his/her level (novice, beginner, intermediate, or expert) based upon which the difficulty level for a topic is decided. The instructor model holds information obtained explicitly by the instructor, such as, course difficulty and students' knowledge level calculation. WEAR allows instructors to author an IT system specifically suitable for their students and provides the students navigation support adapted to their own knowledge and needs.

5.3. InterBook

InterBook is an authoring system to develop adaptive electronic textbooks [12]. Adaptive presentation is aimed to adapt the page content to knowledge, goals, and other characteristics of an individual user. An electronic textbook is also one of the most popular metaphors for representing online course material. Virtually any kind of course material can be represented as an electronic textbook.

The InterBook approach uses two kinds of knowledge: knowledge about the domain being taught and knowledge about the students. The simplest form of domain model is a set of domain concepts that are elementary pieces of knowledge for the given domain. The domain model provides a structure for representation of the student's knowledge of the subject. For each domain model concept an individual student's knowledge model stores some value that is an estimation of the student knowledge level of this concept. This is used to measure the student's knowledge of different topics. All students' actions are tracked and used to increase or decrease knowledge levels for involved concepts. Another component of the student model is the student's learning goals. Adaptive guidance mechanisms will ensure that the student achieves the first learning goal in a sequence, then the second one, and so forth.

InterBook uses advanced features of modern browsers such as multiple windows and frames to provide the student with useful and powerful interface. To author an adaptive electronic textbook, the textbook is prepared as a specially structured Word file and the task is to convert this file into InterBook format. The result is a file (the textbook) in InterBook format which can be served on WWW by the InterBook system. The InterBook adaptive courseware approach was implemented and evaluated in several systems. Empirical studies with ISIS-Tutor [13] and ELM-ART [31] have shown that the approach is efficient, further evaluation is reported in [11].

6. Evaluation

Computer-based instruction provides educators with a powerful technological tool to aid them in reaching their teaching objectives. However, many researchers including [8, 24], believe that educational software must be evaluated to ensure its teaching benefits on the learners before being approved for use. Questions such as "Do the students like the software" and "Who's using it?" are inadequate as a measure of effectiveness. What is being emphasized is the most fundamental evaluative question: "What's being learnt by the students?" A good evaluation must establish whether this type of representation is able to overcome a particular learning problem, and then follows with a deeper search to investigate the nature of the learning experience and its benefits to students.

A review carried out by Reiser and Kegelmann [24] showed that in most cases the people who took part in evaluations were teachers that had to go through the software similar to a student, and then fill out a rating form by comparing the system to what would occur in a classical classroom session. Usually a wide variety of the CBI features are reviewed including, content, technical characteristics, documentation, instructional design, learning considerations, software objectives, and the handling of social issues. Only a small number of evaluators gathered evidence to demonstrate the effectiveness of the CBI in teaching. The authors concluded that organizations should incorporate students as active participants in the evaluation process, in addition to assessing how much students learn as a result of using the software.

McKenna [19] highlighted major flaws in some of the approaches that followed, indicating that the "no significant difference" problem has persistently appeared partly because of failing to describe the unique dimensions of the innovation under study. She also added that there was no enforcement of strict control measures in the lessons presented through different mediums for comparison. Beattie [8] suggested a number of evaluation techniques, some of which are pilot testing, before/after testing, expert criticism, and student questionnaires.

Some evaluators used these types of techniques to study the effectiveness of the use of particular media as opposed to another. Pane, Corbett, and John [23], for example, examined the impact of computer-based animations and simulations on student's understanding in time-varying biological processes. They setup two student groups based on prior test performance in the course to compare computer based and paper based instruction, using as main measure for comparison the pre- and post- test results. Further tests of the animation presentations was attempted by Byrne, Catrambone, and Stasko [14] who examined whether animations would help students learn computer algorithms more effectively. Their approach was mainly based on pre and post testing the student groups participating in the experiments. While the last experiment highlighted the importance of overall effectiveness, the one for Lawrence, Badre, and Stasko [18] concentrated on finding the difference in student performance in carefully selected pre and post test-questions to show the difference between the learning of declarative and procedural questions.

Although the importance of evaluation as a vital player in any instructional software is evident to all researchers, there do not exist any guidelines through which such evaluations could take place. An example of a problem that may exist is the series of experiments that were aimed at testing the differences in instructional effectiveness of the animation versus textual media. These tests depended on providing a clear sequence of photographs to show the procedure while in the animated versions; the animation was shown on a screen. Freyd [16] showed through a large number of experiments the basis of what she called "representational momentum". This theory explains a natural tendency to treat any series of images, as equivalent to an animation and vice versa. Therefore, comparing the two media through tests of effectiveness may not result in any desirable results because what is estimated does not indicate the difference in "cognitive load" during the learning process. Students learning from these textbooks may learn as effectively as the ones that learn through animation, but end up with a smaller overall efficiency when their learning rate is measured by time. The "no significant difference" results seemed to persist throughout these experiments.

Tam, Wedd, and Mckerchar [29] went one step further, when they proposed a three parts evaluation procedure including peer review, student evaluation, pre- and post-testing. In a way, this approach attempts to include a user and expert survey in the evaluation process to combine the two approaches described above, surveys versus pre and post testing. Scriven [25] describes two main aspects of evaluation of instructional material that was further described by Bloom, Hastings, and Madaus [10]. Evaluations are of two types; Formative evaluations that occur during the early design and development of the system to estimate whether or not it achieves expectations and Summative evaluations. The latter is concerned with the evaluation of the completed systems as with respect to how effective they are in teaching.

Although this classification is crucial to understanding the types of possible evaluations, it fails to fully describe all that is of importance in the evaluations process. An example of this is a full categorization of the types of objectives of an educational system [9, 10]; knowledge, compreh-ension, application, analysis, synthesis and evaluation. At the knowledge level a student is capable of recalling a fact or a term but not to understand or apply it. The comprehension level implies that the student can use the material to some degree where he can give definitions or draw direct conclusions. The application level allows a student to apply the knowledge into concrete situations and the analysis level implies that the student can identify the underlying concepts as well as compare them and examine their relationships to each other. The synthesis level implies that the student can also organize presented materials to generate new ideas while evaluation involves the ability to judge the value of the knowledge.

6.1. 3-Dimensional Framework for Evaluating IT Systems

Alkhalifa and Albalooshi [6] propose a framework that is composed of three dimensions; one for each of the major forces that may affect the final product that is obtained. They are as follows:

1st Dimension: System Architecture. This dimension is concerned with the system's main modules, their programming complexity as well as their interactions. Evaluation within this dimension should be performed in any or all of the following methods:

- Each system module must be described in detail as well as the interactions performed between them and checked to ensure that the system as a whole works in that way.
- Expert survey of the system should be capable of assessing the viability of the architecture as a teaching medium. This usually implies that experts or educators would test run the system and fill out a questionnaire.
- Student evaluations could allow students to test run the system and fill out a questionnaire from the perspective of potential users of the systems. This would give their opinion of the suitability of the architecture from their own standpoint.
- Any architectural design must be based on cognitive findings that test the effects of different modules or types of representation.

2nd Dimension: Educational Impact. This dimension is concerned with assessing the benefits that could be gained by students when they use the system. Classically, these are done in pre and post tests and this is carried on in this framework with more attention given to detail.

- Students groups must be selected according to a common mean grade to ensure that further testing can be compared in reference to changes to the means.
- Pre/Post tests done before and after students use the system, contrasted with a regular class session, as well as given following a class session.
- Questions in the pre/post tests must be mapped to each other such as the same types of knowledge are measured and not overall ability.

- The tests should best be attempted with students who were never exposed to this material previously to assess their learning rate.

3rd Dimension: Affective Measures. This dimension is mainly concerned with student opinions on the user friendliness of the system and allows them to express any shortcomings in the system. This could best be done through a survey where students are allowed to add any comments they wish freely and without restraints.

7. Conclusion

The use of computers and related technologies for educational purposes has been and continues to be the goal of many organizations and educators. In this paper we look at a selection of international efforts to utilize the latest advancements in computer technologies for educational purposes. In our investigation we came across many cases on the use of IT systems to promote learning, a few of which we present in section 2. Interactive animated simulated environments with sound effects started to emerge; a typical example is presented in section 3. Such environments have many advantages and their use is becoming popular, though their development is time and cost consuming effort. Another major issue in developing software for educational use is the development technologies to be used; a few are presented in section 4. The time, effort, and technical expertise needed to develop IT systems resulted to the need of authoring tools as presented in section 5. Many researchers and educators strongly believe that educational software must be properly evaluated for its educational benefits and suitability for the target learners as a prerequisite for its use. Section 6 presents a complete study of evaluation procedures and recommends a 3 dimensional framework to evaluation.

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