TEACHER TRAINING MANUAL

MULTIMEDIA APPLICATIONS FOR EDUCATION

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Part 2A: EDUCATION

PART TWO / A

EDUCATION

Chapter One:
Education and theory of e-learning

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1. Introduction

It is true that of all the major components of daily life, formal learning is the one that has, to date, been least affected by the technological developments of the past 50 years. Advances in technology have revolutionized communication, transportation, and even household chores, but in fundamental respects, the process of learning today is much the same as it has been throughout recorded history.

During the last years, however, there has been a powerful growth in the learning sector in parallel with the rapid development of Internet. Distance Learning has played the main role in that growth.

Distance Learning has the potential for rapid growth and acceptance. It should come as no surprise that learning in America, both in schools and the workplace, is already big business. According to The Digest of Education Statistics 1999 [1], education expenditures alone account for over 7% of the GPD, making it second in size only to the healthcare industry.

Many people have touted the ability of eLearning to provide information to "anyone, anytime, anywhere", and although we believe that this is the phrase that best describes it now, this description is also appropriate for traditional distance learning methods or even the Internet in general. We believe that the true power of eLearning will be in its ability to bring the right information to the right people at the right time.

This is the yet-to-be fulfillment promise of eLearning. Web-based integrated learning systems will revolutionize eLearning by enabling personalized, interactive, just-in-time, current and user-centric learning tools. These systems will allow all facets of a course of study, including pre-assessment, learning modules completed, practice items, collaboration, and testing to be tracked. Adjustments can then be made to the learning program to make it more effective, and learners will be able to monitor progress. More analytically, eLearning will embrace the following characteristics:

Personalized: Entire programs of study will be customized for the learner. By analyzing the learner's objectives and existing skill level, courses will be assembled on the fly that address exactly what the learner needs to know without wasting time working on areas in which the learner is already proficient or uninterested. This level of personalization will be achieved by using small chunks of information, or learning objects, to assemble a course from the ground up using pre-existing templates. The reusability of these learning objects will make this level of customization feasible in terms of both time and expense.

Interactive: Much of today's technology-based learning is simply an extension of traditional textbook-based learning, where the user reads content from a screen instead of from a page. Today's interaction generally consists of the learner being able to click on an unknown word for the definition on a linked page or the ability to play a short video clip. Coming manifestations of eLearning will truly engage the learner in a give-and-take

[1] Johnson S., Aragon S., Shaik N., Palma-Rivas N., "The Influence of Learning Style Preferences on Student Success in Online vs. Face-to-Face Environments", WebNet 2000: World Conference on the WWW and Internet, Association for the Advancement of Computing in Education, San Antonio, Texas, November 1, 2000.

type of learning that involves simulations of real-world events and sophisticated collaborations with other learners and the instructor.
Geographic ant time independence: Learners will be able to join in the class from anywhere in the world. This will have as a result that there will be no building restrictions for the learning process and we will have not problems of overcrowding inside the classes. Geographic independence means also that the stored data in a web-based lesson can be changed whenever we want, without any delays in the distribution of the material. When information is in the web all users have access in them. In that way it is not necessary for both the instructors and the learners to be present in the same class at the same time. So there are no excuses for anyone (instructor or learner) to be absent. The freedom of choosing the time increases the sense of controlling the learning experience and thus increases the motivation for learning.
Operating System Independence: different learning applications such as Computer Managed Learning (CML) or Computer Based Training (CBT), are designed for a specific operating system (Windows, Macintosh). This specification means that a producer of a such programs probably will lose a significant part of the marketplace or that he must try hard in order to sypport multiple systems. The independent of platform function of Internet reduces such problems.
As the eLearning industry begins to mature, we are seeing product offerings that are far beyond the simple click-and-read courses that have characterized the industry to date. Future manifestations of eLearning will allow the learner more control over his own learning experience, thus making it more efficient and reducing time and costs. The chart below, illustrates the changes that learning technologies are undergoing and the effect of those changes on the effective delivery cost.
For the creation of Distance learning course usually are used web-based learning environments. These are integrated software packages that offer all the appropriate characteristics and functions for building complete eLearning applications. Recently, there has been in the market a variety of learning environments like those of the list below: Lotus Learning Space [2], Librarian [3], Blackboard [4], webCT [5], TopClass [6], Embanet [7], Intralearn [8], Ecollege [9], eduprise [10] κ.α. In the next unity there will be presented the basic operational specifications and features of the most well known eLearning environments. Finally in the third unity there is a comparative analysis of Online vs. Face-to-Face Learning.

[2] *http://www.lotus.com*
[3] *http://www.click2learn.com*
[4] *http://www.blackboard.net*
[5] *http://www.webct.com*
[6] *http://www.wbtsystems.com*
[7] Poole S (2000). Trigger happy, video games and the entertainment revolution. New York: Arcade Publishing.
[8] *http://www.intralearn.com*
[9] *http://www.ecollege.com*
[10] *http://www.eduprise.com*

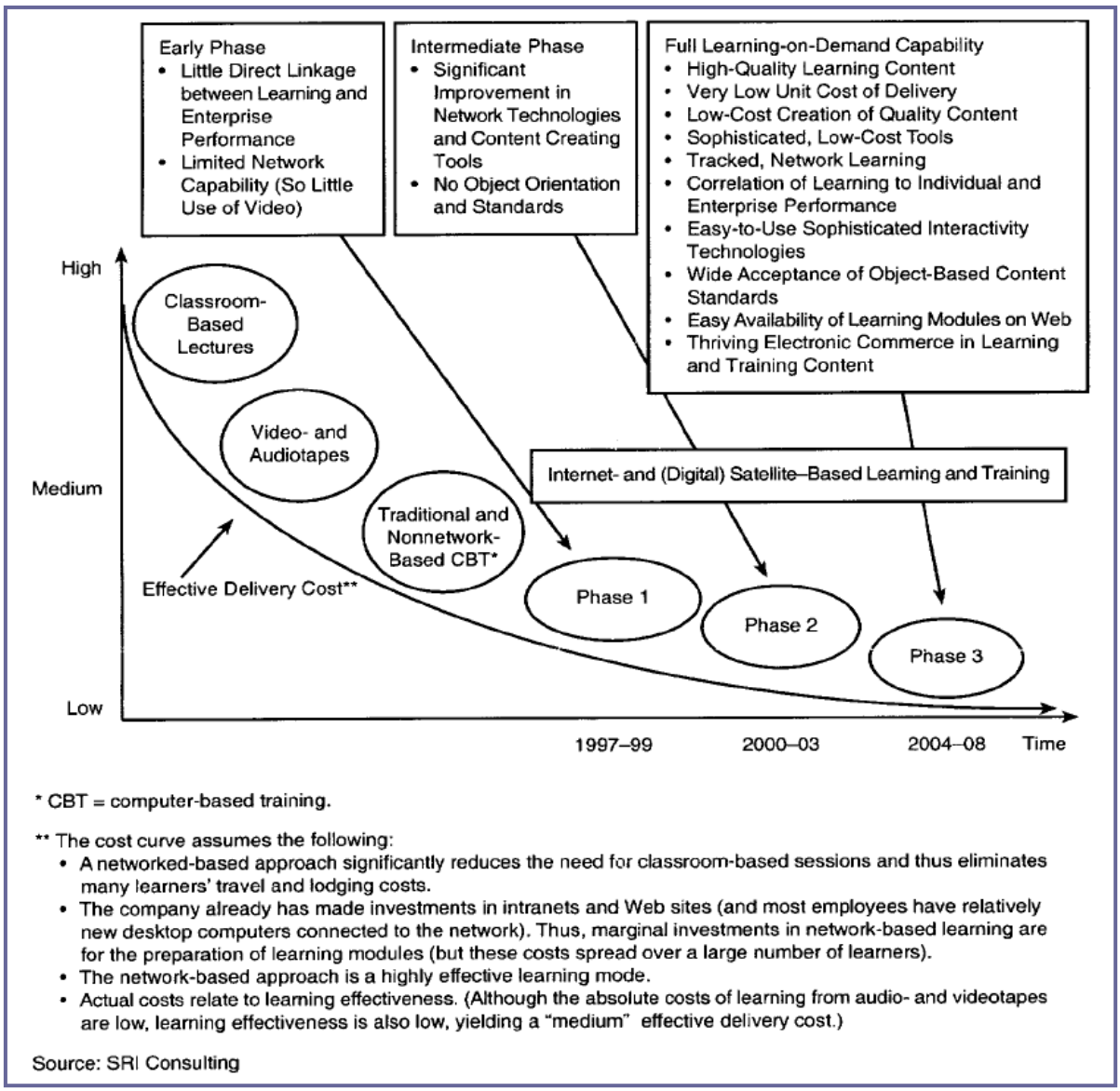

Chart 1: Evolution of Technology-Based Learning.

2. Carrying out distance learning (Commercial Learning Environments)

In recent years there has been a convergence in the available services and characteristics of eLearning Environments [11]. In a higher level most designers have agreed in the following specifications:

- User administration and authentication, user with specific roles like instructor, learner, author, reviewer, inspector, etc.
- Reusable content administration
- Dynamic configuration of the courses.
- Ability for collaborative learning and cooperation among users.
- Finding and modification of users' profiles.

This set of basic functions supposes that every user has an environment in which he can play his own role. Furthermore, every team of users has its own subset of functions. For example, learners and authors may have searching and navigation abilities. Administrators will have administrative ability in team of user etc.
Analytically, most of commercial tools and systems for developing eLearning courses have the following features:

- Developing features. These tools have an open architecture. This means that they allow the communication with existing databases, support the HTML language for content creation and are compatible with all types of browsers 4.X and above. Finally these tools support the Windows O/S (95, 98, NT, 2000).
- Learning tools. Available capabilities include:
- Course administration and monitoring.
- Online testing.
- Online revising.
- Student administration and monitoring.
- Multiple choice questions support.
- Fill in-the-blank questions support.
- Multiple image choice questions support.
- True-False questions support.
- Timed test submission, completion and results recovery.
- Grades can be stored on server.
- Test creation with combination of all types of questions.
- Randomized questions.
- Reports on statistical results.
- Control in the designing of the appearance of the course.
- The designer can view the lesson as a student.
- Teacher tools. The teacher has the following privileges:
- Asynchronous communication between teacher and student.
- Synchronous communication between teacher and student.
- Creating/importing content, creating assignments.
- Course structuring.
- Creating groups of students.

[11] Independent Study conducted by Wichita State University, "Comparison of Features, Tools, Specifications, Support & Pricing", available at http://www.mrc.twsu.edu/mrc/im3/websystems.htm, January 26, 2000.

- Tracking of students activities.
- Add/Remove students.
- Email communication.
- Email management from students.
- Email management from teachers.
- Support of more teachers for one lesson.
- Students tools. The studentshave the following capabilities:
- Authentication with password-student can change his password.
- Web browsing.
- Multimedia support.
- Creating/importing content.
- Student homepage tool/homepage authoring.
- Calendar/scheduling tool.
- Glossary.
- Search tool for course material.
- Store bookmarks.
- Personal email.
- Variety of file types (Word, Excel etc.)-File exchange and file upload.
- Forums.
- Chat-rooms.
- Self-testing tools.
- Student access and progress data available.
- Bulletin board.
- Whiteboard.
- Management tools. Efficient and secure system management is supported with the following capabilities:
- Scalable security levels for secure access.
- Remote access tools.
- Use of server.
- File management.
- Homepage presence also accessible from visitors of the site.
- Multilanguage support.
- Online manual and help for instructors and students.
- Newsgroup facility.
- Course cataloging.
- Related links.
- Support from system administrator to instructors.
- Support from system administrator to students.

Hardware requirements/Software cost. The variety of commercial learning environments covers all needs no matter what is the demand. Pricing can be fixed independently from the number of users or proportional, or to depend on time of operation (price/time). Other systems are offered for a trial period whereas the offered technical support differs from company to company. Finally there are products for any kind of platform like UNIX, Mac Os, Solaris, Linux, NT Servers etc.

In other words, the progress of learning environments shows a convergence on their available features as it is shown on the chart below [12]. Therefore it is of high importance the way these tools are adapted ii the learning process and moreover their efficiency. For the first it is required their use in a variety of cases. Each case is a success story or not for each package and are available from the companies that support these tools. In the next unity we deal with their efficiency.

	FCC	WebCT	TopClass	LSpace	VirtualU	WCB	CourseInfo	Librarian	COSE	CoMENT	LL	Ariadne
Teacher Tools												
Resource Management Tools												
creating /importing content	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Store resources	*	yes	*	*	yes	yes	yes	yes	yes	yes	yes	yes
Add metadata	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Add description	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Add/play multimedia content	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
People Management Tools												
Store & view learner data	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Add / remove learners		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Track learner activities	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Course Management Tools												
Course structuring	*	yes	yes	yes	yes	yes	yes	yes	yes	*	yes	*
adding resources	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
creating assignments	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
performing assessments	*	yes	yes	yes	yes		yes	yes	yes	yes	yes	yes
rapid course revising	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	*
create discussion groups	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	*
Student Tools												
Resource Management Tools												
Web browsing	No	*	*	*	yes	yes	yes	yes	yes	yes	yes	yes
creating / importing content	yes	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes
Store bookmarks	*	yes	yes	yes	yes	yes	yes		yes	yes	yes	yes
Add metadata	*					yes			yes	yes	yes	
Add description	*					yes			yes	yes	yes	yes
Play multimedia	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
People Management Tools												
view people data	*		yes	yes		yes	yes	yes	yes	yes	yes	yes
Homepage authoring	yes	yes	yes			yes	yes		yes	yes	yes	?
Learning Management Tools												
Calendar tool	*	yes		yes	yes		yes					yes
Self-testing tools	*	yes	yes	yes			yes					yes
searchable resource archive	*	yes		yes			yes	yes	yes	yes		yes
create discussion groups	yes									yes	yes	?
	FCC	WebCT	TopClass	Lspace	VirtualU	WCB	CourseInfo	Librarian	COSE	CoMENT	LL	Ariadne
Interaction Tools												
E-mail	yes	yes	yes	yes	yes	yes	yes	yes	*	yes	yes	yes
Noticeboard		yes	yes	yes	yes	yes	yes		yes	yes		
File exchange	yes	yes	yes	yes	yes		yes		yes	yes	yes	yes
asynchronous discussions	yes	yes	yes	yes	yes	yes	yes	yes	*	yes	yes	yes
Chat	yes	yes		yes	yes		yes			yes		
Whiteboard	*	yes		yes		yes						
VideoConferencing	*			yes								

Chart 2: Functional features of eLearning Environments.

3. Comparative Analysis of Online vs. Face-to-Face Instruction (Analogies and Differences)

While online instruction is gaining popularity, it is not free from criticism. Many educators and trainers do not support online instruction because they do not believe it can actually

[12] Britain S., Liber O., "A Framework for Pedagogical Evaluation of Virtual Learning Environments", available at *http://www.jtap.ac.uk/reports/htm/jtap-041.html*.

solve difficult teaching and learning problems [13], while others are concerned about the many barriers that hinder effective online teaching and learning. These concerns include the changing nature of technology, the complexity of networked systems, the lack of stability in online learning environments, and the limited understanding of how much students and instructors need to know to successfully participate [14]. Online instruction also threatens to commercialize education, isolate students and faculty, and may reduce standards or even devalue university degrees [15]. Currently, an increasing number of universities and educational institutions are offering online courses and programs. One new educational entity, called California Virtual University, represents 95 accredited California universities and has over 1,600 online courses in their current catalog, covering more than 100 degrees and certificates [16]. With little empirical knowledge about Internet-based education outcomes and processes, the need for research in this area is not only timely, but also imperative.

In these unity will be presented the empirical studies conducted from the Human Resource Education Department of University of Illinois [17], [18]. The primary purpose of these exploratory empirical studies was to compare a graduate online course with an equivalent course taught in a traditional face-to-face format to identify differences and similarities in a variety of outcome measures.

In the first study comparisons included student ratings of instructor and course quality; assessment of course interaction, structure, and support; and learning outcome measures such as course grades and student self-assessment of their ability to perform various tasks. The aim of the second empirical study was to compare the relationship of learning style preferences and learning success for students enrolled in an online versus a traditional face-to-face course format. Comparisons included in this case, the environmental factors that maintain student motivation in the classroom, task engagement strategies and cognitive processing habits (cognitive controls).

Results from these studies will be presented in order to make useful conclusions.

The first study was designed to answer the following research questions:

What differences exist in satisfaction of the learning experience of students enrolled in online vs. face-to-face learning environments?

What differences exist in student perceptions of student/instructor interaction, course structure, and course support between students enrolled in online vs. face-to-face learning environments?

What differences exist in the learning outcomes (i.e., perceived content knowledge, quality of course projects, and final course grades) of students enrolled in online vs. face-to-face learning environments?

The study had as a theoretical background many other studies which were presented previous years on the same subject. This exploratory empirical study compared outcome and process data obtained from students enrolled in one of two versions of a graduate level instructional design course for human resource development professionals. One version of the course was

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[13] Conlon T., "The Internet is not a Panacea", Scottish Educational Review, 29, 30-38, 1997.
Curry L., "Pattern of Learning Style Across Selected Medical Specialties", Educational Psychology, 11, 247-277, 1991.

[14] Brandt D. S., "Teaching the Net: Innovative Techniques in Internet Training", Paper presented at the 11th Annual Computers in Business Conference, Washington DC. (ERIC Document Reproduction Service No. ED 412 975), 1996.

[15] Gallick S., "Technology in Higher Education: Opportunities and Threats", University of California at Los Angeles, Los Angeles, CA. (ERIC Document Reproduction Service No. ED 415 929), 1998.

[16] Hanly B., "Stay Home and Go Back to School". Wired News, Wired Digital Inc., available at http://www.wired.com/news/news/culture/story/15060.html, September 20, 1998.

[17] Johnson S., Aragon S., Shaik N., Palma-Rivas N., "Comparative Analysis of Online vs. Face-to-Face Instruction", Journal of Interactive Learning Research, available at http://www.outreach.uiuc.edu/hre/public/comparison.pdf, 2000.

[18] Johnson S., Aragon S., Shaik N., Palma-Rivas N., "The Influence of Learning Style Preferences on Student Success in Online vs. Face-to-Face Environments", WebNet 2000: World Conference on the WWW and Internet, Association for the Advancement of Computing in Education, San Antonio, Texas, November 1, 2000.

taught on the campus of a large Midwestern university through a traditional face-to-face format while the other version of the same course was offered totally online, with no direct face-to-face contact between the instructor and the students. Both courses were taught by the same instructor, delivered by the same department, and required the same content, activities, and projects. Nineteen students, most of whom are pursuing a graduate degree in HRD, were enrolled in the on-campus course. Nineteen students were also enrolled in the online version of the course. These students are also pursuing a graduate degree in HRD through a degree program that is taught completely online. For the needs of the program were used the appropriate instruments (which were properly modified) in order to assess students perceptions of course quality, structure and support. All data were collected at or near the end of the semester. The on-campus students completed paper versions of the instruments. Since the online course students were distributed across the country, an online version of the instrument was created. The online version was identical to the paper version in both format and content. Each online student was sent an e-mail message that asked them to complete the instrument within a set time frame and included a web address so they could locate the instrument through their web browser. The online students completed the forms and submitted their results electronically. All instrument data were entered into a statistical analysis package for later analysis. Finally three HRD doctoral students with instructional design experience were asked to independently evaluate each student project in terms of the presentation quality, course organization, degree of detail provided, and overall quality. The reviewers were not told that the purpose of the review was to compare the two course formats and they did not know which projects were resulted from online or face-to face instruction.

The results are very interesting. The results of this study show that, although student satisfaction

with their learning experience tends to be more positive for students in a traditional course format, the learning outcomes do not vary significantly between the two instructional formats. These results support the argument that online instruction can be as effective as traditional face-to-face instruction.

Overall, students from both groups provided positive ratings of the quality of the instruction and the course. Although the face-to-face group provided a slightly more positive rating of the quality of the instructor than the online group, the reasons for this difference are not evident. It is possible that the instructor was more effective in the traditional format. Another possible explanation is that student ratings may tend to be higher when there is a personal connection between the instructor and the students, something that may not be as fully developed in an online course.

A variety of characteristics of quality learning environments were examined in this study, including interaction among students and the instructor, course structure, and instructor and departmental support. The face-to-face students did have the ability to dialogue with the instructor around the content as it was presented. They also had the opportunity to receive multiple examples and illustrations from the instructor. For the online students, this "dialogue" came in the form of e-mails, IRC chat discussions, phone calls, and synchronous hour discussions. While every attempt was made to provide appropriate and adequate examples and illustrations within the online content, the possibility still remains that some students will still need more.

Generally, the face-to-face students indicated a more positive perspective on these learning environment characteristics than the online students. Considering the fact that the face-to-face class met in person once a week for a 3 hour period throughout the semester, the differences in student interaction levels are to be expected. Students in face-to-face courses can more easily get together at least once a week for an extended period of time to discuss class projects, work out any differences of opinion, and build social relationships. In contrast, the online students do not have similar opportunities, although the technology does provide a surrogate form for similar interactions. This suggests that the online environment may lack the strong social dimension that is beneficial to face-to-face classroom experiences.

Several reasons may account for the more positive perception of the face-to-face group on the quality of instructor and student interaction. One possibility is that, because of

proximity reasons, online students do not enjoy the same amount, type, or timeliness of communications about the course as the face-to-face students. Another possibility could be that the online students' expectations with regard to student progress and instructor interaction are most likely based on experiences formulated in face-to-face settings through many years of schooling. Even though the amount of interaction may have been adequate to support their learning, it may not have been equal to what was expected. Also, it is realistic to assume that the relationship between student progress and student/instructor interaction are among the most important for students.

Differences between the online and the face-to-face groups were also significant for the dimensions of instructor and departmental support. Students in the face-to-face course reported higher levels of instructor support than did the online students. Across both classes, students reported the same levels of instructor encouragement. A more detailed item analysis reflected that the differences stemmed from the characteristics of instructor feedback. This makes sense in view of the differing contexts of the two classes. The face-to-face setting allowed the instructor to vary the nature and type of feedback as the dynamics of student/instructor interactions would demand. In the online course however, the instructor feedback was limited largely to e-mail, fax, uploaded files, and periodic telephone conversations as a means of delivering feedback. The face-to-face students received more live and dynamic forms of support from the instructor while the online group received support that was a form of one way static communication. In terms of departmental support, the online students reported higher ratings than the face-to-face students. This difference is easily explained by the fact that the face-to-face class had direct contact with the instructor and a part time teaching assistant, therefore they had little need for support from the department. In contrast, given the complexities of online technologies, the online class had more need for technical support, a service that was provided by the department.

The lack of difference in the learning outcomes from the two course formats supports the continued development of online instruction programs. Using a blind review process to judge the quality of the major course projects, the ratings of three independent reviewers showed no difference in the quality of the projects across the two course formats. In addition, the distributions of course grades for both the online and face-to-face classes were to a large extent equally distributed. Overall, both groups indicated a level of comfort at performing the tasks. There were of course few differences because face-to-face students were provided with less time in order to fulfill their task compared to the online students.

A second study was designed to answer the following research questions:

- Are there distinguishable differences in the learning style preferences of students enrolled in an online versus a face-to-face learning environment?
- How do learning style preferences relate to the student outcomes achieved in online and face-to-face learning environments?
- What learning style constructs significantly influence student outcomes in both the online and face-to-face delivery formats?

Curry's Model of Learning style components and Effects [19] served as the theoretical framework for the study. In this study was followed the same method as the one in the first study. Comparisons the environmental factors that maintain student motivation in the classroom, task engagement strategies and cognitive processing habits (cognitive controls).

Based on the results of the analyses, the following conclusions are made: first, even though there were learning style differences found between face-to-face and online students, the differences were not highly apparent when the delivery format was controlled. Looking at the results from the correlation analysis for all students, motivation was the only variable found to influence course performance.

[19] Curry L., "Pattern of Learning Style Across Selected Medical Specialties", Educational Psychology, 11, 247-277, 1991.

Second, the significant results from the correlation analyses for the face-to-face students also serves to reaffirm what we know contributes to positive learning outcomes for students. As student participation increased and avoidance decreased, performance was shown to increase. The surprising correlation was the negative one that existed between abstract conceptualization (learning by thinking) and course grade. It may simply be that because the instructional design class was an application, hands-on course, success is highly dependent upon participation.

Finally, the most exciting finding from this study is the fact that correlations between learning style and course performance were not found for the online students. Consequently, this finding suggests that learners can be equally as successful in the online environment regardless of learning style.

The findings of the described studies show that online learning can be as effective as face-to-face learning in many respects in spite of the fact that students have not the same satisfaction form their online learning experience compared to face-to-face and despite the fact that students have different learning style preferences.

Firstly, analyses suggest the development and use of online programs should continue. Further examination of feedback and student progress are needed to improve overall student/instructor communication. This includes identifying and implementing new communication measures to facilitate student/instructor communication at appropriate points in the course. Second, a better understanding of why online learners report lower levels of comfort with their learning is needed so specific strategies for improving delivery of online programs that increase student confidence levels can be developed. However, it is important that quality and thoroughness of the design and delivery be the catalyst for ensuring positive online learning experiences. Finally, educational practitioners who may enroll in or develop online courses need to be familiar with the limitations of online programs. Such awareness will ensure that the expectations of learners are met and the intended course goals can be attained.

As it has been obvious from the previous paragraphs, the available commercial products tend to converge to their available functional specifications. Although new services under the supervision of research institutes comprise remarkable efforts, they have the tendency to be more user-centric. But even these needs, show that everyone has realized the needs of teachers/trainers and trainees/students.

The fight between distance learning against face-to-face learning shows that there is no winner. And it must not have a winner. The value of distance learning is certified by all the cases it has been successfully applied. There are cases where distance learning seems to be the only choice. As it is obvious from the studies we can find in international bibliography, trainees are touched and are very accepting to be trained with the new mean (internet). The traditional education techniques cannot be integrally applied in distance learning. It needs gradual adjustment, so as the trainees to be able to go through the pattern of learning the have grown with and have followed during their basic education. That is why distance learning must function in addition with face-to-face learning. In that way the drawbacks of distance learning will be reduced and will gradually increase its degree of penetration into the educational system. This procedure has a fundamental factor. Continuous assessment of the available learning systems and the involvement of trainers and trainees in all the stages. For this assessment there is still much need for work and documented scientific methodology.

4. How video gaming languages can integrate distance learning

Advantages and disadvantages of computer games used as learning tools

Computer games engage. They are seductive, deploying rich visual and spatial aesthetics that draw players into fantasy worlds that seem very real on their own terms, exciting awe and pleasure. They motivate via fun ('part of the natural learning process in human development', [20], via challenge and via instant, visual feedback within a complete, interactive virtual playing environment, whereby ambience information creates an immersive experience, sustaining interest in the game. They are fast and responsive, and can be played against real people anywhere in the world, or against a computer. They handle huge amounts of content and can be instantly updated and customized by individual players. It has been suggested [21] that computer games can incorporate as many as 36 important learning principles.

For example, they put learners in the role of decision-maker, pushing them through ever harder challenges, engaging the player in experimenting with different ways of learning and thinking [22]. Crucially for learning, computer games can provide instant feedback.

In other words, computer games are valuable tools in enhancing learning. They are seen as a means of encouraging learners who may lack interest or confidence [23] and of enhancing their self-esteem. In training and educational settings it is suggested that they can reduce training time and instructor load, for example affording opportunities for drill and practice (which is a form of instruction where learners rehearse sets of material following the same pattern), thereby enhancing knowledge acquisition and retention [24]; [25]. However, recall may be promoted less by games than by lessons if games are difficult because they have multiple goals and distracting components [26].

Though regulated by rules, computer games allow manipulation of objects, supporting development towards levels of proficiency [27]. They are said to be particularly effective when 'designed to address a specific problem or to teach a certain skill', for example in encouraging learning in curriculum areas such as maths, physics and language arts, where specific objectives can be stated, and when deployed selectively within a context relevant to learning activity and goal [28].

It is important, however, that they are used to facilitate tasks appropriate to learners' level of maturity in the skill [29]. Moreover, for skills to be enhanced by game playing, players must possess such skills to some degree already [30].

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[20] Bisson C, Luckner J (1996). Fun in learning: the pedagogical role of fun in adventure education. Journal of Experimental Education, 19(2), 108–112.

[21] Prensky M (2001). Digital game-based learning. New York: McGraw-Hill.

[22] Gee JP (2003). What video games have to teach us about learning and literacy. New York: Palgrave Macmillan.

[23] Klawe MM (1994). The educational potential of electronic games and the E-GEMS Project. In T Ottman and I Tomek (eds) Proceedings of the ED-MEDIA 94 World Conference on Educational Multimedia and Hypermedia. Panel discussion 'Can electronic games make a positive contribution to the learning of mathematics and science in the intermediate classroom?' AACE (Association for the Advancement of Computing in Education), Vancouver, Canada, 25–30 June 1994.

[24] Brownfield S, Vik G (1983). Teaching basic skills with computer games. Training and Developmental Journal, 37(2), 52–56.

[25] Ricci KE (1994). The use of computer-based videogames in knowledge acquisition and retention. Journal of Interactive Instruction Development, 7(1), 17–22.

[26] Oyen A, Bebko JM (1996). The effects of computer games and lesson contexts on children's mnemonic strategies. Journal of Experimental Child Psychology, 62, 173–189.

[27] Fabricatore C (2000). Learning and videogames: an unexploited synergy. At www.learndev.org/dl/FabricatoreAECT2000.pdf, accessed 14 April 2004.

[28] Kirriemuir J (2002). The relevance of video games and gaming consoles to the higher and further education learning experience. April 2002. Techwatch Report TSW 02.01. At www.jisc.ac.uk/index.cfm?name=techwatch_report_0201, accessed 14 April

[29] Din FS, Calao J (2001). The effects of playing educational video games on kindergarten achievement. Child Study Journal, 31(1), 95–102.

[30] Subrahmanyam K, Greenfield P, Kraut R, Gross E (2001). The impact of computer use on children's and adolescents' development. Journal of Applied Developmental Psychology, 22(1), 7–30.

Even simple types of game can be designed to address specific learning outcomes such as recall of factual content or as the basis for active involvement and discussion [31]. Exploratory, interactive games are good vehicles for embedding curriculum content such as maths and science concepts that may be hard to visualize or manipulate with concrete materials. Riddles and interactive computer games have been used successfully with college students to enhance creative and other forms of critical thought [32].

Complex games, in particular, have the potential to support cognitive processing and the development of strategic skills. Brain oscillations associated with navigational and spatial learning occur more frequently in more complex games. This increases users' learning and recollection capabilities and encourages greater academic, social and computer literacy skills [33].

Simulation games enable engagement in learning activities otherwise too costly to resource or too dangerous, difficult or impractical to implement in the classroom [34] as well as those that are hard to accomplish by other means. Imaginative, well-produced simulation games can be seen as interactive stories. Participation in these stories can change learners' relationships to information by encouraging visualisation, experimentation and creativity in finding new ways to tackle the game [35]. Furthermore, simulation games are flexible and complex enough to cater for different learning styles, for example via the graphics. They broaden learners' exposure to different people and perspectives, encourage collaboration, and support meaningful post-game discussion. They put the learner in the role of decision-maker and push players through ever harder challenges.

There are opportunities with new and emerging technologies for providing effective coaching in an adventure games environment. For example, the player can experience a role or roles in a near real-life setting and at the same time learn about the setting itself, developing intuitive skills at coping in that environment [36]. When connected to an intranet, learners can interact simultaneously with other users as well as with the environment itself [37]. Increasing use of mobile devices and of handheld games consoles such as the Game Boy Advance offers opportunities for developing educational software to support blended learning, for example classroom-based learning linked to learning online and/or outdoor activities such as museum visits and field trips.

There are, however, some educational considerations. For example, for skills to be enhanced by game playing, players must possess them to some degree already. Teacher bias towards a particular learning method and teacher input into debriefing can affect the

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31 Dempsey JV, Lucassen BA, Haynes LL, Casey MS (1996). Instructional applications of computer games. Paper presented to the American Educational Research Association, 8–12 April 1996, New York. ERIC Document Reproduction Service No. ED 394 500.

32 Doolittle JH (1995). Using riddles and interactive computer games to teach problem-solving skills. Teaching of Psychology, 22(1), 33–36.

33 Natale MJ (2002). The effect of a male-oriented computer gaming culture on careers in the computer industry. Computers and Society, 32(2), 24–31.

34 Berson MJ (1996). Effectiveness of computer technology in social studies: a review of the literature. Journal of Research on Computing in Education, 28(4), 486–499.

35 Betz JA (1995). Computer games: increase learning in an interactive multidisciplinary environment. Journal of Educational Technology Systems, 24(2), 195–205.

36 Khan MM (2002). Implementing an intelligent tutoring system for adventure learning. The Electronic Library, 20(2), 134–142.

37 Lee KM (2000). MUD and self efficacy. Educational Media International 2000 (September), 37(3), 177–183.

effectiveness of games in encouraging learning [38]. A number of risk factors can impact negatively on encouraging learning via computer games. For example, learning objectives may not be congruent with game objectives, games can distract from learning as players concentrate on completing, scoring and winning, and games require suspension of belief – it may be difficult to retain learning acquired in that state [39]. What seems like a game to someone will feel like work to another; hence, it is argued the intention should be enlightenment, not entertainment. There is also an opportunity cost of learning via computers: time spent in front of a screen could instead be spent, for example, in social or sport activity [40].

How have computer games been used for learning?

Computer games have been used to serve a variety of functions in training and educational environments, for example: Tutoring, amusing, helping to explore new skills, promoting self-esteem, practicing skills, or seeking to change attitudes. Even simple types of game have been used to address specific learning outcomes such as recall of factual content or providing the basis for discussion, while complex games, in particular, have been seen to support cognitive processing and the development of strategic skills, increasing learning and recollection capabilities, and promoting computer literacy skills. Computer games have been particularly effective in raising achievement levels of both children and adults in areas such as maths and language, where specific objectives can easily be stated, and have been used to support National Curriculum learning. Information-processing educational game components that have been designed to imitate popular computer games have been found to help poor readers to make significant learning gains, with the greatest improvement shown by the poorest readers and resource-deprived learners. They have also had positive effects on motivation and classroom dynamics [41].

The use of quiz games has also led to positive results in long-term student retention (ie ensuring they complete a course) by attracting higher student interest than traditional classroom approaches. For example, in training environments such as the Naval Training Systems Center in Orlando, Florida, computer-based versions of board games such as Serious Pursuit were adapted to cater for service personnel whose jobs required a pre-existing knowledge base for certain tasks. This prompted development of GameShell, a software program to house question and answer databases. When these games were used there was better retention. This was attributed to more focused attention, because the students enjoyed the approach. Simulation games have been used in schools to enhance children's spatial abilities and general cognitive development, with both boys and girls performing equally well [42], while [43] reports that versions of strategy games like Sim City have been used in schools to encourage learning in subjects such as geography. Simulation games have also been used in business environments, for example in teaching administration skills. Off-the-shelf games simulations such as Doom II have been used in conjunction with free tools downloaded from the internet to provide

38 Randel JM, Morris BA, Wetzel CD, Whitehill BV (1992). The effectiveness of games for educational purposes: a review of recent research. Simulation and Gaming, 23(3), 261–276.

39 Clark D (2003). Computer games in education and training. Presentation at LSDA seminar Learning by playing: can computer games and simulations support teaching and learning for post-16 learners in formal, workplace and informal learning contexts? 20 November 2003, London.

40 Stoll C (1999). High tech heretic – reflections of a computer contrarian. New York: First Anchor Books.

41 Rosas R, Nussbaum M, Cumsile P, Marianov V, Correa M, Flores P, Grau V, Lagos F, Lœpez X, Lœpez V, Rodriguez P, Salinas M (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. Computers and Education, 40, 71–94.

42 De Lisi R, Wolford JL (2002). Improving children's mental rotation accuracy with computer game playing. Journal of Genetic Psychology, 163(3), 272–282.

43 Jayakanthan R (2002). Application of computer games in the field of education. The Electronic Library, 20(2), 98–102.

cost-effective military training, for example where real-world environments or locations may be unavailable to troops. Simulation games have been found to be most effective in encouraging discovery learning where the system provides two kinds of instructional support: learner-requested background information and elaborate system-initiated advice. However, the role of teacher mediation remains important, in explaining or augmenting the game. For example, task cards were used with games, requiring learners to describe their strategies and to provide tips to others, thereby stimulating reflection and writing skills. Working with sections, rather than the whole game, may be more useful to particular learning objectives. This means the teacher must know the content behind the titles and understand controls, menus and skill levels of the game, and this requirement thus increases teacher workload. Complex games have been useful in encouraging attitude change, in supporting the development of critical thinking, in problem solving and in developing decision-making skills. They have been explored as a means to foster learners' understanding of theoretical models and interaction effects and to support the development of team, social, communication and resource sharing skills [44], [45], [46].

44 Leutner D (1993). Guided discovery learning with computer-based simulation games: effects of adaptive and non-adaptive instructional support. Learning and Instruction, 3(2), 113–132.

45 Ritchie D, Dodge B (1992). Integrating technology usage across the curriculum. Paper presented to the Annual Conference on Technology and Teacher Education, 12–15 March 1992, Houston, TX.

46 Helliar CV, Michaelson R, Power DM, Sinclair CD (2000). Using a portfolio management game (Finesse) to teach finance. Accounting Education, 9(1), 37–51.

5. Conclusions

The reasons for playing games appear to be gender-related – males can focus on winning a game, whereas females can focus on completion. Either way, struggle is a key factor in motivating learners. Struggle is also important in supporting cognitive learning, but there should be a satisfactory end to each game, to reflect an element of progress. Context is also key: it must be meaningful and relevant to target audiences. There is a strong case for games to incorporate creative tools, giving the learner control. This can extend to allowing them to enhance the game or create new games. It is true that few learners may want or feel able to take up such options and that even if they do so the results may be unsatisfactory. Nevertheless, it is vital to encourage aspiration in learning, with at risk students in particular. It would be beneficial for the game to afford opportunities for players to personalise the medium, thereby allowing them to key into their lifelong learning experience. This is important because games should not just relate to curriculum, but also to youth culture and learning styles.

The implications for the planning and design of educational computer games include the issue of the cognitive style changes associated with a generation growing up in the age of digital computer games. If complex games support the development of 'expert behaviours' such as pattern recognition, strategic decision-making, superior memory skills and self-monitoring, students having honed such skills may become disenchanted with learning games if there is little opportunity to deploy those skills. Educational games should therefore engage and stretch players in learning at different levels, from the straightforward to the sophisticated. This review has indicated that producing educational games that are true games is a worthwhile activity. Indeed, it is a necessary development if we are to reach out to current and future generations in ways that cater for their needs and expectations.

Educators and industry experts must work together to research the computer culture, to ensure that innovations are capable of engaging and sustaining interest. Designers should not only explore ways of combining new technologies such as mobile networking, context-aware computing and sensor-based computing but should also ensure the new generation of edugames builds on the principles of successful commercial games such as risk–reward structures. However, there are budgetary implications in following this route. The modest profits thus far gained from educational games pale into insignificance against the huge profits to be made from commercial games. As the required investment is correspondingly large, the endeavour requires collaboration between educationalists and industry and the commitment of policy-makers and funding bodies.