3D Graphical Multi-User Online Learning Environments for Internet-based Distributed Learning: First Year Results

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Abstract: The paper presents first year (baseline) research into using a 3D on-line learning environment for teaching Computers in Education, a course at the University of North Texas for pre-service teachers (students who are training to become teachers). The study looked at nine sections of the course during the fall semester of 2003. Three of the sections used the 3D online learning system while the remaining six sections took the course in the normal face-to-face manner. Several interesting patterns emerged during exploratory analysis of this data.

Introduction

A new generation of 3D online MOOs (multi-user object orientated online constructivist environments) is becoming available for Internet-based distributed learning. These new interfaces have strong ties to their text-based cousins of the early 1990s but now provide highly collaborative, immersive environments that promote interactions among students and with the instructor. Some on-line games boast subscriber populations that rival those of many actual North American cities (J. Whiting, 2002). As a result of this popularity, the number of systems capable of supporting on-line learning environments is increasing. As computer performance on low-cost personal computers increases, these types of systems (MOOs) allow teachers to provide students with unique on-line collaborative learning opportunities in the areas of language, science, computer graphics, and other fields (Jones, 2003). With the current emphasis on offering courses via web-based delivery systems, the importance of real-time face-to-face communications between course instructor and student and among the students is more apparent than ever. An on-line 3D virtual environment supporting text, audio, and overheads allows for immersive environments to be created so that the students and instructors can interact as if they were at the University.

Research indicates that the environment being presented for course delivery may impact the attitudes and satisfaction of students taking on-line courses (Walker 2003; Y. Sogabe & M. R. Finley, 2003). Dissatisfaction with courses can have several aversive consequences, such as: students dropping out of a course, students not taking distance delivered courses in the future, low evaluation ratings for the instructor, or low evaluations for the program of which the course is a part (J.R. Hill & A. Raven, 2000; J.R. Hill, 2001). While web-based delivery has increased the number of students able to attend universities without having to commute, it lacks many key features present during in-person traditional course delivery. An on-line 3D MOO allows for immersive environments to be created in which the students and instructors interact as if they were at the University, while keeping Internet connectivity to a minimum for the student. It is important to evaluate and understand how immersive environments with better feedback mechanisms impact students and instructors.

The 3D online learning environment being used in the Department of Technology and Cognition at the University of North Texas provides the ability to create a context of communications among students and between the instructor using audio chat, text chat, and overhead/whiteboard presentations in as low bandwidth as a dialup Internet connection. The Created Realities Group (CRG) has developed an online 3D virtual collaboration environment that allows users on Windows, Mac, or Linux systems to interface on as low as a dialup Internet connection. Students at remote sites assume control of an Avatar (figurine) in a shared 'created environment' on their screens such as a school building or other space. Popular features of the system include integrated real-time voice (VOIP), distributed power-point presentations, and virtual-space segmented conversation areas so that learners can move the representations of themselves to areas for small group or private discussions. Figure 1 shows a screen capture of a class meeting being held online by the University of Hawaii using the CRG system.

Figure 1 – Screenshot from an online class being done by the University of Hawaii.

This paper presents our initial research looking at students using a 3D online learning environment during the delivery of a pre-service educational course funded by an internal grant at the University of North Texas.

The Research

During the fall semester of 2003 (September-December 2003), three sections of the University of North Texas CECS 4100 course (Computers in the Classroom) out of nine were chosen to use the 3D online learning environment for the delivery of the course. Six sections took the course in the traditional face-to-face method. Instructors and students participated in pre- and post- questionnaires and follow-up interviews for the classes in the current mode of offering as well as those in the 3D on-line learning environment mode. The CECS 4100 course focuses on computer topics that would be covered in introductory and secondary school courses with an emphasis on curriculum integration. This course has been delivered in a traditional classroom format on the University of North Texas (UNT) campus and at University of North Texas at Dallas campus for the past several years.

How often the classes meet was very different between the treatment and control groups. The face-to-face courses (control) meet each week on campus for a total of at least 3 hours each week. The 3D online courses (treatment) were taught as a blended course. Blended courses combine face-to-face meetings with online communications. For this semester, the treatment groups met in person a total of 7 times throughout the semester and used the 3D online system for an additional 6 online meetings. The control group therefore had much more instructor contract time than the treatment group.

It should be noted that students participating in the treatment group experienced a number of technical problems related to both delivery and lab issues. The CRG software had been used for three semesters prior to the start of this course in other UNT courses and we felt comfortable that technical problems would not play a major factor. The 3D online software was installed and demonstrated during the first two in-person meetings of the UNT Dallas campus course. The users then took CDs home with the software and installed it on their home computers. 40% of the treatment group sent e-mails to the technical support person asking questions regarding the install. These problems were solved within the first two e-mail exchanges. Only two of the students were unable to get the software operational for the class. These two students found other systems to use for class meetings. The training sessions and introductory uses looked very good. Then the course encountered about 60 days of problems. This began with a problem related to the server supporting the 3D environment. Students could not stay connected to the server for extended periods of time because a combination of issues that took three weeks to resolve. The technical problems continued when it was discovered that the computer lab at the Dallas campus had upgraded the OS. This change kept the students using the lab from attending the online course until other arrangements could be made. The instructor during this period provided the materials as attachments in e-mails sent to the participants. These problems affected the treatment group's initial use of the 3D online learning environment. The traditional format sections had no remarkable problems in the delivery of the course.

Participants

107 undergraduate students at the University of North Texas taking the CECS 4100 course participated in the research. 14 students participated as the treatment group in the three sections being taught at the UNT Dallas campus. Due to a data collection issue, less than half of the potential students enrolled in the three sections of the treatment courses were available for analysis. As will be discussed later, this lack of data affected the overall research. 93 students participated in the control group in six sections being taught on UNT campus. The demographics for the sample showed a median of 21 years of age, although there were some differences in the composition of the group by gender analysis. The 14 participants in the treatment group were all females who ranged in age from 19 to 40 with a median age of 23, whereas the 93 participants in the control group ranged from 18 to 46 and were divided into 8 males with a median age of 25.5, and 85 females with an average age of 21.

There are differences between students taking classes on the main campus in Denton and classes offered at the UNT Dallas campus. Students in Dallas tend to be slightly older and typically hold down full time jobs or have other similar commitments. This can be seen when the students are asked how far away they are till graduation. The majority of students (83.9%) hold a bachelor's degree, and there is not a definite date for graduation as a cohort. Most of the students taking courses at the UNT Dallas campus were at least 2 years away from graduating. While students taking the course on the main campus reported that they would be graduating within the next year to year and a half. Most of the students (70.1%) plan to teach at the K-3 level, thus, it is not a surprise that most of them have Interdisciplinary (elementary school), as their area of specialty.

Another interesting difference between the two groups was that of home computers. Home computers owned by the participants in the treatment group were slightly older than those owned by the control group, based on the number of support questions answered by the technical support group. 94.4% (101 students) had computer at home, and 84.1% (90 students) had Internet at home. One student in the treatment group did not have either computer or Internet at home, whereas in the control group 5 students were in that condition, and an additional 9 students had computer, but no access to Internet at home. In the future, the demographics questions will be enhanced to better track this issue.

In terms of the number of hours spent using the computer at home and at school, although most of the students reported spending about the same average time in both settings (2-3 hours), the distribution of the time is different. The majority of students spent 2-3 hours, *or more* at home, whereas they spent 2-3 hours *or less* at school. Furthermore, there were differential tendencies between the two groups. 51.6% of the students in the control group reported using the computer in the classroom 2-3 hours a week, whereas 50% of the students in the treatment group reported zero use of the computer in the classroom.

Method and Data Collection

The primary instrument used was a collection of measures gathered in the publication "Instruments for Assessing Attitudes Toward Information Technology", made available by the Institute for Integration of Technology into Teaching and Learning (Knezek, G., Christensen, R., and Miyashita, K. 2000, 2004). The battery of instruments measures attitudes, dispositions, and technology proficiency among teachers. The instruments have been developed and validated over the past ten years by researchers associated with the Institute for the Integration of Technology into Teaching and Learning. All have built upon the work of previous scholars in many states and nations with support from numerous agencies, including the Meadows Foundation, the Japan Society for the Promotion of Science, the Fulbright Foundation, and the Texas Center for Educational Technology.

The specific measures used in this investigation were:

Concerns-Based Adoption Model (CBAM)	A self-assessment instrument that measures the level of adoption of an educational innovation.
Stages of Adoption	A self-assessment instrument that measures the teacher's level of adoption of technology.
Teachers' Attitudes Toward Computers (TAC)	Measures attitudes toward computers in nine areas
	Interest: Enjoyment and satisfaction in using computers.
	Comfort: Lack of anxiety; comfortable using technology.
	Accommodation: Acceptance of computers; willingness to learn.
	Email: Usefulness of email with students.
	Concern: Fear that computers will have a negative impact on society.
	Utility: Belief that computers are useful for productivity and instruction.
	Perception: Overall feeling toward computers.
	Absorption: Belief that computers are a part of many areas of work and leisure.
	Significance: Belief that computers are important for student use.
Technology Proficiency Self-Assessment (TPSA)	Determines the educator's own perception of his/her skill levels in four areas: Email, World Wide Web, Integrated Applications, and Teaching with Technology.
Apple Classroom of Tomorrow (ACOT)	Measures the teacher's level of understanding and use of technology.
General Preparation Profile for Prospective Teachers (GP3)	Measures the general preparation of pre-service teachers to use technology in the classroom, based on ISTE's standards.

Regarding reliability, TAC has shown reliability coefficients from .84 to .97 across the nine subscales (Knezek & Christensen, 2002:26). The validation of GP3 yielded an Alpha of .93 (Knezek, Christensen, Morales, & Overall, 2003). CBAM, Stages of Adoption, and ACOT are single-item measures, thus, no reliability coefficient is obtainable. Nevertheless, test-retest reliability for CBAM has been estimated to be between .72-.73, and for Stages between .80- .91 (Knezek & Christensen, 2001:35).

Table 1 shows final pre- and post- data collections that were available for analysis. Due to a problem with students not taking either the pre- and/or the post- tests the ability to perform the data analysis was limited. There was 35% attrition between pre- and post- tests with the outcome being that only 55.8% of the possible sample size was available to examine. The lack of matching tests creates unbalanced groups, which result in limited data analysis alternatives. Upon discussion with the instructors involved with the research, it was determined that the problem with missing pre- or post- testing can be corrected with better tracking of the students taking the tests. This problem will be addressed in the next phase of the research.

Groups	Pre-Tests Taken	Post-Tests Taken	Matches Pre-Post- Tests
UNT 6 sections (control)	160	112	93
UNT Dallas 3 sections (treatment)	32	17	14
	192	129	107

Table 1 – Summary Information on Pre- Post- Tests available for data analysis

Results

In order to account for possible differences between the treatment and control groups, the first step was to test the equivalence of the groups at the starting point on the measures administered. Pretest data were analyzed, and the results are shown on Table 2.

None of the measures yielded statistically significant differences between the control and the treatment groups, which suggests equivalence of the two groups on adoption, attitudes, proficiency, and preparation regarding technology. Having equivalent conditions in the pretest, an anova for the posttest was performed. The results are shown on Table 3.

The results yielded three statistically significant differences: TAC – Accommodation, TAC – Concern, and TPSA – Teaching with Technology.

Table 2. ANOVA for different technology integration and technology beliefs measures administered as a pretest to 14 treatment and 93 control CECS 4100 UNT students.

Measure	Group	Mean	SD	F	Sig
CBAM	Treatment Control	3.857 3.717	1.875 1.535	.095	.759
Stages of Adoption	Treatment Control	4.785 4.489	.892 1.074	.964	.329
TAC / Comp. Interest	Treatment Control	4.128 4.234	.419 .548	.478	.491
TAC / Comp. Comfort	Treatment Control	4.242 4.320	.533 .722	.149	.701
TAC / Comp. Accommodation	Treatment Control	4.700 4.784	.413 .365	.637	.427
TAC / Interaction	Treatment Control	3.800 3.967	.908 .788	.530	.468
TAC / Comp. Concern	Treatment Control	3.446 3.717	.659 .813	1.415	.237
TAC / Comp. Utility	Treatment Control	4.080 4.247	.510 .526	1.233	.269
TAC / Perception	Treatment Control	5.942 5.789	.778 1.227	.206	.651
TAC / Absorption	Treatment Control	2.985 2.922	.754 .786	.079	.779
TAC / Significance	Treatment Control	4.128 4.311	.512 .473	1.787	.184
TPSA / E-mail	Treatment Control	4.342 4.458	.516 .621	.434	.511
TPSA / WWW	Treatment Control	3.871 4.126	.635 .622	2.038	.156
TPSA / Tech Applications	Treatment Control	3.471 3.673	.825 .879	.650	.422
TPSA / Teach w.Technology	Treatment Control	3.614 3.569	.878 .741	.042	.839
ACOT	Treatment Control	3.714 3.195	.913 .986	3.422	.790
GP3	Treatment Control	3.520 3.566	.563 .601	.071	.790

Table 3. ANOVA for different technology integration and technology beliefs measures administered as a posttest to 14 treatment and 93 control CECS 4100 UNT students

Measure	Group	Mean	SD	F	Sig
CBAM	Treatment Control	4.461 5.290	1.853 1.571	3.036	.084
Stages of Adoption	Treatment Control	5.000 5.086	.960 .985	.093	.761
TAC / Comp. Interest	Treatment Control	4.028 4.189	.536 .601	.890	.348
TAC / Comp. Comfort	Treatment Control	4.071 4.215	.775 .687	.514	.475
TAC / Comp. Accommodation	Treatment Control	4.400 4.718	.811 .453	4.714	.032
TAC / Interaction	Treatment Control	3.885 4.086	.791 .719	.919	.340
TAC / Comp. Concern	Treatment Control	3.348 3.845	.853 .731	5.381	.022
TAC / Comp. Utility	Treatment Control	4.044 4.266	.551 .549	1.974	.163
TAC / Perception	Treatment Control	5.800 5.972	.855 1.187	.272	.603
TAC / Absorption	Treatment Control	3.114 3.124	.946 .917	.002	.969
TAC / Significance	Treatment Control	4.200 4.344	.549 .510	.952	.332
TPSA / E-mail	Treatment Control	4.514 4.651	.678 .519	.781	.379
TPSA / WWW	Treatment Control	4.485 4.612	.621 .503	.729	.395
TPSA / Tech Applications	Treatment Control	4.300 4.428	.650 .651	.469	.495
TPSA / Teach w.Technology	Treatment Control	4.057 4.492	.809 .596	5.877	.017
ACOT	Treatment Control	3.857 3.849	.949 .736	.001	.972
GP3	Treatment Control	3.948 4.220	.524 .538	3.129	.080

Figure 2 shows analysis for the subscale Computer Interest. What is of interest is that the 3D online learning environment (treatment) tracked the face-to-face course delivery (control). The computer interest subscale of the control group and the treatment group decrease at the same rate between pre- and post- tests. For the computer interest sub-scale, this decrease between pre- and post- tests is a normal occurrence. The difference in starting levels between control (4.23) and treatment (4.12) is most likely a result of the different student group compositions that take classes at the main campus as compared to those who attend courses at the Dallas campus. Students who attend courses at the Dallas campus tend to be older, less experienced computer users who also maintain a job or household full time.

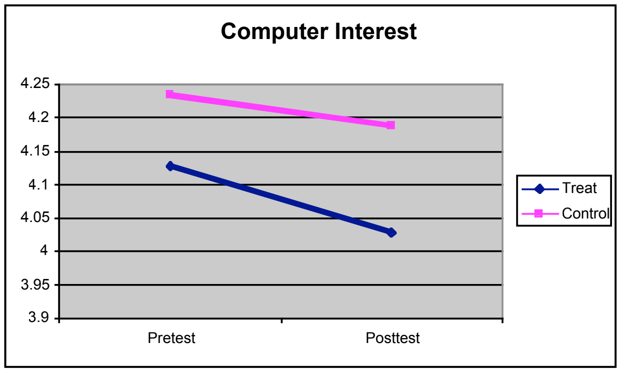

Figure 2 – Pre/Post comparisons on the computer interest subscale.

Figure 3 shows analysis for the subscale Computer Comfort (anxiety). What is of interest is that the 3D online learning environment (treatment) was again parallel to the face-to-face course delivery (control). The computer comfort subscale of the control group and the treatment group decrease at the same rate between pre- and post- tests. This means that the control group showed slightly less increase in anxiety (decline in comfort) from the beginning to the end of the course.

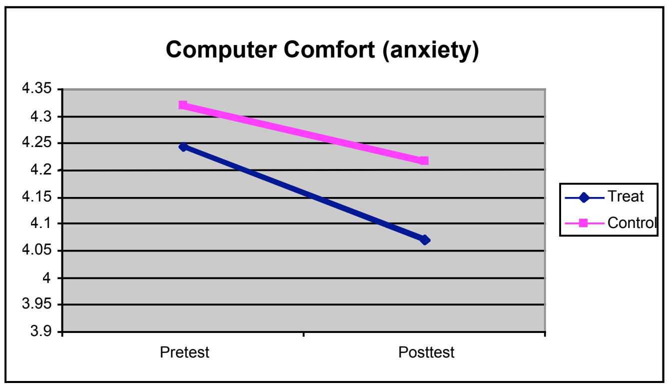

Figure 3 – Pre/Post comparisons of computer comfort (anxiety) subscale.

Viewed together, both of these subscales show that the pre-post trends for the 3D online learning environment for the delivery of the CECS 4100 course were very similar to that of the face-to-face course when looking at Computer Comfort and Computer Interest.

Figure 4 shows that while accommodation (lack of avoidance) to use technology remained at about the same level between the pretest and the posttest for the control group, for the treatment group there was a clear decrement. This means that the feeling of avoidance to use technology increased between the pretest and the posttest for the treatment group.

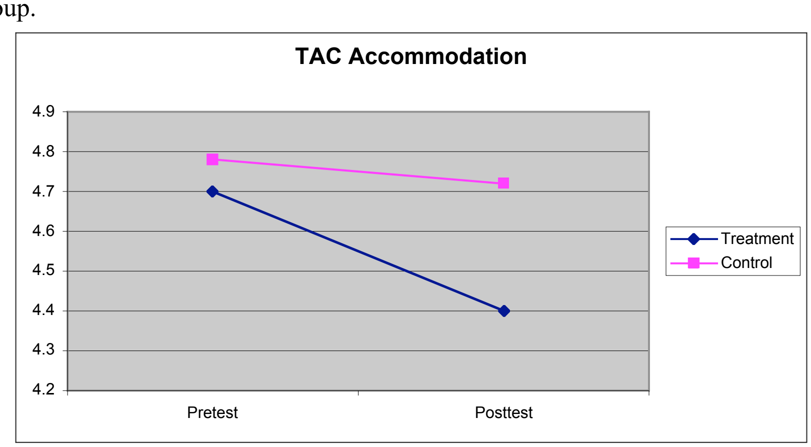

Figure 4 – Pre/Post comparisons of computer accommodation (avoidance) subscale.

Figure 5 shows that there was a decrement on computer concern between the pretest and the posttest for the treatment group, for the control group there was an increment.

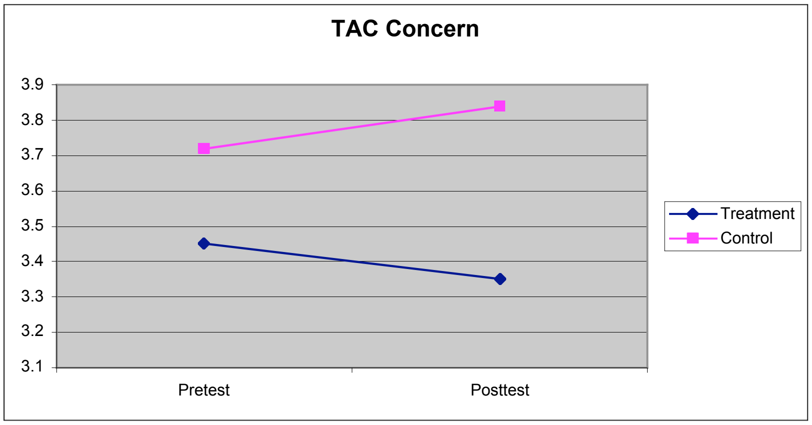

Figure 5 – Pre / Post comparisons of computer concern subscale

Figure 6 shows that both groups started with about the same mean score on the Teacher with Technology subscale, but at the posttest, the control group rated themselves significantly higher than the treatment group.

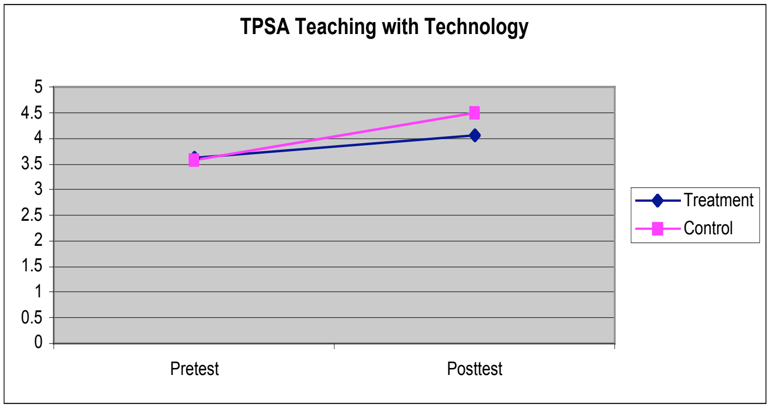

Figure 6 – Pre / Post comparisons of teaching with technology subscale

Discussion

One unexpected, universal student behavior was encountered during our baseline study that we conjecture to be unique to the 3D online learning environment. Each time the system was first demonstrated remotely to a class, the students dispersed throughout the environment to explore (learn by play) and it was very difficult to collect them back again to complete the initial training in an online mode. Because of this, we found that completing the walk-through on-line was more difficult than during a structured classroom session. Since the initial trials, we have implemented a means to globally text-chat with everyone in an area ('make announcements') in order to be able to coordinate these types of introductory sessions. We hope this will make online training sessions more easily accomplished in the future.

We also conjecture that this 'spontaneous exploration' feature of the 3D online learning environment can be harnessed to better implement underutilized forms of pedagogical practice and perhaps to create new forms of teaching/learning some day. The broad area of Discovery Learning (Bruner, 1956) and popular outside of school learning techniques such as orienteering (map-based navigation) and scavenger hunts are a few of the prospective methods that immediately come to mind. It would appear that such approaches could be implemented in a 3D online learning environment in such a way that Vygotsky's Social Context for Learning (Vygotsky, 1988) could be made available through virtual game-playing partners or groups of virtual peers. Virtual peers selected at the appropriate novice-to-expert or child-to-adult level, like chess partners at or near a player's own level of skill, might provide safe, low-cost, unique avenues for expanding the sphere of readiness referred to by Vygotsky as a learner's Zone of Proximal Development. These and other theory-based pedagogical frameworks are targeted for future research.

The selection of participants in the study was not optimal. We believe that the student populations attending each campus might be a significant factor on top of the 3D online learning environment that affected the outcomes seen in the treatment group. It is our goal in the future to ensure that we have control groups based on campus location so that we can watch this issue more closely. In the future we will need to ensure that we have at least one control group at each campus for the approach being studied so as to rule out factors related to the type of student that attends either campus.

The prolonged technical difficulties encountered at the start of the semester for the treatment group had to have an impact on student's post-tests. The technical difficulties might be enough by themselves to account for the decrease in outcomes on Accommodation (Fig 4), Computer Concern (Fig 5), and Teacher with Technology (Fig 6). Only additional research will allow us to answer this question.

Lessons Learned

The primary lessons learned during these pilot tests were in areas one might expect from new technology and doing instruction over the Internet. These lessons are relevant to any Internet-based technology:

1. Be certain to have several test sessions scheduled before actual course use so that students and instructors can feel comfortable with the technology and work the bugs out of the system.
2. For undergraduate classes, a reward system of some type (extra points) is needed to encourage the students to participate in the initial test sessions that were not directly related to course delivery. (We did not see a problem with the graduate students grasping the concept and participating early and often in the test sessions.)
3. Planning ahead and having an alternate plan and a place to post information about what was happening before and after a session is very important. This lowered student anxiety if something unexpected happened.
4. Being able to communicate to the students when there were problems such as the Internet connection on campus going down the night of two classes, an instructor missing a session because of a blackout in the Northeastern United States, or students having Internet problems could be dealt with in an efficient manner that did not distract from the course delivery.

Conclusion

While the presented research needs additional studies to provide more depth to issues discovered in this first round, we feel that these initial results show positive trends in several key issues for the use of 3D online learning environments for the delivery of college courses. The experience of this exploratory research is driving our future initiatives. The next phase of our research will be to structure the participating sections such that we have a clearer picture of changes within the treatment groups. We are very much interested in seeing where 3D online learning environments might fit between total asynchronous course delivery (web-pages) and face-to-face instruction. The course to be examined during the fall semester of 2004 will allow us to compare web-based, 3D online learning environment, and face-to-face delivery all located on the main campus. This study design should allow us to have a much clearer insight into what we saw during this initial research. Additional universities will also be using the 3D online learning environment in the coming months and data collection from those courses will be compared to this data and future data as it is collected in order to gain more insight.

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