TITLE: Innovation in Online Education: Teaching ArcObjects Online

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ABSTACT

An online course was designed to teach students the basics of customization of ArcGIS Desktop using ArcObjects and Visual Basic for Applications. Various multimedia (audio lectures, animations and interactive learning tools) were incorporated into the course to enhance learning. The course was delivered, via WebCT, to twenty-four volunteers recruited from GIS industry. All volunteers had previous programming experience, but little or no experience programming with ArcObjects. Fifteen volunteers completed or almost completed the course. Quiz and assignment marks of the volunteer students were compared to marks from a similar course delivered in face-to-face mode. Few significant differences were found, however results may not be statistically significant due to sample size and differences between the two courses. Seventeen of the volunteer online students completed a final survey. Most indicated that they were pleased with the course and felt confident continuing to work with ArcObjects on their own.

INTRODUCTION

In the autumn of 2001, while working as an instructor at the British Columbia Institute of Technology (BCIT) in the Geographic Information Systems (GIS) department, the author was informed that she would be expected to teach a course in the spring of 2002 on the customization of ESRI's ArcGIS using ArcObjects. The ESRI educational department offered face to face courses in ArcObjects, but none at a time or place that could be scheduled by the author. ESRI also has an excellent web based "Virtual Campus" with many different courses, but none on ArcObjects (ESRI Virtual Campus, 2004). A large amount of time was spent learning ArcObjects from the resources available (help documentation, ArcObjects Online) before passing the knowledge gained on to students. After the BCIT course ended, a face to face course in ArcObjects taught by ESRI was taken by the author. It was discovered that though most of what was taught to the students in the BCIT course was correct, some concepts had been misinterpreted. As well, some of the tools and resources provided by ESRI had not been used.

The moral of this story is, it would have been much better to have received instruction in ArcObjects before teaching the course! As well, without the help of a face to face instructor, more time was spent than should have been learning the software, and everything was not interpreted correctly. A web-based course in ArcObjects would have been a great resource. This led to another thought – would it be possible to teach ArcObjects effectively as an online course over the web? Were tools available that could guide a student to understanding the complex concepts of component programming with multiple interfaces? Would skills acquired online be comparable to skills acquired in a face to face environment? These questions formed the basis of a research project undertaken by the author for City University, London, England, as part of the requirements for the Master of Science in Geographic Information Degree (MGI).

THE ONLINE COURSE

The online course was designed to be delivered using WebCT, an online teaching tool used by many educational institutions (WebCT Web Page, 2004). The course would be delivered in July and August of 2003 in the form of a short pilot course to a group of volunteer students. No official course credits would be granted for completing this course and no tuition would be charged, however, BCIT allowed the use of their WebCT software for course delivery and development.

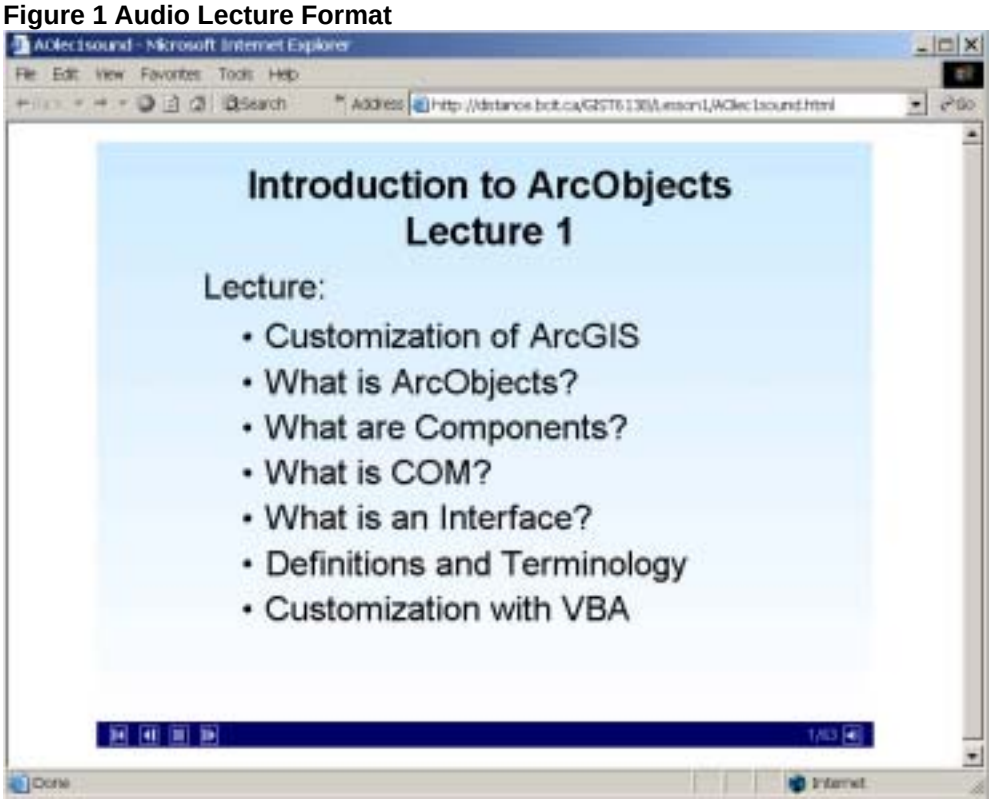
The following criteria was created for volunteer selection.

1. Course participants must have some education and experience in programming and GIS software.
2. Course participants must have a working knowledge of ArcGIS software, especially the ArcMap interface.
3. Course participants must have access to a computer running ArcGIS Desktop, Arcview level functionality.
4. The computer used by the participant must also have speakers or headphones, an up to date web browser and a high speed internet connection.
5. Course participants must be able to commit ten hours a week to working on the course.

The alumni of the BCIT GIS Advanced Diploma was judged to be a good source of student volunteers. These individuals would have the educational background needed, were familiar with the difficulty of BCIT GIS courses, and had not been taught the subject prior to 2002. In May 2003 an email was sent to these former students with details on this study and the course delivery. It was also requested that students pass on this offer to co-workers and peers in the GIS industry. In addition, the same offer was made to first year, part-time MGI students at City University. The response was very good, not only from alumni, but also from others who had heard about the offer by word of mouth or by alumni posting the offer on bulletin boards on the internet. By the end of May 2003, thirty volunteer students had been selected and had agreed to commit ten hours a week to the course, starting July 21, 2003. Due to various circumstances, the number of volunteers dropped to twenty-four by the time the course commenced. Of this group, fifteen were BCIT alumni from 1992 to 2002, eight were non-BCIT alumni GIS professionals, and one was an MGI student.

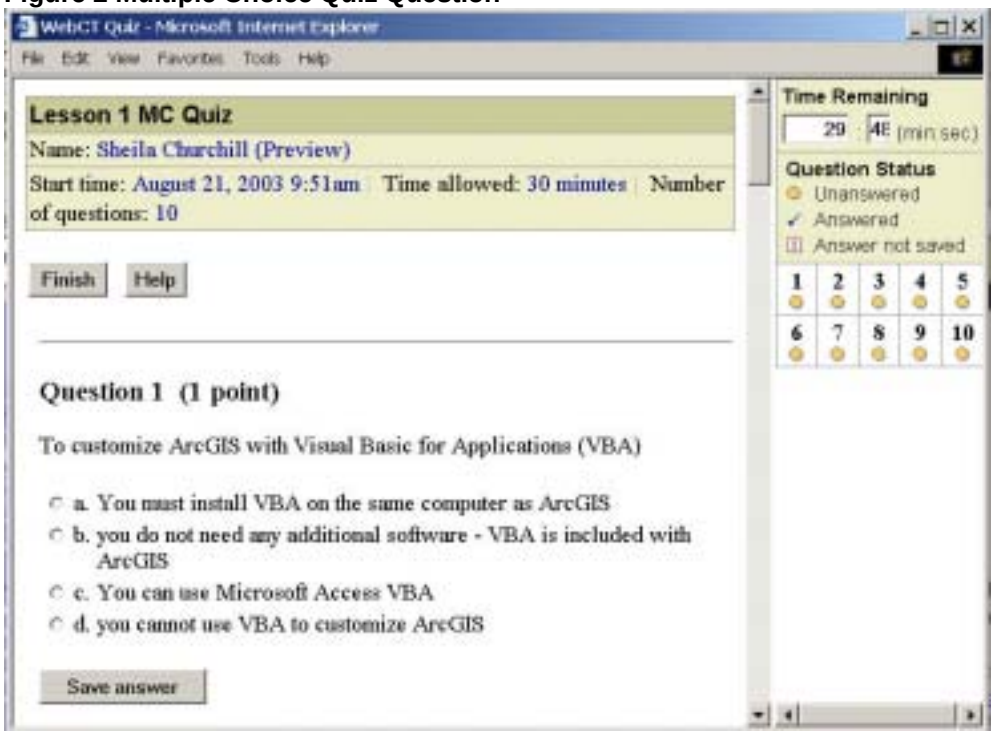
It was decided to use the same content of the GIS Advanced Diploma's GIS Customization 1 (GIST6211) course that had been taught to the BCIT students in the spring of 2003 (in face to face mode) for the pilot online course, and to divide the content of the online course into four lessons. Four lectures were created in Microsoft Power Point format, and audio was recorded for each Power Point slide in order to include as much content as the face to face lectures had contained. Impatica for Power Point was used to compress the Power Point presentations into much smaller Impatica and html files. Figure 1 shows the appearance of one of the audio lectures.

Figure 1 Audio Lecture Format



Four quizzes were created in WebCT, one for each lesson. An example of a quiz question is shown in Figure 2.

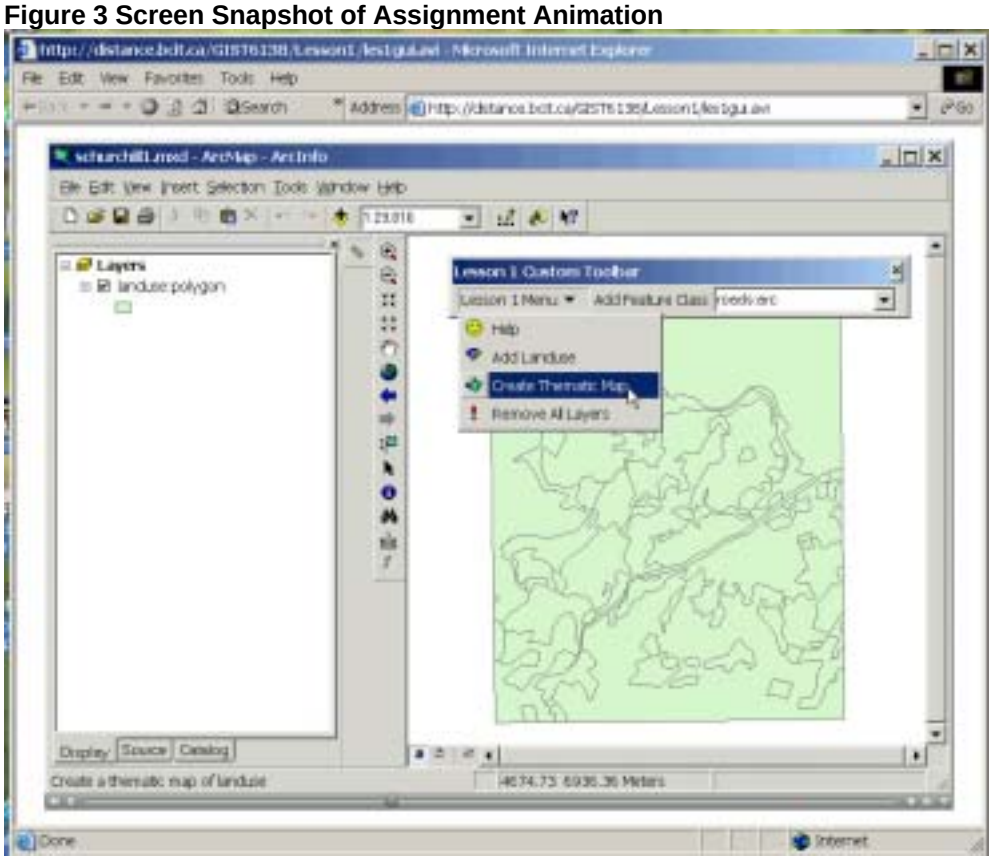
Figure 2 Multiple Choice Quiz Question



Four assignments were created, one for each lesson. The assignments progressed in difficulty from having all code supplied (easy) to having no code supplied (difficult). Animations with audio were created using Snagit 6 that demonstrated what was expected for each assignment. For each lesson, one animation demonstrated how the required task could be carried out in ArcGIS

without customisation, and the other animation demonstrated how the customisation of the task should work. A screen snapshot of an assignment animation is shown in Figure 3.

Figure 3 Screen Snapshot of Assignment Animation



One of the purposes of this study was to explore alternative methods for teaching problem solving in an online environment. A search was made on the internet for interactive learning tools, which led to the discovery of the products of Half-Baked Software (Half-Baked Software Inc., 2004). This company has created a suite of simple, interactive learning tools that are easy to create and are in html format, which is compatible with WebCT. Interactive learning tools were created using the Half-Baked Software products Hot Potatoes and Quandary. The learning tools were designed to give the students additional information and practice working with specific concepts or tasks. As well, learning tools were created from Snagit 6 software, similar to the assignment animations. Figures 4, 5 and 6 give examples of Crossword, Decision Tree and Gap Fill Learning Tools.

Figure 4 Crossword Learning Tool

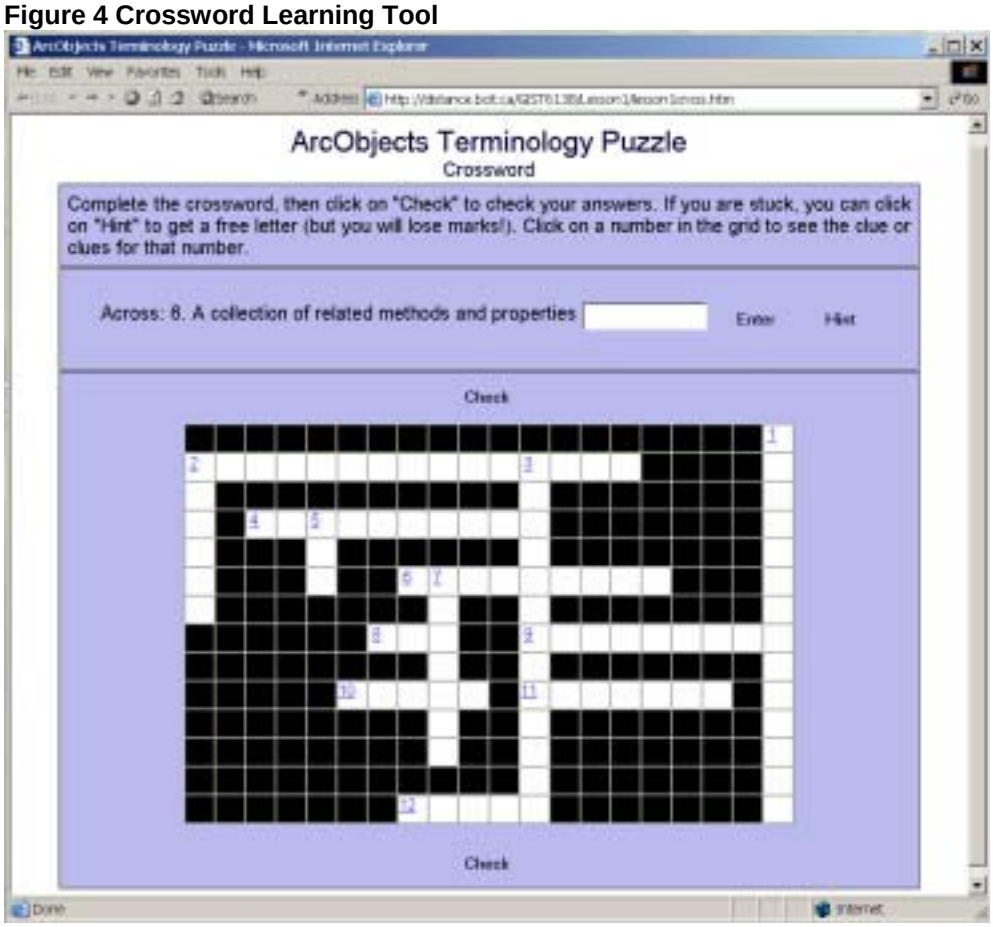


Figure 5 Decision Tree Learning Tool

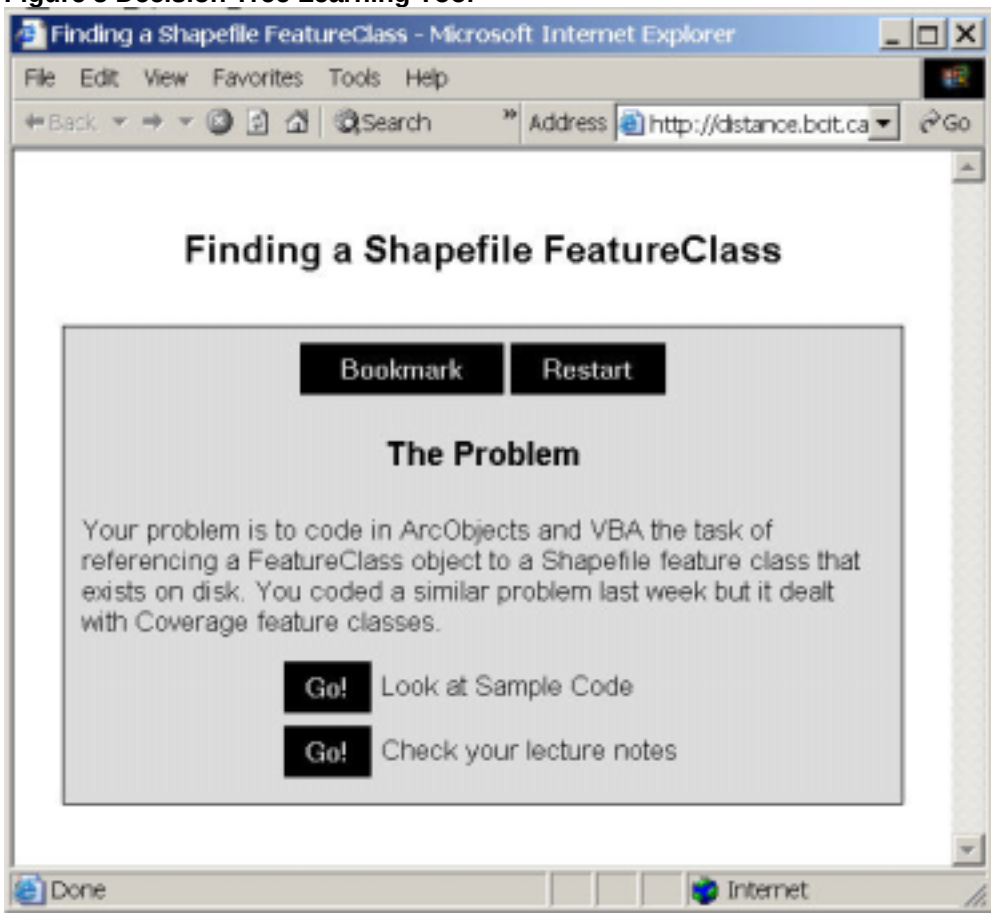
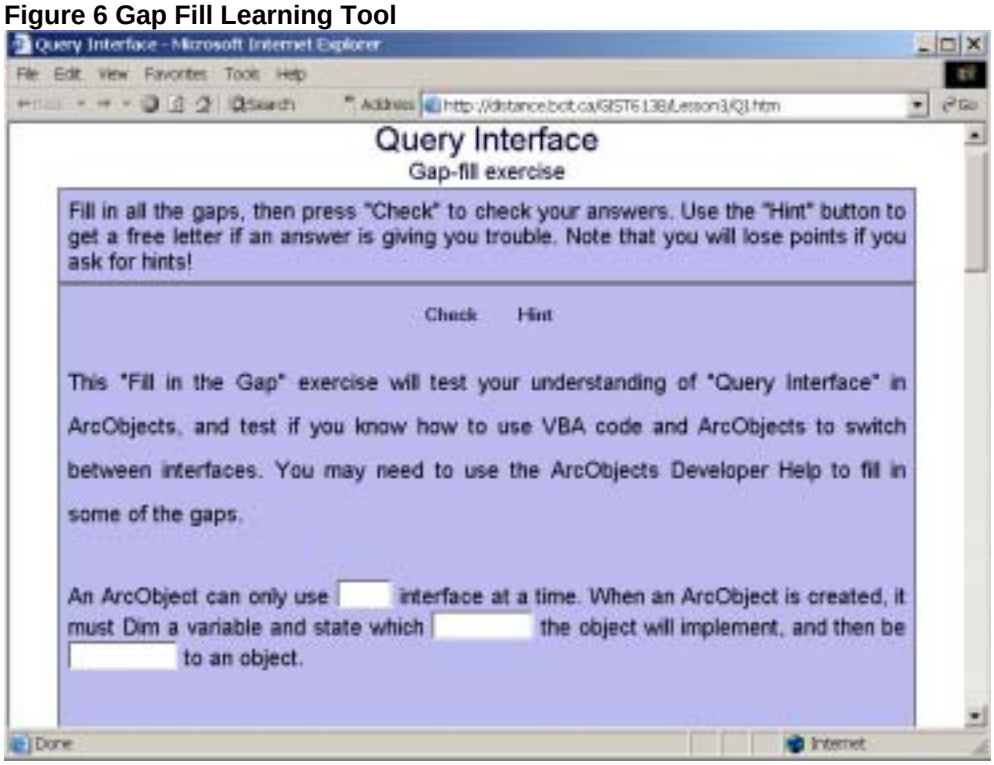
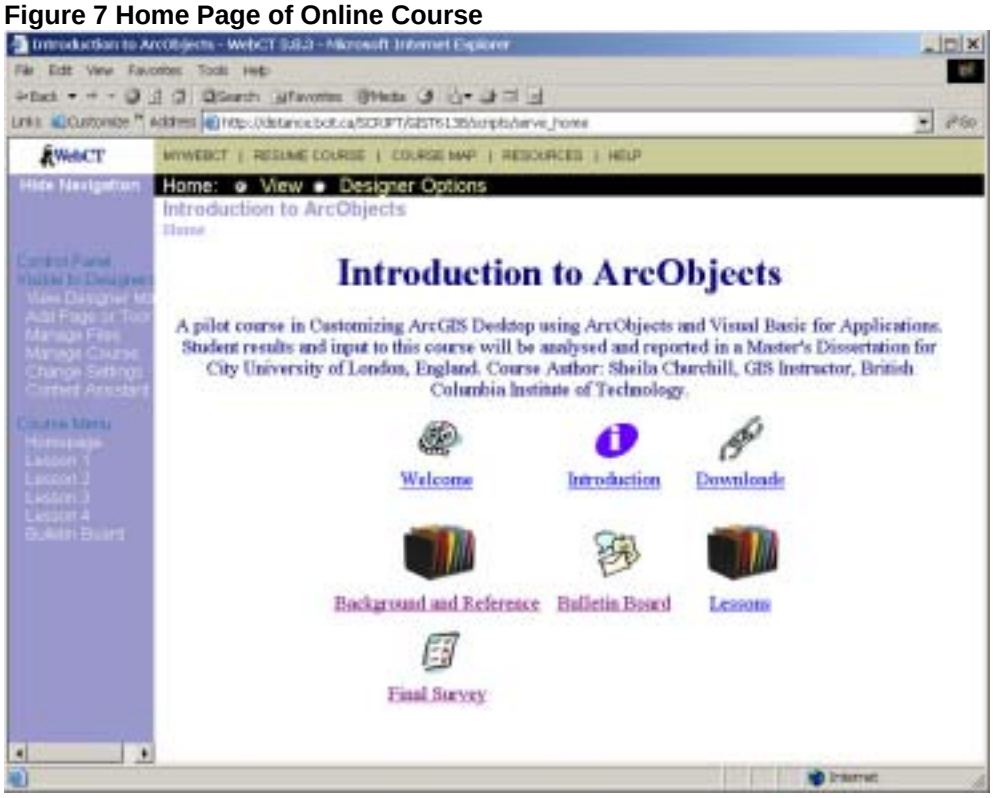


Figure 6 Gap Fill Learning Tool



A short video was created as a welcome message and converted to digital format. An “Introduction” document was created for the students, explaining how the online course worked and the order in which to undertake the various tasks. Links to internet download sites were also included for required plug-ins. The above were added to the course “Home Page” as well as links to Background and Reference, Lessons, Bulletin Board and the Final Survey. A screen snapshot of the “Home Page” is shown in Figure 7. The Background

Figure 7 Home Page of Online Course



and Reference icon led to another page which included information on working with Visual Basic for Applications, an outline of common programming problems the volunteer students might encounter, descriptions of ArcGIS data models and a list of references. This is shown in Figure 8. The Bulletin Board icon led to the Bulletin Board, where students could post messages and queries. This is shown in Figure 9.

Figure 8 Background and Reference

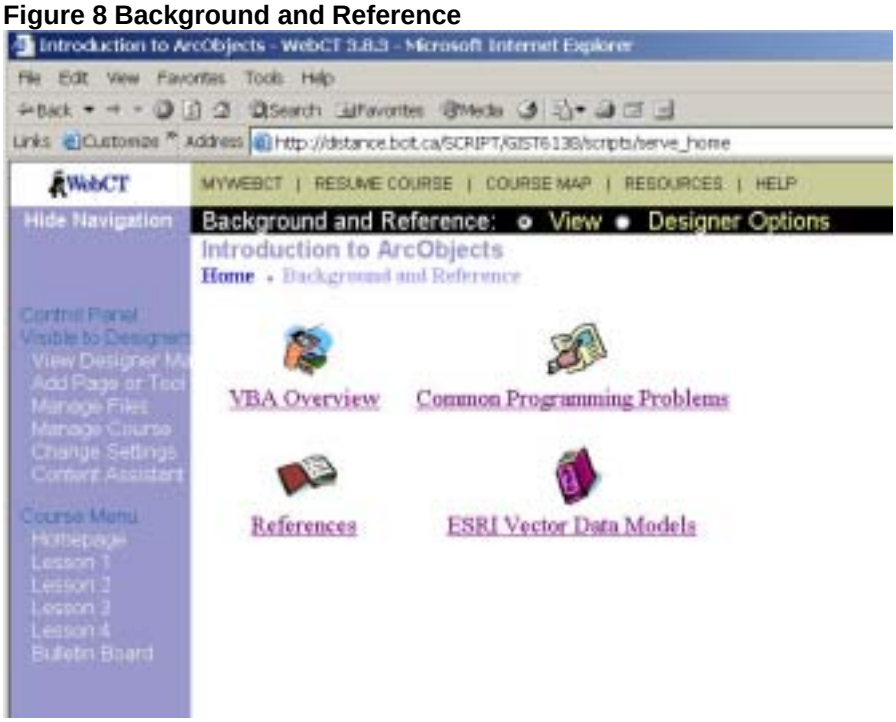
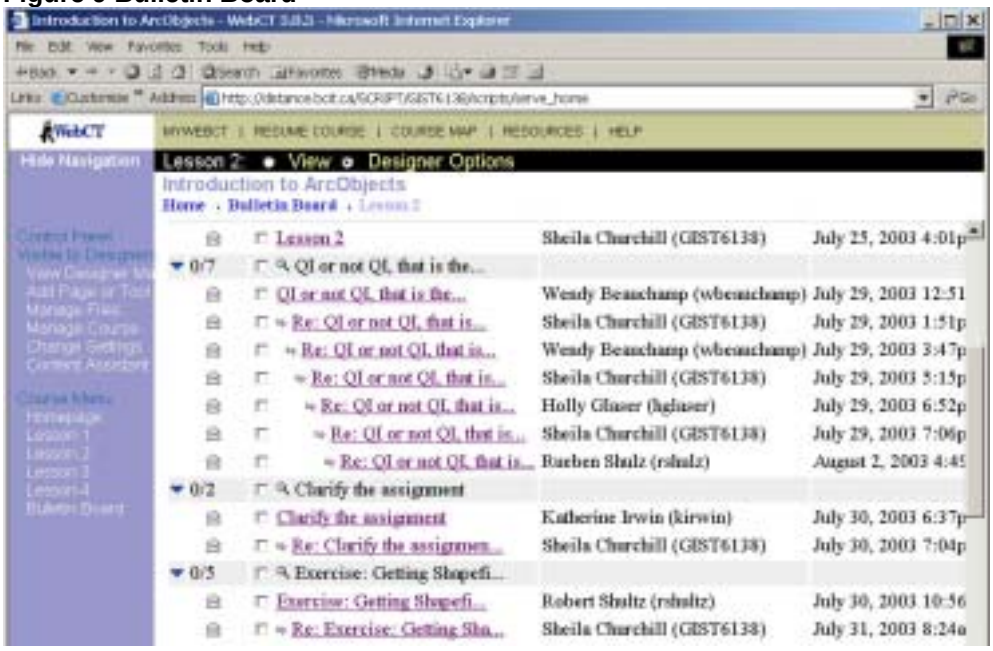


Figure 9 Bulletin Board



The Lessons icon led to an organizer page where there was an icon for each lesson. The student could also go directly to the lesson by using the Course menu on the left hand side of the web page. Each lesson page contained all the tasks for that particular lesson, including Audio Lecture, Lecture Note

Printout, Learning Tools, Assignment, Assignment Animations, Assignment Submission and Multiple Choice Quiz. Lesson 2 is shown in Figure 10.

Figure 10 Lesson 2 Page

DATA CAPTURE

Two samples were used in analysis. The first sample consisted of results of quizzes and assignments from the online course, which were collected via WebCT. The sample size was twenty-four. The selection of this sample was not random. Students who fulfilled a specific criteria were selected until a quota was filled. As well the initial recruitment of the sample (from BCIT alumni) snowballed as individuals contacted passed on information to peers. The location of the student was not a factor in their selection, and participants resided in various locations in Canada, the United States and the United Kingdom.

The second sample consisted of results from quizzes and assignments from thirty-nine students taking a face to face course (GIST6211) as part of the BCIT GIS Advanced Diploma in the spring of 2003. The selection of this sample was not random. All students enrolled in the full-time Advanced Diploma in GIS at BCIT in 2003 who had passed the prerequisite courses were required to take this course. As well, a few part-time students were also enrolled. All students attended classes in the city of Burnaby, British Columbia, Canada.

Both samples had course material delivered to them over four weeks. Online students could work on the course at any time they wished, but only had the WebCT bulletin board and email for communicating with the instructor.
Face to face students had two hours a week of lecture, two hours a week of lab and an additional three hours a week of office hours where the course instructor was available to them. All these were scheduled at specific times.

Face to face assignments were graded based on functionality, documentation, indentation, and timeliness in submittal. Students were awarded bonus marks for undertaking assignment "challenges". These bonus marks could not increase the assignment total beyond thirty marks. Online assignments were graded on functionality only. No bonus marks were awarded. Face to face multiple choice quizzes had to be completed within a certain time or a student would receive a zero grade. Online students were given time extensions to complete the quizzes. Face to face quizzes consisted of five questions chosen randomly for each student from a set of fifteen. Online quizzes consisted of the same ten questions for each student.

The face to face student results from the three quizzes of GIST6211 were chosen for comparison with the online student results of the four online course multiple choice quizzes, as they covered similar material. The face to face student results from the three assignments of GIST6211 were chosen for comparison with the online student results of the four online assignments. Three of the assignments were almost identical for the two groups, the fourth assignment given to the online students was new, but encompassed material taught to both groups.

ANALYSIS

In order to compare face to face results with quiz results from the online course, each quiz result from the face to face course had to be recalculated to be out ten marks instead of five, and the total quiz result had to be recalculated to be out of forty instead of fifteen. As well assignment results from the face to face course were recalculated to be out of forty instead of thirty marks. Once this was done, means and standard deviations were calculated for each quiz and assignment, as well as for total quizzes and assignments. This was also done for the online quiz and assignment results.

Statistical comparison of the results of the face to face and online courses was then carried out. The unrelated *t*-Test was used to discover if there was a difference between the means and variances of the two samples. The Kolmogorov-Smirnov method was used for comparing distributions of the two samples. The examples given in Kitchen & Tate (2000) were used as guides for the statistical calculations.

Results from the unrelated *t*-Test of the online and face to face quizzes are shown in Table 1. No comparison could be made with the fourth online quiz as there was no fourth face to face quiz.

Table 1 Unrelated *t*-Test Results for Quizzes

	Number of Online students	**Number of Face to face students**	**Online mean**	**Face to face mean**	***t* Critical**	***t* Calculated**
Quiz 1	21	39	7.667	8.872	1.671	2.796
Quiz 2	18	39	7.611	9.026	1.674	3.319
Quiz 3	17	39	8.647	7.590	1.674	2.550
Total Quiz	11	39	33.091	33.983	1.684	0.627

Results from the Kolmogorov-Smirnov tests of the online and face to face quizzes are shown in Table 2. Bin categories used in first three tests were 0, 1-2, 3-4, 5-6, 7-8, 9-10. Bin categories used in the last test were 21-24, 25-28, 29-32, 33-36 and 37-40.

Table 2 Kolmogorov-Smirnov Results for Quizzes

	Number of Online students	Number of Face to face students	Online mean	Face to face mean	D Critical	D Calculated
Quiz 1	21	39	7.667	8.872	0.368	0.0586
Quiz 2	18	39	7.611	9.026	0.388	0.282
Quiz 3	17	39	8.647	7.590	0.395	0.391
Total Quiz	11	39	33.091	33.983	0.464	0.203

Results from the unrelated *t*-Test of the online and face to face assignments are shown in Table 3. No comparison could be made with the fourth online assignment as there was no comparable assignment delivered to the face to face students.

Table 3 Unrelated *t*-Test Results for Assignments

	Number of Online students	Number of Face to face students	Online mean	Face to face mean	*t* Critical	*t* Calculated
Assignment 1	20	39	9.550	9.308	1.672	0.988
Assignment 2	17	39	9.118	8.590	1.674	1.444
Assignment 3	13	39	8.615	9.231	1.676	0.914
Total Assignment	9	39	37.444	36.171	1.680	1.045

Results from the Kolmogorov-Smirnov test of the online and face to face assignments are shown in Table 4. Bin categories used in first three tests were 0, 1-2, 3-4, 5-6, 7-8, 9-10. Bins used in the last test were 25-28, 29-32, 33-36 and 37-40.

Table 4 Kolmogorov-Smirnov Results for Assignments

	Number of Online students	Number of Face to face students	Online mean	Face to face mean	D Critical	D Calculated
Assignment 1	20	39	9.550	9.308	0.374	0.0282
Assignment 2	17	39	9.118	8.590	0.395	0.201
Assignment 3	13	39	8.615	9.231	0.436	0.128
Total Assignment	9	39	37.444	36.171	0.503	0.128

Due to the small sample size of the online course, the lack of randomness in the sample selection and the differences between the two courses, results from tests made comparing means and sample distributions may not be meaningful.

Results from the unrelated *t*-Tests comparing face to face quiz results and online quiz results show that there is a significant difference in means in quiz 1 and quiz 2, with the face to face course having a higher mean than the online course. For quiz 3, results of the unrelated *t*-Test also show a significant difference in the means, but the online course has a higher mean than the face to face. For the comparison of total quiz marks, the unrelated *t*-Test results show no significant difference in the means.

Several factors could cause these results. The face to face students were more accustomed to taking online quizzes, as they had encountered them in other courses. As the online students became accustomed to the quizzes their marks improved. The opportunity existed for face to face students to collaborate on quizzes. Even though they received randomly selected questions, if a few students did the quiz at the same time there would be some duplicate questions. As well, as the online course progressed, many of the volunteer students who were struggling with the course dropped out, leaving only the stronger students to complete the quizzes. The smaller group of stronger students could cause higher means, but would make the results of the test less meaningful due to decreased sample size.

Results from the Kolmogorov-Smirnov test comparing population distributions of the face to face and online courses showed no significant difference between population distributions of individual quizzes or total quiz mark. Only for quiz 3 did the value of D calculated approach the value of D critical. This result indicates that the distribution of quiz marks for each course was the same.

Unrelated *t*-Tests comparing face to face assignment marks with online assignment marks all show no significant difference in means. This was true for individual assignments as well as total assignment marks. Two factors influenced these results. The first is that, unlike face to face students, online students were not penalized for late assignments, poor indentation or lack of documentation. This would create a trend of online students having higher marks. The second is that face to face students were able to receive a great amount of assistance from their peers, the stronger students helping those who had difficulty with their assignments. This option was not available to the online students. This would create a trend of face to face students having higher marks. The possibility exists that these two factors could have cancelled each other out.

Kolmogorov-Smirnov test results of the comparison of face to face and online assignment marks all indicated that the population distributions of the two samples were not significantly different.

SURVEY RESULTS

Online course students were requested to complete a survey at the end of the course. Seventeen students completed the survey. Results of the survey showed that 47% of the students completed the course and another 41% almost completed the course. Those who almost completed the course sited lack of time as the reason for non-completion. Only one student had technical difficulties with the multimedia aspects of the course. 41% of the students found all the multimedia aspects of the course helpful, 53% found most of the multimedia aspects of the course helpful. The Crossword, the Gap Fill and the animations were found to be the most useful learning tools. 65% of the students did feel that they would have learned more taking the course in face to face mode. However, 65% of the students also felt that they had learned enough to continue with ArcObjects on their own. 94% felt that the course had delivered what was promised and 70% of the students enjoyed the course.

The final question of the online survey allowed for students to comment on the course. The comments were mainly positive and the volunteer students were appreciative of the opportunity to take the course. They liked the audio lectures and the fact that they could listen to them as many times as they wished. However, they found that trying to get to a specific slide in the lecture to listen to the audio was frustrating, as they had to click through every slide previous to it. Some students had difficulty finding time to do the course, and found work and life had priority. A couple of students had problems with programming skills, and were not sure if the problems were due to lack of information on ArcObjects, or lack of programming experience. The multimedia aspects of the course were found to be informative and enjoyable. A few students found the bulletin boards too disjointed and time consuming to use. One student found the help resources too confusing but the lectures too simplistic.

CONCLUSION

Were students able to learn ArcObjects in an online environment? For the nine volunteer students who successfully completed all assignments and quizzes of the online course the answer is yes. For the additional seven students who completed the online survey and felt that they had learned what they had expected to learn the answer is maybe. For the one student who was still completely lost, the seven students who disappeared from the course and the six students who dropped out before the course started the answer is no.

Sixteen out of seventeen students surveyed found most of or all of the multimedia portions of the course useful for learning. Comparison of quiz and assignment marks of students taking the online course to students who had taken a similar face to face course found almost no significant differences. Various factors affecting the online and face to face courses could have influenced these results.

The limiting factors of this research are the small sample sizes (especially for the online course), the fact that the two courses were not exactly the same and the circumstance that the students taking the online course were volunteers, not paying tuition or working towards course credit.

However, the results of this study are still encouraging. The volunteer students enjoyed and benefited from the course, especially the multimedia aspects of it. The final survey comments showed that students were appreciative of the fact that with an online course they could work on their own schedule and did not have to travel to a specific location at a specific time. Most of the students were confident that they could continue the learning process on their own, after being taught the basics.

In conclusion this study had demonstrated that:

1. WebCT is capable of incorporating a varied amount of multimedia into its courses.

2. Given time and access to specific hardware and software a course instructor can create interactive learning tools for an online course.

3. Students enjoy experiencing and interacting with multimedia online.

4. Students appreciate the flexibility of online courses.

5. Some students are successful at learning complex programming skills from an online course, and some are not.

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