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Research and innovation in teaching and learning are prime topics for the *Journal of Instructional Technology and Distance Learning* (ISSN 1550-6908). The Journal was initiated in January 2004 to facilitate communication and collaboration among researchers, innovators, practitioners, and administrators of education and training involving innovative technologies and/or distance learning.

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Editorial

Two Sides of a Coin

Donald G. Perrin

I have the joy of teaching a face-to-face course in *Management Science* for the California Lutheran University MBA program (CLU) and an online course in *Employee Training and Development* for University of Maryland University College (UMUC). I am interested in the way specific pedagogies developed for each course influence the other. The CLU course is a three-hour class each week for 11 weeks. The UMUC web course is 24X7 for 11 weeks in a condensed format or 15 weeks in a semester format. The content and goals of these two courses are very different.

Management Science at CLU is a core course based on mathematical decision models used in business and industry to optimize resources, save time, reduce cost, and maximize profits. Assisted by computer software, these models support complex decisions based on objectives, variables, and constraints. Nine textbook chapters provide tutorials, case studies and problems related to decision sciences, new product development, price-setting, product mix, manufacturing, transportation, scheduling, network design, simulation, and forecasting. Key elements of each chapter are demonstrated and discussed in class and assigned as homework. Evaluation includes a take-home open book mid-term and a final group or individual project presented as a live and written report.

Employee Training and Development for UMUC is an adaptation of ADDIE instructional design model (Assess, Design, Develop, Implement, Evaluate) to training in business, industry, and government. The textbook is descriptive and encyclopedic. Each chapter is a step in the ADDIE process. Practical aspects are taught and discussed online as students develop their own training programs week-by-week. Every student produces two training programs during the course and generates a third in the final proctored exam. The examination is a performance test that simulates a training request from management.

The common element in both courses is that students engage in the higher levels of learning – analysis, synthesis and evaluation – and their performance is observable and measurable. Both courses focus on development of a process or product with return on investment. The final project is part of the student's portfolio. Both courses have rubrics and performance criteria. Students do additional work until they demonstrate proficiency. Final grades are A for exemplary work or B when all requirements are met.

Different subject matter and skills require different support systems. The CLU course is quantitative analysis and decision making supported by computer software; the UMUC course is creative writing to motivate and instruct learners and achieve specified learning outcomes. The CLU text is a step-by-step development of each topic supplemented by live lecture-demonstration-discussion and tutoring; the UMUC text is a resource actualized through web tutorials, conferences, and peer learning. CLU has 15 live students per course; UMUC has 30 online. Both courses have high completion rates.

So, what is it that flows from the UMUC learning model to CLU and vice versa?

First and most important is the concept of flexibility. Flexibility in classroom learning requires knowledge of each learner's goals and what learners need to succeed. Scheduled on-campus classes are impractical for many adult learners because of time, distance, and real life demands including job, family, health problems and other crises. Many of the traditional controls imposed on adult learners are counter-productive to performance, retention, and graduation. Penalties for absence or late assignments ignore the realities of modern living.

Fear of making mistakes crimps creativity. Learning from mistakes is a legitimate way to learn. It is an important component of exploration, discovery and research. It is also an important diagnostic for prescriptive teaching and learning to meet specific learner needs.

What flows from the classroom to distance learning? It reminds us of the uniqueness and importance of every student. They entrust us to help them in their preparation for life's journey by guiding them as they develop the knowledge, skills, and aptitudes that will make them successful in their future lives.

Editor's Note: Longitudinal studies are infrequent because consistent data is seldom collected on a year-to-year basis. This study shows less than significant differences for three courses that were conducted over a 4 year period.

Longitudinal Comparison between Online and Face-to-Face Courses in an Adult Continuing Education Program

Mary Rose Grant and Heather R. Thornton

Abstract

A longitudinal study was conducted to explore differences in student perceptions between online and face-to-face courses in an undergraduate adult credit and continuing education program. Differences were assessed in the areas of Instructional Effectiveness, Course Difficulty, Course Comparability, Necessity of Prerequisites and the Perceived Quality of the Textbook. Using archival data from 58 online and face-to-face end-of-course evaluations from courses taught between 2002 and 2005, 784 student responses were collated and analyzed. Online and face-to-face classes in biology, history, theology and philosophy taught by the same discipline-prepared instructors were examined. Instructors used the same syllabi and learning objectives during this four year period. Statistical tests were used to determine whether any differences existed between online and face-to-face course ratings. Overall, results revealed that there were more differences between the years than between the course formats. This study has implications for administrators who are considering launching online courses and faculty considering transitioning courses from face-to-face to online formats.

Keywords: adult credit program, undergraduate adult education, non-traditional learners, adult online education, teaching effectiveness, online versus face-to-face, course difficulty, longitudinal, textbook use, prerequisites, online faculty, adult continuing education, baby boomers versus gen x'ers, online humanity courses

Introduction

Over the years, Web-based courses have become a viable option for adult students with demanding schedules and extracurricular obligations. Increasing availability of and enrollment in such courses presents the need for educators to determine whether these courses provide comparative learning outcomes and satisfaction levels for students as more traditional face-to-face courses (Allen & Seaman, 2006). While perceptions remain that face-to-face classes are superior to online courses in rigor, quality, achieving student learning outcomes and levels of satisfaction, online courses are gaining support (DeFleur & Adams, 2004; Enger, 2006). Online courses are demonstrating rigor and quality in development, as well as delivery and presentation of content (Allen & Seaman, 2006; Neuhauser, 2002). Veteran faculty and administrators hesitate to offer online courses and programs despite these facts and growing student interest in online formats. The fear that students will not receive the same quality of education and level of rigor as they would in traditional courses prevails in higher education arenas. These fears stem from lack of knowledge about online pedagogy and guidance in the development of online courses.

The common view that online classes do not transfer information to students as well as traditional face-to-face courses or achieve the same learning outcomes does not stand up against current research in the field (Peabody, 2001; Symonds, 2001). Researchers often compare the two course formats, either with data from students' perceptions of the course or with data on performance-based learning outcomes (i.e. grades). While such studies have been criticized for not accounting for students' individual differences, researchers have recently presented evidence that there are no differences in learning outcomes between groups when individual differences are taken into account (Liu, 2006; Thurmond, Wambach, Connors, & Frey, 2002).

Theoretical Framework

Certain theories suggest that adults may perform better in Web-based learning environments because such environments cater to their individual needs and learning preferences more so than face-to-face environments. Adult learning theory, developed by Knowles (1970), posits that adults are autonomous and self-directed individuals who prefer to participate actively and take responsibility for their own learning. Since adult learners have garnered a myriad of life experiences, learning to be effective must relate theory and concept to practical and applicable experiences outside of the classroom (e.g. the workplace). Adult learners usually have specific goals in mind when they enroll in a course, and they appreciate organization and structure in course requirements as well as presentation of course materials. Adult learners may not be interested in taking courses for the sole sake of learning but to attain goals that are tangible (e.g. career advancement and marketable skills). Finally, adult learners require respect; they bring life and work experiences to the classroom and want to be treated as co-creators or facilitators of their own learning.

Another theory that supports online learning for adults is the constructivist learning theory. Constructivism asserts that knowledge is constructed based on previous experience (Spigner-Littles & Anderson, 1999). The emphasis on experience and subjective reality is consistent with the needs of adult learners. These learners connect new learning to previous experiences, and acquire knowledge actively and internally rather than externally or passively as transmitted by an instructor. Adult learners, with life experience find it difficult to accept learning that is not authentic or experiential. It is difficult to change misperceptions or pre-conceived ideas and beliefs when new concepts are only transmitted through passive lecture with no interaction between instructor and student. Adult learners are more likely to replace old beliefs when they are allowed to construct new knowledge on their own. Therefore, courses are more effective when the instructor is a facilitator, rather than a passive transmitter of student learning (Enger, 2006; Spigner-Littles & Anderson, 1999; Wonacott, 2000). The online learning environment gives adult learners an opportunity to take on a more active role in the learning process.

In addition to the above mentioned theories, there is evidence that faculty can benefit from awareness and identification of generational learning styles. For instance, students who are in the Baby Boomer generation require and respond to different teaching strategies than do students in Generation X. Many current adult learners are Generation X'ers, while many of the faculty are Baby Boomers (Coates, 2007). Research regarding learning preferences of Generation X'ers supports the theories of adult learning and constructivism (Boomsma & Waldschmidt, 2007; Coates, 2007). For instance, members of Generation X value efficiency and tend to be independent. They want to know what their options are and what is expected of them upfront. "Generation X'ers" also value visual presentations and technology. This assessment of students aged 27 to 42 suggests that this group of individuals is able to accept, appreciate, and be successful in online learning environments (Coates, 2007).

Online Courses Open Educational Doors for Adult Learners

One primary advantage of online learning for adults with busy schedules is the flexible nature of the virtual environment (Huang, 2002; Spigner-Littles & Anderson, 1999). Learning in an any-time any-place modality accommodates the best frame of mind for learning, which is not after an eight-hour work day. Online courses open up educational possibilities for adults who otherwise might not have found the time to pursue an education. In addition, the Internet provides numerous learning resources that not only provide practical applications to learners' lives but also encourage expanded discovery and constructivist learning. Wonacott (2000) found that learners who were more computer savvy could utilize this available resource more effectively.

Evidence That Online Courses Provide a Similar Quality of Education

Evidence suggests that Web-based courses provide the same quality of education and level of student satisfaction as face-to-face courses. One such study comparing face-to-face and online graduate courses reported that, although students enrolled in face-to-face courses had higher perceptions of the instructor's overall teaching effectiveness, comparisons of student learning outcomes (i.e. grades) resulted in no significant differences between the groups for several different outcome measures (Johnson, Aragon, Shaik, & Palma-Rivas, 2000).

Neuhauser (2002) examined differences in gender, age, learning preferences and styles, media familiarity, effectiveness of tasks, course effectiveness, test grades, and final grades for online and face-to-face courses where 91% of the students were 22 years of age or older. She compared general effectiveness of online instruction to face-to-face instruction and found no significant differences between groups for any of the variables in question. Although not statistically significant, 96% of students who had taken the online course reported that the course was either as effective as or more effective for their learning than traditional face-to-face courses. She concluded that online instruction is as effective as face-to-face instruction.

In addition to evidence that no significant differences exist between online and face-to-face student learning, Liu (2005) presented evidence that content can be delivered to students in online courses as effectively, if not more effectively, as in face-to-face courses. In his study, learning outcomes were compared between graduate online and face-to-face research methods courses. Learning outcomes from chapter quizzes, final exam, essay writings, peer critiques, and group projects were investigated. Results showed that online students outperformed face-to-face students on quizzes and the final exam, implying that graduate online education can provide improved learning outcomes for students compared to the same traditional face-to-face course. These results indicate that online courses are effective and should continue to be developed.

Current Study

The current research seeks to demonstrate that students enrolled in undergraduate online courses receive the same quality of education with the same amount of rigor as they would in a traditional face-to-face course. There are few longitudinal studies that compare adult student perceptions of online and face-to-face courses in an undergraduate adult education program. This study expands on existing research by examining student perceptions about online learning in an adult undergraduate program at an urban private institution over the course of four years (Grant, 2004).

All online and face-to-face courses in this study were matched by instructor. Specifically, the face-to-face and online courses in each discipline in this study were taught by the same instructor over a four year time frame. In addition, courses were evaluated from the inception of the online course program. A literature search determined that the majority of studies in this area involve samples of traditional undergraduate or graduate students; this research utilizes a sample of undergraduate nontraditional adult students over the age of 22, with an average age of 34, that were enrolled in an adult and continuing education program.

The authors believe that there will be no significant differences between online and face-to-face student perceptions of the course, and differences that are found will indicate that students enrolled in online courses will perceive that they are receiving a higher quality of education than those enrolled in face-to-face courses.

Hypotheses

1. There will be no significant differences between ratings of Instructional Effectiveness for online and face-to-face groups across all course subjects.
2. There will be no significant differences between ratings of Course Comparability for online and face-to-face groups across all course subjects.
3. There will be no significant differences between ratings of Course Difficulty for online and face-to-face groups across all course subjects.
4. There will be no significant differences between perceived Necessity of Prerequisites for online and face-to-face groups across all course subjects.
5. There will be no significant differences between Perceived Quality of the Textbook for online and face-to-face groups across all course subjects.

Methods

Participants

Data was utilized from 806 students attending an urban private Midwestern university School for Adult and Continuing Education with an FTE of about 700 students. Evaluations were completely anonymous; therefore no demographic information was documented. On average, the school enrolls approximately 500 degree seeking adult students in online courses each year. The majority of students enrolled in online courses are female (63%) and 31% of students enrolled in online courses are African American. Responses were used from students who enrolled in either the online or face-to-face version of the following core classes: one anthropology course (n=19), eight biology courses (n=99), eleven history courses (n=105), 17 philosophy courses (n=237), and 22 theology courses (n=343) from the years 2002 to 2005. It should be noted that the online course program began in 2002.

Measure

Researchers used archival data from end-of-course evaluations submitted by students at the end of each term. Evaluation forms were distributed to students in the 7th week of the 9-week term for both online and face-to-face courses taught by the same instructor.

The evaluation instrument consisted of 20 items that assessed Instructional Effectiveness, Course Comparability, Course Difficulty, Necessity of Prerequisites, and the Perceived Quality of the Course Textbook. Factor analysis was performed on all items to obtain the following subscales: Instructional Effectiveness, Course Comparability, and Course Difficulty. Factors were extracted through varimax rotation. All subscales demonstrated sufficient reliability with alpha coefficients of 0.96, 0.89, and 0.84 respectively. Two items, one assessing *Necessity of Prerequisites* and the other assessing *Perceived Quality of Textbooks*, were analyzed individually as they did not load with other factors.

Instructional Effectiveness: This 13-item subscale measures the degree to which students believed the instructor conducted the course in the appropriate pedagogical manner. Students rated their professors based on the degree to which the instructor appeared prepared to teach the course, course delivery, and use of learning enhancement tools (e.g. educational videos); instructor characteristics like impartiality, accessibility, and responsiveness to students were also included in the subscale. Questions are presented on a 7-point Likert scale ranging from 'strongly disagree' to 'strongly agree.' Examples include "The instructor was knowledgeable in the subject area", "The instructor presented the material in an understandable manner", and "The instructor used

education technologies to enhance the learning experience." One question relating to the instructor's approachability and fairness was "I felt free to ask questions or disagree with the instructor during class."

Course Comparability: The Course Comparability subscale is composed of two items to assess the degree to which the course being evaluated ranks against other courses students have taken at the university, and how the professor rates against other professors as well. Questions included "In comparison with other college teachers, this instructor was…" and "In comparison with other college classes you have had, this class was..." Questions are on a 7-point Likert scale ranging from 'poor' to 'excellent.'

Course Difficulty- This 3-item subscale assesses the degree to which students perceived course assignments as difficult, as well as perceptions of overall course difficulty. Questions are on a 7-point Likert scale ranging from 'too easy' to 'too difficult.' Questions such as "Assignments and homework were…" and "Overall, this class was…" were included in this subscale.

Analysis

Means were calculated. Anthropology courses were excluded from further analysis due to lack of a sufficient number of online course evaluations. Philosophy evaluations for the year of 2002 were excluded from further analyses because online courses taught by the instructor of interest were not offered. In addition, face-to-face history course data from the year 2003 was excluded for the same reasons. Data was aggregated across year and category for ease of analysis. A 2-way analysis of variance (ANOVA) was used to test each course using course format (online/face-to-face) and evaluation year (2002 to 2005) as independent variables and each of the subscales and individual items as dependent variables. Significant effects were followed up with Scheffe post hoc tests.

Data from two different faculty members was used for biology courses. In addition, data was used for introductory level and advanced philosophy courses. In order to remove the effect of differences in faculty teaching styles (in biology courses) and difficulty due to course level (for philosophy courses), an analysis of covariance (ANCOVA) test was utilized. Fisher LSD post hoc tests were used to follow up significant ANCOVA results.

Results

Theology

See Table 1 for significant results. A significant main effect of year, F (3, 335) = 6.29, $p<.001$, was found for evaluations of Instructional Effectiveness (see Figure 1). Online and face-to-face students rated the course instruction as more effective in 2004 than any other year and ratings were lowest in 2003.

A significant main effect of year, F (3, 334) = 8.57, $p<.001$, was also found for both online and face-to-face evaluations of Course Comparability (see Figure 1a). Students' ratings of Course Comparability were significantly lower in 2003 than any other year. Online and face-to-face students rated Course Difficulty highest for 2002 and lowest in 2005, F (3, 335) = 3.25, $p<.05$ (see Figure 1b).

This trend may be due to the individual faculty member adapting to teaching online. In addition, teaching online may subsequently influence teaching the same course in the face-to-face format. A main effect of year, F (3, 334) = 5.28, $p<.01$ was found for the Perceived Quality of the Textbook (see Figure 1c). Students responded that the textbook was least useful in 2003. A significant format x year interaction, F (3, 334) = 4.31, $p<.01$, for the Perceived Quality of Textbook was also found (see Figure 2).

Table 1

Univariate Analysis of Variance Results Comparing Online and Face-to-face Evaluations of Theology Courses Taken From Years 2002 to 2005

Variable	Significant Effect	df	Sum of Squares	Mean Square	F
Instructional Effectiveness	Year	3	14.43	4.81	6.29***
Course Comparability	Year	3	26.52	8.84	8.57***
Course Difficulty	Year	3	5.75	1.92	3.25*
Perceived Quality of Textbook	Year	3	38.39	12.80	5.28**
	Format*Year	3	31.28	10.43	4.31**

Note. All nonsignificant results were omitted from table. See table in appendix for both significant and nonsignificant results.

* ($p < .05$) two-tailed

** ($p < .01$) two-tailed

*** ($p < .001$) two-tailed

Post hoc analysis revealed that online students rated the quality of the textbook significantly higher than face-to-face students in 2003. Textbook ratings for face-to-face classes increased the next year and were rated significantly higher than online students.

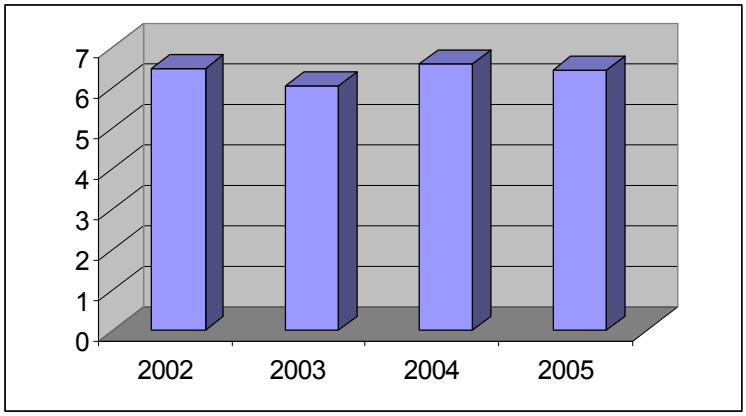

Figure 1. Instructional Effectiveness Main Effect of Year for Theology Courses

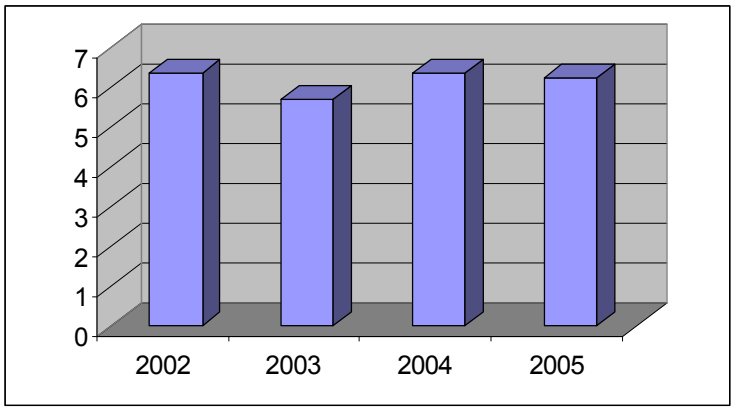

Figure 1a. Course Comparability Main Effect of Year for Theology Courses

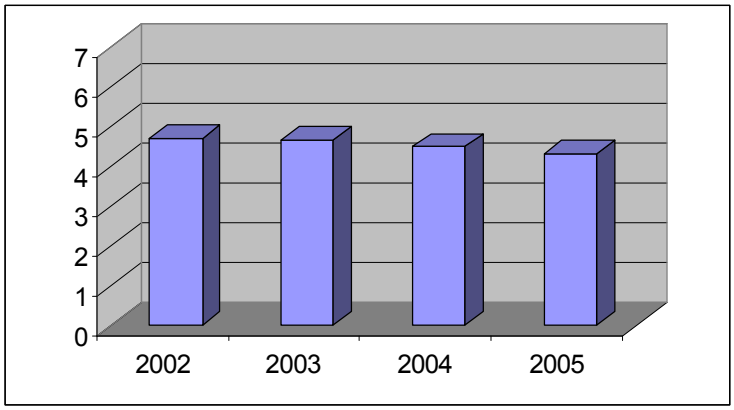

Figure 1b. Course Difficulty Main Effect of Year for Theology Courses

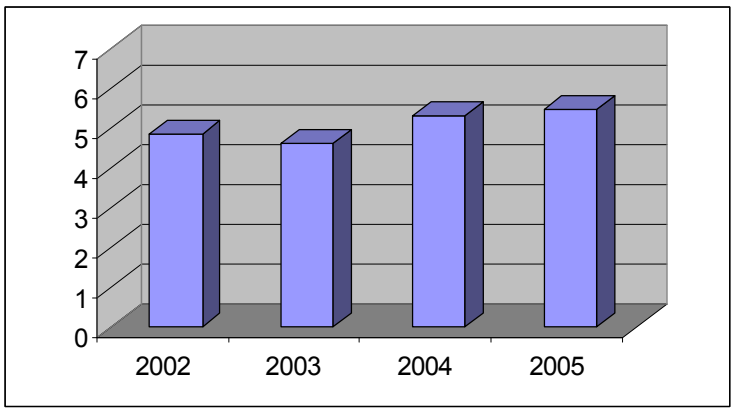

Figure 1c. Perceived Quality of Textbooks Main Effect of Year for Theology Courses

Face-to-face students rated the quality of the textbooks significantly lower in the year 2003 than both 2004 and 2005. However, online students' perceptions of the textbook remained relatively stable across the four years.

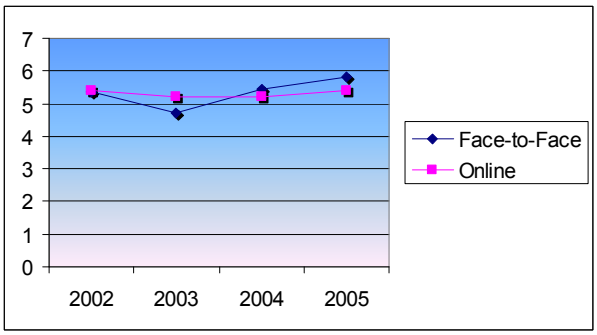

Figure 2. Format x Year Interaction Effect of Perceived Quality of Textbook for Theology Courses

Philosophy

In 2003, upper division courses were introduced in online format. When the effect of course level was removed, univariate analysis revealed a significant interaction between course format and year, F (2, 205) = 3.71, p<.05 for Course Difficulty (see Table 2 and Figure 3). In 2003, students enrolled in face-to-face courses perceived their courses as more difficult than students taking online courses. However, in 2004, online course ratings of difficulty dramatically increased above face-to-face courses. Responses shifted again in 2005 when those enrolled in online courses responded that their courses were less difficult. ANCOVA was used to adjust scores to correct for the difference between lower and upper level philosophy courses. However, other factors like individual student differences that cannot be corrected with ANCOVA may explain the increased difficulty for online students in 2003.

Table 2

Univariate Analysis of Covariance Results Comparing Online and Face-to-face Evaluations of Philosophy Courses Taken From Years 2003-2005

Variable	Significant Effect	df	Sum of Squares	Mean Square	F
Course Difficulty	Format*Year	2	5.21	2.61	5.17**

Note. All nonsignificant results were omitted from table. See table in appendix for both significant and nonsignificant results.
* (p < .05) two-tailed

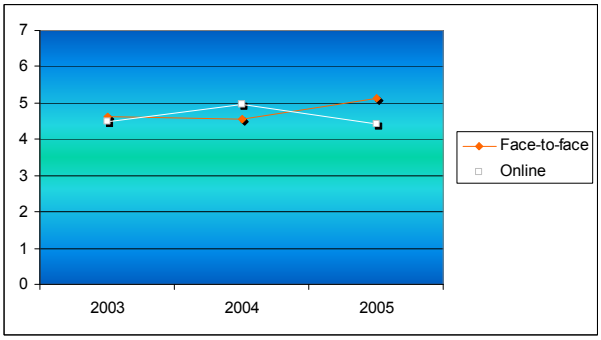

Figure 3: Format x Year Interaction Effect of Course Difficulty for Philosophy Courses

History

Face-to-face students perceived the instruction to be more effective than online students across all years (see Table 3 and Figure 4). There was a significant main effect of format for *Course Comparability*, F (1, 86) = 4.15, p<.05. Face-to-face students consistently provided higher ratings of *Course Comparability* than online students. This suggests that students enrolled in face-to-face courses rated the instruction and course as somewhat more effective than other face-to-face courses.

Table 3

Univariate Analysis of Variance Results Comparing Online and Face-to-face Evaluations of History Courses Taken From Years 2002, 2004, and 2005

Variable	Significant Effect	df	Sum of Squares	Mean Square	F
Course Comparability	Format	1	3.90	3.90	4.15*

Note. All nonsignificant results were omitted from table. See table in appendix for both significant and nonsignificant results.
* (p < .05) two-tailed
** (p < .01) two-tailed
*** (p < .001) two-tailed

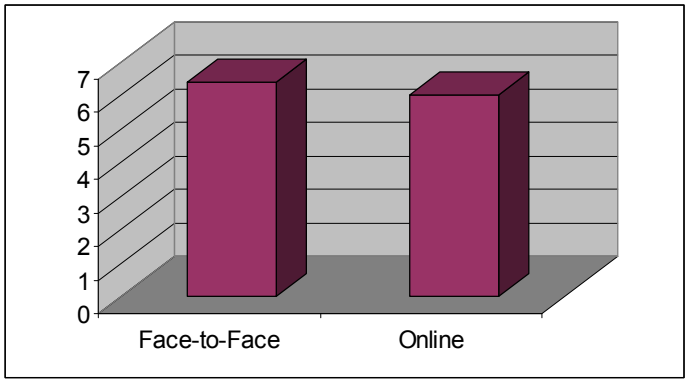

Figure 3: Course Comparability Main Effect of Format for History Courses

Biology

Table 4 shows all the significant effects for this course subject. When the effect of course instructor was removed, a significant main effect of format, F (1, 92) = 7.90, p<.01, was found for evaluations of Instructional Effectiveness (see Figure 4). Face-to-face students rated their instruction as more effective than online students.

Table 4

Univariate Analysis of Covariance Results Comparing Online and Face-to-Face Evaluations of Biology Courses taken from years 2002 to 2005

Variable	Significant Effect	df	Sum of Squares	Mean Square	F
Instructional Effectiveness	Format	1	7.03	7.03	7.90**
Course Comparability	Year	2	9.92	4.96	4.05*
	Format	1	9.65	9.65	7.88**
Course Difficulty	Format*Year	2	7.17	3.58	6.20**
Necessity of Prerequisites	Format	1	15.33	15.33	8.38**
	Format*Year	2	12.78	6.39	3.49*

Note. All nonsignificant results were omitted from table. See table in appendix for both significant and non-significant results.

* ($p < .05$) two-tailed

** ($p < .01$) two-tailed

A significant main effect of year, F (2, 92) = 4.05, p<.05, was found for evaluations of Course Comparability (see Figure 4a). Classes were rated significantly higher for the year of 2003 than any other year. A significant main effect of course format, F (1, 92) = 7.88, p<.01, was also found for Course Comparability (see Figure 4b). Face-to-face biology courses were rated more favorably than online courses when compared with other courses students had taken. Results revealed a significant format x year interaction, F (2, 92) = 6.20, p<.01, for the Course Difficulty subscale (see Figure 4c). Online courses were rated as less difficult than face-to-face courses in 2002. However, ratings shifted in 2003 when online courses were rated as more difficult than face-to-face courses. In 2004, ratings of difficulty were similar for both online and face-to-face courses. A significant main effect of course format, F (1, 76) = 8.38, p<.01, was found for the Necessity of Prerequisites variable (see Figure 4d). In online courses, students perceived prerequisites to be less important than students attending face-to-face courses. A significant format x year interaction, F (2, 76) = 3.49, p<.05, was found for the Necessity of Prerequisites variable (see Figure 4e).

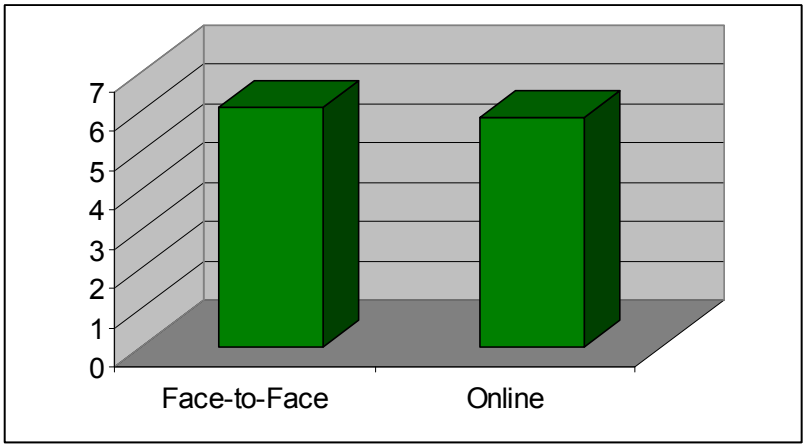

Figure 4: Instructional Effectiveness Main Effect of Format for Biology Courses

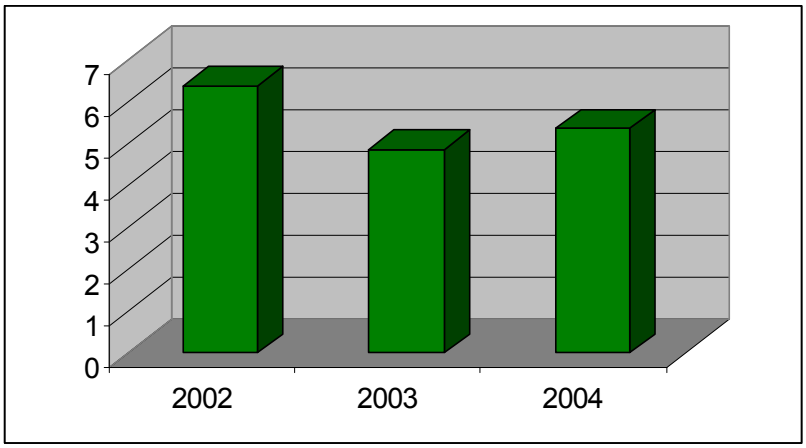

Figure 4a: Course Comparability Main Effect of Year for Biology Courses

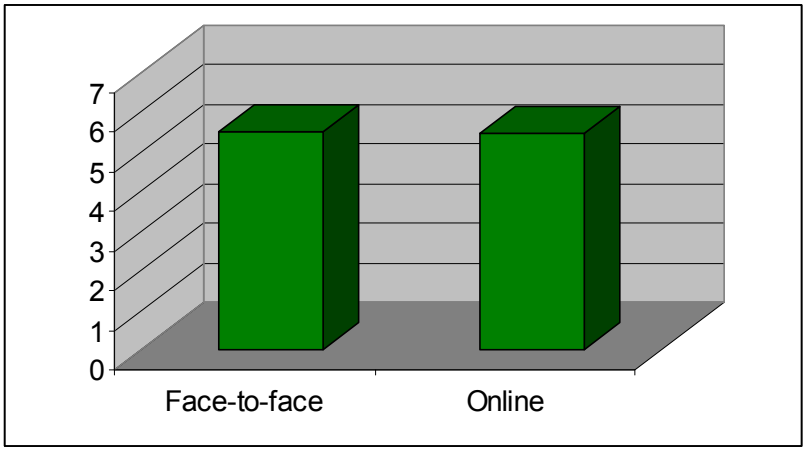

Figure 4b: Course Comparability Main Effect of Format for Biology Courses

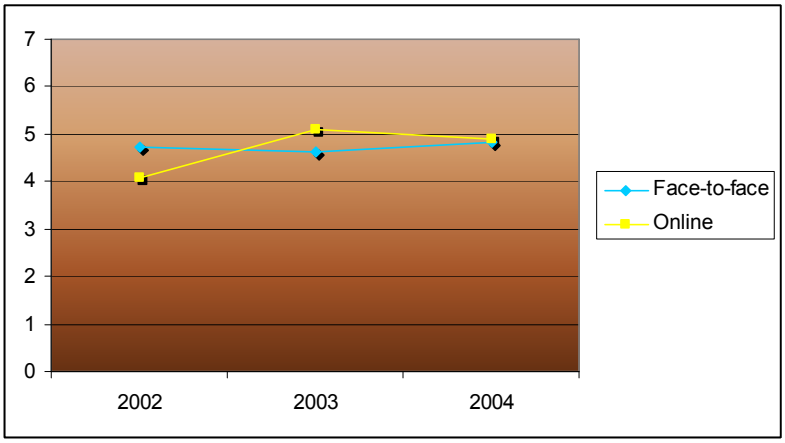

Figure 4c: Course Difficulty Format x Year Interaction Effect for Biology Courses

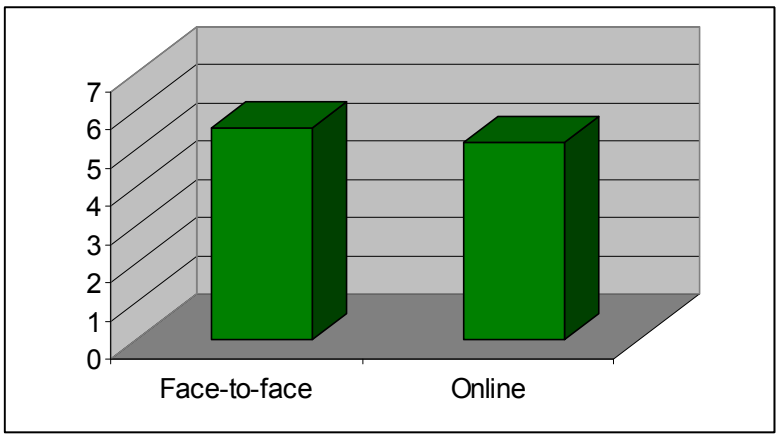

Figure 4d: Necessity of Prerequisites Main Effect of Format for Biology Courses

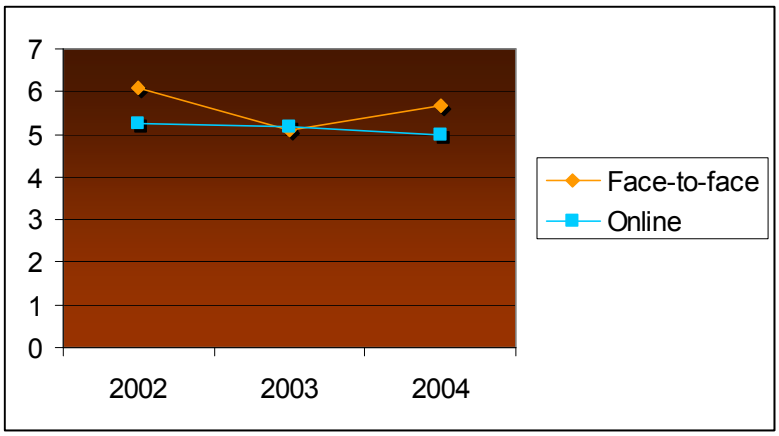

Figure 4e: Necessity of Prerequisites Format x Year Interaction Effect for Biology Courses

Discussion

Instructional Effectiveness

The proposed hypothesis stated that there would be no significant differences between rating of Instructional Effectiveness for online and face-to-face students across all subjects. Overall, results confirmed this hypothesis. Students in both online and face-to-face courses did not perceive a significant difference in Instructional Effectiveness for theology, history and philosophy. No significant differences in online and face-to-face course ratings of Instructional Effectiveness were found in these courses. This indicates that students in face-to-face and online courses perceived that they were receiving adequate and effective instruction in their respective courses. This also indicates that effective teaching cuts across both mediums. The instructors selected to teach had never taught online before the beginning of the program, but were instructors who consistently received higher student ratings in face-to-face courses. Since additional instructors were introduced to the online and face-to-face course environments in 2003, ANCOVA was utilized to remove the effect of differences in teaching styles. However, for biology courses, findings indicated that students enrolled in face-to-face courses perceived the instructional effectiveness to be higher than those enrolled in online courses. This may be due to the content laden nature of biology courses.

In addition, ratings varied across years for those in theology courses. This fluctuation may be due to the effect of the preparation and adjustment period for developing the instructor's interface when transitioning from teaching exclusively face-to-face to online.

Course Comparability

The proposed hypothesis stated that there would be no significant differences for ratings of the course and instructor for online and face-to-face formats when compared to similar courses students had completed. No significant differences were found for theology, history, and philosophy courses when students were asked to rate how the course in which they were enrolled compared to other courses they had taken. Specifically, online courses were perceived as similar to other online courses and face-to-face courses were rated similarly to other face-to-face courses. In addition, face-to-face courses were not rated as poor or excellent when compared to online courses. This trend suggests that course experience is consistent over time. This includes online course instruction.

However, this trend is somewhat different for evaluations of history and biology courses. When comparing both history and biology courses to those previously taken, face-to-face students rated their current course as much better than previous courses. These results disconfirmed the second hypothesis. Students enrolled in biology and history face-to-face course formats rated their class as excellent compared to other courses they had taken in the past. This may be due to enhanced instruction and increased quality of content in face-to-face courses as a result of teaching the same course online. However, online students reported that their biology and history courses were only slightly better than other online courses. This may suggest that the instruction in online courses is consistent across disciplines since instructors were given similar training for online course development and delivery. Some fluctuations in Course Comparability ratings from 2002 to 2004 for both online and face-to-face courses did occur. While theology courses received the lowest comparability ratings in 2003, biology courses received the highest ratings compared to other courses in 2003. This may be due to student preferences for humanities versus science courses.

Course Difficulty

The third hypothesis stated that there would be no significant differences between online and face-to-face ratings of Course Difficulty. There were no significant differences found between online and face-to-face ratings of Course Difficulty for theology, history, and biology, and history courses. Both online and face-to-face courses were viewed as similarly difficult. However, philosophy courses received different ratings. Although, philosophy ratings of Course Difficulty did fluctuate from 2003 to 2005 for both face-to-face and online philosophy courses, no other significant relationships were found for this variable. This indicates that there were no significant differences for difficulty level between face-to-face and online courses.

Perceived Necessity of Prerequisites

The fourth hypothesis stated that there would be no significant differences between online and face-to-face students for the perceived necessity of prerequisites. Overall, results confirmed this hypothesis. This variable yielded no significant differences for all courses. Prerequisites were equally necessary for all online and face-to-face courses. However, when the year was taken into account, ratings changed for online and face-to-face courses. Differences were found for biology courses. Responses fluctuated from year to year for face-to-face and online courses. In addition, students enrolled in face-to-face courses responded that the prerequisite for the current course was useful. Also, face-to-face student's ratings were higher than those enrolled in online courses. This may indicate that online students may have a perception that their core courses are disconnected from an overall curriculum plan. In addition, this result may speak to the availability of supplemental resources found on the internet. Online students may be exposed to more resources initially as well as throughout the course. Students in online courses often are required to conduct Internet searches and obtain additional course information outside of the materials provided.

Perceived Quality of the Course Textbook

There were no significant differences between online and face-to-face courses for the Perceived Quality of the Textbook across all course subjects except biology. The textbook was rated least useful for both online and face-to-face courses in 2003. This, too, may result from availability of online resources. This confirms the fifth hypothesis and indicates that there were no significant differences in the perceived quality of the textbooks between online and face-to-face courses. This suggests that a textbook in online courses is used equally as much as in face-to-face courses, if not more.

Study Limitations and Future Directions

Although some limitations exist, as mentioned below, the current study is valuable for its longitudinal nature, inclusion of data from multiple course disciplines, and study of undergraduate adult learners. Since researchers used archival data from end of course evaluations, the data set was independent of this study and therefore unbiased by the authors' perceptions. Unfortunately, certain variables could not be controlled or results further investigated. Researchers used ANCOVA to correct this where appropriate. However, student variability could not be assessed because specific demographic information was not gathered. More information should be added to the end of course evaluation instrument. As in any longitudinal study, the data set will continue to expand. The inclusion of new data and the periodic recalibration of the study should allow us to refine our results and focus only on the significant differences between online and face-to-face delivery systems.

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Appendix

Table 5A

Univariate Analysis of Variance Results Comparing Online and Face-to-face *Evaluations of Courses Taken From Years 2002 to 2005*

Course	Variables	Effects	df	Sum of Squares	Mean Square	F
Theology						
	Instructional Effectiveness	Format	1	0.00	0.00	0.00
		Year	3	14.43	4.81	6.29***
		Format*Year	3	2.00	0.67	0.87
	Course Comparability	Format	1	0.37	0.37	0.36
		Year	3	26.52	8.84	8.57***
		Format*Year	3	0.97	0.33	0.32
	Course Difficulty	Format	1	0.93	0.93	1.57
		Year	3	5.75	1.92	3.25*
		Format*Year	3	2.22	0.74	1.25
	Perceived Quality of Textbook	Format	1	0.95	0.95	0.39
		Year	3	38.39	12.80	5.28**
		Format*Year	3	31.28	10.43	4.31**
	Perceived Necessity of Prerequisites	Format	1	0.55	0.55	0.20
		Year	3	0.31	0.10	0.04
		Format*Year	3	15.01	5.00	1.79
History						
	Instructional Effectiveness	Format	1	1.39	1.39	3.82
		Year	2	0.11	0.06	0.15
		Format*Year	2	1.38	0.69	1.90
	Course Comparability	Format	1	3.90	3.90	4.15*
		Year	2	0.07	0.04	0.04
		Format*Year	2	1.01	0.50	0.54
	Course Difficulty	Format	1	2.92	2.92	3.86
		Year	2	0.22	0.11	0.15
		Format*Year	2	3.94	1.97	2.61
	Perceived Quality of Textbook	Format	1	1.67	1.67	1.02
		Year	2	0.35	0.18	0.11
		Format*Year	2	5.49	2.75	1.67
	Perceived Necessity of Prerequisites	Format	1	0.11	0.11	0.05
		Year	2	0.15	0.08	0.04
		Format*Year	2	10.48	5.24	2.41

* (p<.05) two-tailed ** (p<.01) two-tailed *** (p<.001) two-tailed

Table 6

Univariate Analysis of Covariance Results Comparing Online and Face-to-Face Evaluations of Courses Taken From Years 2002 to 2005

Course	Variables	Effects	df	Sum of Squares	Mean Square	F
Biology						
	Instructional Effectiveness	Format	1	7.03	7.03	7.90**
		Year	2	4.61	2.30	2.59
		Format*Year	2	3.22	1.61	1.81
	Course Comparability	Format	1	9.65	9.65	7.88**
		Year	2	9.92	4.96	4.05*
		Format*Year	2	6.90	3.45	2.82
	Course Difficulty	Format	1	0.76	0.76	1.31
		Year	2	1.54	.77	1.33
		Format*Year	2	7.17	3.58	6.20**
	Perceived Quality of Textbook	Format	1	5.67	5.67	3.20
		Year	2	9.94	4.97	2.80
		Format*Year	2	9.33	4.66	2.63
	Perceived Necessity of Prerequisites	Format	1	15.33	15.33	8.38**
		Year	2	8.39	4.19	2.29
		Format*Year	2	12.78	6.39	3.49*
Philosophy						
	Instructional Effectiveness	Format	1	1.42	1.42	1.20
		Year	2	3.95	1.98	0.19
		Format*Year	2	2.51	1.25	1.06
	Course Comparability	Format	1	2.36	2.36	1.31
		Year	2	9.19	4.59	2.54
		Format*Year	2	0.40	0.20	0.11
	Course Difficulty	Format	1	0.11	0.11	0.22
		Year	2	1.32	0.66	1.31
		Format*Year	2	5.21	2.61	5.17**
	Perceived Quality of Textbook	Format	1	4.13	4.13	1.52
		Year	2	4.01	2.00	0.74
		Format*Year	2	3.03	1.52	0.56
	Perceived Necessity of Prerequisites	Format	1	2.46	2.46	0.85
		Year	2	5.05	2.52	0.87
		Format*Year	2	7.73	3.86	1.34

* ($p < .05$) two-tailed ** ($p < .01$) two-tailed *** ($p < .001$) two-tailed

Editor's Note: This paper deals with multiple challenges - integration of online and traditional library services, providing equivalent levels of service for online learners, and accomplishing this quickly with limited budgets. It reviews what other libraries are doing or have already done to meet these challenges.

Delivering Library Services to Distance Learners: A Grass Roots Effort at a Regional Campus

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Abstract

Purdue University Calumet (PUC), a regional campus in northwest Indiana, serves over 9,500 students. Though over 8,000 students currently use the University's course management system for online education, the PUC Library faces many challenges in providing necessary resources and services to distance learners. In 2006, new Library Faculty began integrating online library services through a 'grass roots' effort at a course and faculty level which is described in this paper. PUC Librarians must overcome the challenge of limited budgets, experience, infrastructure, technology knowledge, time and campus culture in order to deliver library services equitably to both on-campus and online learners.

Keywords: Course management systems, distance education, distance learning, library services, library instruction, online instruction, instructional technology

Introduction

Libraries have been delivering services to distance learners and remote users for over a century. Evidence of this dates back to 1892, when, as Moyo (2003) claims, Penn State became one of the first universities to offer correspondence study to rural students (p. 282). From those humble beginnings, many institutions of higher learning have provided programs to accommodate nontraditional learners and continue to improve programs each year. In fact, a national study conducted by the U.S. Department of Education, National Center for Education Statistics, (2003, p. iii) reported 2,320, or 56% of all 2-year and 4-year Title IV-eligible, degree granting institutions, offered distance education courses.

At Purdue University Calumet (PUC), the number of courses using course management software to provide online learning has increased from 226 in the Spring semester of 2005 to 685 in the Fall semester of 2007. The number of students engaged in some aspect of online learning in one or more courses through course management software has increased in that same time period from 3,723 to 8,000. A critical component of distance education is the services provided by university libraries. Whether that involvement takes the form of library components in course management programs for students enrolled in online education courses or the form of online services to all students whether enrolled as a distance learner or not, a responsibility of academic libraries is to provide the same services to distance learners as it provides to those who come to campus to learn.

However, that provided service does not always occur easily or efficiently. Often the technology available and the services provided do not match. This may result from lack of resources - money, time or personnel. Another problem, providing needed online services, can be due to resistance to change. It is necessary to adapt to a changing student body demographic that searches online for information whether out of necessity as part of an online educational experience or because "Googling" has become their standard means of accessing information. Students new to a

university may no longer ask "where's the library?" and search for a physical library services building. Instead they may be searching for library services with the click of a mouse.

University libraries need to deliver services by means which meet the needs of the students. As Wittkopt (2003) suggests, library courses should provide students with a set of library skills including how to effectively use the research process (p.18). More importantly, the academic library needs to be accessible to the students so they can approach the learning experience with academic rigor. For example, librarians and professors want PUC students to be able to use library services appropriately, have skill in searching academic databases for information, be able to access information when needed, and be able to judge the credibility of information they find. de Jong and Branch (2005) express concern over results of studies that indicate that distance students do not take "full advantage of library services provided by their institutions –they rely on other less credible, resources of information" (p. 66). Thus, the need for library orientation and library utilization is just as critical for distance learners as it is for traditional on-campus students.

This article addresses the issues involved in delivering library services to distance learners by examining how these library services have been traditionally delivered and how services can be provided in the online environment. This article also provides a case study of development of a 'grass roots' effort to bring academic library services to distance learners.

Providing Traditional Library Services in an Online Format

To place the "new" role of librarians in the distance learning environment in context, it is vital to delineate the role librarians have played in providing educational support for instruction. Traditionally, librarians have been responsible for providing reference services to students, faculty and staff on campuses, building the library collections to support curriculum objectives of degree programs; serving as custodians for archival materials; enhancing access to materials through Interlibrary Loan, and increasing effective use of libraries through bibliographic instruction. An example of traditional delivery of library services is the information literacy session that plays a major part of the library experience for a college student.

In a PUC information literacy session, professors devote one of their class periods to library instruction. Usually, they call their specialist/library liaison and set up a day for their class visit. Library instruction, or information literacy, is vital to the retention of students. Library instructional sessions familiarize students with the Library and educate students on how to strategically search databases and electronic journals. When a student completes these sessions, the Library won't be a daunting and unknown place.

PUC students meet in the electronic classroom in the Library for a three-part instructional session that consists of a lecture, Library tour, and one-on-one assistance from the librarian. Instructional sessions introduce students to the electronic catalog, electronic databases and journals, and the physical layout of the library via a walking tour. Students are encouraged to work on computers in the classroom after the lecture. The librarian canvases the room for people in need of help and conducts one-on-one instruction. Students are introduced to Boolean operators, wild card and truncated searches, and learn how to differentiate between scholarly, consumer and trade publications. For some sessions, the librarian will bring in samples of periodicals in different formats such as microfilm and bound and unbound periodicals. She/he may demonstrate other items from the Library's collection, such as monographs, serials, and media and material from Archives or Special Collections. This gives the students an overview and hands-on experience.

Often a Library scavenger hunt is given which challenges the student to search for specific titles, types of material and electronic entries in the Library. This familiarizes students with the Library and teaches them how to use the databases and electronic catalog. The professor may use these scavenger hunts as a graded exercise. Some offer it as extra credit.

These sessions have proven to be very effective in making the incoming students familiar with the Library and the surrounding campus community.

Another way to deliver library instruction and information literacy training to PUC students is a classroom visit by the librarian. This is not as effective for new users because there is no physical tour of the library. This type of session is effective for showing the home page and navigating various databases, electronic journals, and the electronic catalog. Many professors prefer a librarian class visit because the visits are shorter (usually one-half hour) and leave time for the professor to lecture and assign work.

In this example, while labor intensive, the librarian is fairly passive. They wait for an information seeker - student or faculty - to come to them for assistance rather than going out and actively disseminating information. Anhang and Coffman (2002) claim that with distance learners, it is imperative that the once passive librarian take information out to the user (p. 51). Distance education has not required a shift in the mission of an academic library, but a shift in how that mission is accomplished. As more and more academic libraries respond to the challenges of distance education, the roles and responsibilities of academic librarians are changing. Sacchanand (2002) suggests he perception of librarians as *information prov*iders should be changed to *facilitators of learning*.

Librarians may also need to change their perception of library services. According to the year 2000 ACRL Library Trends, libraries are required to provide "equivalent resources to distance learners as they do to traditional learners." But who are those distance learners and what are their needs, particularly when it comes to library services?

Barron (2002) argues that libraries are in the business of helping students get information they need "when they want it" and get it to them regardless of where they are physically located (p. 26). Providing service to traditional library users can be somewhat different to providing the same service to distance learners. Burgstahler (2002) identifies the importance of ensuring access to everyone. Students who are employed and attending school part- or full-time, raising a family, returning to education, attempting to apply learning to career or personal needs, restricted by time and distance in completing coursework, and having out-of-date library skills, are students who match the description of distance learners provided by Alexander Slade as cited by de Jong and Branch (2005, p. 65). These characteristics can also influence whether distance learners make use of the library services provided for them (de Jong & Branch, 2005, p.65).

Additionally, many distance learners are also nontraditional students. According to a 2002 National Center for Education Statistics study, nearly three-quarters of all undergraduates are in some way "nontraditional." These students need to use the library and require the same services as traditional students. Many nontraditional students work full time, are single parents, and are returning to school after a long pause. Some have never attended college before. Many are computer illiterate. If they are distance learners, they may never have set foot in an academic library or have not done so in many years.

Nontraditional students may not be able to devote as much time to their studies as traditional students, therefore, when they visit the library, or see a 20 minute podcast of a virtual library tour; they need it to be worth their precious time. They need to learn as efficiently as possible. They may need to revisit the library physically or virtually more than once before they find what they need or are able to navigate in a website or database Whatley (2006) identifies, "expectations that adult learners have for their educations have big implications for how libraries present instruction to these students" (p.100). It is important that librarians consider this type of student when designing web pages, podcasts or planning an instructional session.

Popovich and Neel (2005) report results of a study that illustrates how respondents ranked general reference information, commercial database searching, orientation to research strategies and use of the Internet as services provided by a librarian in distance education programs (p.237). These are important library services however they are delivered.

The initial reference interview is very important when trying to assist patrons. When done face-to-face with the traditional patron in the library, a librarian can ask direct questions, narrowing down the topic and getting to the bottom of what the person really is seeking. Trying to do a reference interview for a distance learner is more difficult. Some solutions to this problem would be chat rooms, Instant Messaging, or a 24/7 reference exchange service with other libraries. Roccos (2001) suggests that libraries can provide good interactive service through web portals or online courseware. Many libraries are combining or blending services so that when libraries are closed, libraries that are open that can provide phone or online reference service to patrons. It is important to realize, as de Jong and Branch (2005) point out, that "providing distance learners access to scholarly resources does not always translate into use of those resources" (p. 64).

Providing bibliographic or information literacy instruction to a distance learner can be more challenging than for someone who was able to come to an instructional session in the library. Those who are able to visit will benefit from a physical tour, hands-on practice with databases and electronic resources, and asking questions of the librarian. Distance learners may benefit from library components added to course management packages such as WebCT or Blackboard. Rieger (2004) provides information about linking course websites to library collections and services. Another effective tool is a virtual library tour conducted by a librarian via podcast or webinar. This would allow distance learners to experience the library without having to enter the building. Hahn and Lehman (2005) provide information on development of a "distance-delivered, for credit library and information literacy course" tailored to the needs of their students, most of whom will "never be on any of the campuses to receive face-to-face instruction" (p. 17).

Interlibrary Loan and document delivery can be a challenge for the distance learner. Many libraries rely on Interlibrary Loan to supplement or enhance their collections. Providing electronic journal articles to distance learners is not difficult compared to delivering paper resources. Many academic libraries do not have financial or human resources to provide remote delivery of paper documents. On the same note, most distance users don't have the time or means to come to the library to study or to physically pick up materials. A courier would help, but this would require more funding, processing and administrative work for the library and added insurance liability.

E-books are an option where funding is available to purchase ebooks or to scan books or excerpts to be sent to remote users.

Many challenges arise as we consider delivering library services to distance learners. We know that "keeping in contact with distance students is critical to their success" (Hahn & Lehman, 2005, p. 19). Resources such as the ethical framework for provision of library services to distance learners developed by Needham and Johnson (2007) and the model of assessment of library resources and services provided by Jerabek, McMain, Hardenbrook and Kordinak (2006) are invaluable for programs in development phases. Many library systems are light years ahead of us in providing services to distance learners. Yet, we know that other institutions face many of the same challenges and are struggling to make library services equitable for both on-campus and online students.

In the following section, we present a case study illustrating how some of these challenges have been faced.

A Case Study

Despite recognition of a need to provide quality library services to all students whether they receive education in a traditional classroom or in a virtual classroom, not all academic libraries have been able to meet these needs in a timely fashion. Many libraries, faced with an increasing student population in distance learning, developed library services as an online library course like one developed by Regent University (Lee & Yaegle, 2005). Still others developed programs to integrate online classrooms as in the Houston Community College System (Drumm & Havens, 2005). While many campuses are on the leading edge of administering online delivery of library services, others like PUC may be struggling to incorporate library services into distance learning. It is valuable to read about highly advanced programs; it is just as valuable to find a way to deliver library services. This has truly taken the format of a 'grass roots' program and may be useful for other university libraries in similar situations.

Getting on Track with Distance Learning at Purdue University Calumet

Though the Guidelines for Distance Learning Library Services were approved by the Association of College & Research Libraries (ACRL) in June of 2004, they have not fully trickled down into the daily operation of the PUC Library. According to the ACRL guidelines, "Members of the distance learning community are entitled to library services and resources equivalent to those provided for students and faculty in traditional campus settings." With that in mind, PUC set out to improve the Library's reach to distance learning and on-campus students by developing a presence within the University's course management software.

PUC Library

PUC is part of the statewide five campus Purdue University system. Located in northwest Indiana, 120 miles from Purdue's main West Lafayette campus and 25 miles from downtown Chicago, the campus offers associate, baccalaureate and master's degrees in over 100 areas of study. Nearly 93% of over 9,300 students in the program reside in Indiana. Approximately 400 students reside on campus. Academic classes were first offered at PUC in 1946.

The PUC Library has undergone tremendous change in the last two years. During the summer of 2006 the Library altered the organizational structure and enhanced librarian positions to include a subject specialist/liaison role. Librarians were assigned subject specific areas in which to serve as liaisons to the faculty, managers of selected discipline collections, and providers of specialized instructional assistance to users.

Existing PUC librarians took on the roles of Social Sciences Librarian and the Education Librarian. New librarians were hired to fill the Humanities Librarian/Collection Management Librarian and the Science and Business Librarian. A search for an Engineering and Technology Librarian was undertaken but not completed. With the hiring of the two new library faculty, the library was able to improve services offered to both on-campus students and to distance learning students via the course management software.

The first service expansion in Fall 2006 was to have a member of the library faculty work collaboratively with academic faculty to integrate scholarly information sources into online learning and the university's course management system. The Science and Business Librarian, new to the PUC Library, had previous experience developing course-specific web sites and subject research guides. The librarian had also collaborated with faculty to develop and market web sites and guides. Based on that experience, she became the first member of the library faculty to pilot the development of course management subject guides.

A Crash Course

After attending one WebCT Vista training session, the Librarian began speaking to faculty in the School of Nursing, School of Management and the Science departments about developing course management subject guides for their courses. She attended faculty department meetings and met one-on-one with faculty to promote the idea. Using other Library web guides as an example, she demonstrated to faculty how useful a select list of resources could be to students. As a result, subject guides, or learning modules as they are called in WebCT Vista, were created for more than 25 sections of 15 courses in the first year. Learning modules contain links to the campus online catalog, library databases, electronic journals, select Internet sites, Acrobat .pdf documents and original Word and PowerPoint documents containing search tips and screen shots. By request of the Nursing faculty, the librarian's photograph was included in WebCT Vista course materials. The photograph was intended to "put a face with a name" and help bridge the miles between the librarian and the student.

The School of Nursing took the most advantage of this new library resource. By piquing the interest of a few influential faculty members, others soon followed. In addition to adding library learning modules in specific courses, the School asked that a comprehensive library resources module be created for the Graduate Student Resources and Advising Information course. Since WebCT Vista course access is limited only to those registered in that specific course, the comprehensive module was made accessible to all graduate nursing students regardless of their current schedule or course load. Interest from the School of Management faculty was slow at first but grew as the academic year progressed. Science faculty, including biology, chemistry, physics, computer science and math showed minimal interested in the service.

If a course was hybrid, meaning it contained an on-campus classroom or lab component; the librarian physically attended a session and used the learning module as an instructional guide. Students enrolled in a course that did not require them to physically come to campus were encouraged to call or email the Librarian to set up an appointment for assistance. Telephone consultations were promoted as an effective way to receive synchronous research assistance.

Rounding the Track

In August of 2007 the Library was invited to present library resource information to the Distance Education Faculty Development Training Program. Developed in 2005, the program was designed to help create a community of scholar-teachers in distance education to improve the quality of distance learning offerings at PUC and to help faculty develop skills in instructional design, pedagogy, media, and technologies used in teaching and learning. Approximately 25 faculty are accepted into the program each year. They are paired with a faculty mentor and the resources to develop their new distance learning course and ensure it's success.

The August meeting was the first time that the Library was invited to participate in the Distance Education Faculty Development Training. The majority of the 28 current faculty participants and their eight alumni mentors were not aware that the Library could provide such a service to them and their students. As a result of this meeting, faculty members immediately requested assistance from their library liaison and various learning modules are currently in development.

Other Yellow Flags

The Library requested a library tab in Blackboard Vista version 4, the new course management system introduced to campus in the Fall of 2007 for all new courses. It has not yet developed online tutorials, e-mail reference service, Instant Messaging reference service, information literacy training podcasts, electronic reserves and comprehensive InterLibrary Loan services to non-area students. The Library is actively seeking funding for two reference librarians that will add much needed experience and time to these activities.

Conclusion

Libraries have long provided services for distance learners. The explosion of online education has created challenges for institutions in various stages of development of methods to provide library services for the online learner. As Miller and Lu (2003) suggest "the issue of online learning is perhaps the most important facing higher education as individual institutions and as an industry in the past 100 years" (p. 168). Developing effective online learning strategies and assessing the effectiveness of that online learning will be critical as universities face this important issue. Benoit, Benoit, Milyo and Hansen (2006) present a summary of a study that examined traditional and web-assisted instruction and the impact on student learning and satisfaction.

The academic university library needs to face the issue of online learning as well. There are many challenges to be faced by institutions including limited staff, limited technology expertise, the structure of the traditional library, the specific library culture and campus culture, limited marketing to faculty and administration, and support by faculty and administration for library services. The necessity to frame library services to meet the needs of the students is important, not only to the success of the students but to the success of the university. As Miller and Lu (2003) so aptly conclude, "the transformation must be intentional, well-informed, and undertaken with a degree of caution that demonstrates a respect for intellectual knowledge, and must find a way to integrate a vastly different sense of knowledge capacity and management. To do these things effectively requires leaders of great skill, faculty of great concern, and a community committed to change" (p. 24).

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Editor's Note: This is a study to determine reasons for low completion rates in faculty training courses in a corporate university. It identifies forces external to the course that impact completion rates and defuses the assumption that online courses are inferior in content or pedagogy.

Factors Affecting Completion Rates in Asynchronous Online Facilitated Faculty Professional Development Courses

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Abstract

Course or program completion has long attracted great interest and some controversy, whether expressed in positive terms (e.g. retention) or negative ones (e.g. attrition). One corporate university conducted a study to determine possible causes for a large disparity in completion rates between classroom and online courses in its Faculty Professional Development (FPD) program. The study focused on factors identified from previous course completion studies and additional factors derived from observational analysis of FPD courses. Study results indicated that time conflicts with work commitments, level of organizational support, and learners' early course experience were important factors affecting completion rates in online facilitated courses, corroborating the findings of earlier studies. Learners' technology proficiency and comfort level did not affect course completion in this study, however. The study also identified possible contributory factors to consider when analyzing course completion rates or comparing them across delivery modes, including course completion requirements, enrollment and withdrawal policies, learners' delivery mode preferences, and course quality. Study results strongly suggest that achieving comparable completion rates for online facilitated courses relative to classroom courses requires the development of support structures comparable to existing structures for classroom and web-based training courses.

Keywords: course completion, retention, student success, attrition, dropout, faculty professional development, online education, corporate university, asynchronous courses, online facilitated courses.

Introduction

Course or program completion has long been an issue that attracts interest and controversy, whether expressed in positive terms (retention, completion, student success) or negative (attrition, dropout, non-completion). One corporate university noticed a large disparity in completion rates after introducing online facilitated courses to its faculty professional development program. It decided to conduct a study to determine possible causes for this disparity.

This corporate university is a consortium of education and training institutions and organizations with a headquarters and five regional campuses scattered across the U.S. Its stated mission is to provide practitioner training, career management, and services to enable its target community "to make smart business decisions and deliver timely and affordable capabilities." It serves a worldwide constituency and has consistently attempted to be on the leading edge of integrating training, education and emerging technologies.

In late 2004, it embarked upon an effort to expand its learning options for students to include online facilitated courses. (These courses were distinct from the corporate university's web-based training (WBT) which rely on self-paced, asynchronous, content-led and instructor facilitated course delivery using discussion forums, e-mail and other communication tools.)

The first courses developed were for the university's internal faculty professional development program (FPDP) and then expanded into "assignment-specific" courses for the university's primary constituency. In total, the FPD program offers eleven education-related courses for its faculty, of which four were converted to online facilitated format.

After several offerings of these online facilitated faculty development courses, it became apparent that many participants who started courses did not complete them. Analysis of initial results indicated a huge disparity in completion rates between classroom and online facilitated courses (44% online vs. 98% classroom). Consequently, a study was initiated to determine the possible reasons for this disparity in completion rates between delivery modes.

The Issue of Completion Rates in Online Courses

Some studies suggest that corporations are finding no significant difference in learning and performance between distance education and face-to-face courses, comparable to the "no significant difference" phenomenon reported in higher education institutions (Russell, 1998 and Zolkos, 1999). Distance education in the corporate sector are frequently linked to specific job requirements, unlike in higher education where students have more flexibility with course or program choices (Tyler-Smith, 2006; Henke & Russum, 2002). As a self-contained curriculum, the FPDP courses are *selectively mandatory* as dictated by an internal policy directive on faculty certification. FPD courses can be required for job performance and may impact employees' job ratings and future career opportunities. Application of these requirements varies by campus or course so that online facilitated FPD courses are often not mandatory and this has implications for course completion rates.

Many research studies have found online courses exhibit higher attrition rates compared to on-campus courses (Diaz 2002; Royer 2006; Diaz and Cartnal, 2006). This has contributed to a belief that higher attrition rates are a major weakness in online education (Carr, 2000; O'Brien and Renner, 2002) despite the fact that online students often outperform traditional students (Diaz 2002; Royer 2006).

Higher drop rates do not indicate lack of success or even the presence of a problem. There are many factors besides the actual delivery mode that can account for the difference in retention rates between classroom-based and online courses:

- *Online students are more likely to be employed*. One study, for instance, found that five out of six online students were employed and thus could not attend traditional classes. The study noted that "employment responsibilities may also contribute to the attrition rate" in online courses relative to campus-based courses with lower student employment rates (Bocchi, Eastman, and Swift 2004).
- *Online students are more mature*. Many online students drop classes "because it is the *right thing to do*" for them, i.e., as a "mature, well-informed decision that is consistent with a learner with significant academic and life experience" (Diaz 2002).
- *Job performance is a better measure.* In one study, fully 25 percent of survey respondents (n=375) dropped out of an online course because they learned what they needed to know in order to do the job before the course ended (Wang et al. 2003). Although this finding may overstate the case, it highlights the fact that dropout rates alone are often not a reliable method of evaluating effectiveness of e-learning courses.
- *Statistics lie.* As one researcher noted, "statistics on retention and drop outs are, at best, fragmented, do not compare like with like, and are either unreliable and/or misleading" (Tyler-Smith 2006). Thus it is very important to examine completion rates within the context of individual programs to ascertain their meaning and implications.

- *Other possible factors* include student characteristics (demographics), course and instructional quality, subject matter, "socioeconomic factors, disabilities, or apathy" (Diaz 2002); "cumulative grade point average, class rank, number of previous courses completed online, searching the Internet training, operating systems and file management training, and Internet applications training" (Dupin-Bryant 2004).

Another study notes "there has been very little research on dropouts in online education." Available research suggests that the reasons for dropping out of distance education programs are "complex, multiple, and interrelated" in the aggregate and "varied and unique to each individual" (Willging and Johnson 2004). This observation applies to online courses (Tyler-Smith 2006).

Reasons for Non-Completion of Online Courses

In the corporate university environment there are many potential reasons for non-completion of courses:

Time conflicts with work commitments: This issue has several dimensions, as reported in previous research findings:

1. *Increased work hours*. Over one-quarter (27.7%) of respondents in one study reported that their work hours increased while doing e-learning courses.
2. *Infringement on non-work hours*. Almost one-third (30.4%) of respondents in the same study reported doing their e-learning from home (Wang et al, 2003), while e-learners in another study reported that about 60% of their time spent on the course utilized their personal time rather than work time (Thalheimer 2004).
3. *Reduced capacity to perform work and e-learning duties*. Work tasks and non-supportive policies (e.g., office "open door" policies) increased dropout rates (Wang et al. 2003).

Asking employees to learn on their own time or to juggle e-learning with full-time work responsibilities is may compromise results. Assigning e-learning as an additional responsibility requires employees to sacrifice something, usually personal time at home. Assigning e-learning on top of regular work duties gives it a lower priority, which also decreases the likelihood of completion (Takiya et al. 2005).

Lack of organizational support creates problems even for motivated learners. One study found that programs with "top-level visibility" organizational support had higher completion rates (Wang et al. 2003).

Cognitive load factors include "technical access, asynchronicity, text-based discussions, multiple conversations, information overload and [physical] isolation" (Tyler-Smith 2006, Whipp and Chiarelli 2004). Unfamiliarity of these elements of the learning environment increases the cognitive load and can make the initial stages of e-learning a daunting task, particularly for first-time learners.

User proficiency, comfort with technology: Even in a technology-rich workplace, not all employees are highly proficient or comfortable with using technology. The "technology hurdle" can cause large enrollment drops early in a course (Kleinman & Entin 2002). Comfort level is also a key factor: one study reported a 26% dropout rate and 13.6% of respondents reported feelings of "discomfort" or "high discomfort" with the technologies. This alone could account for up to half of the reported dropout rate (Wang et al. 2003).

Lack of motivation: Upon closer inspection, this seemingly obvious factor more complex than it appears. Many researchers cited lack of motivation as a cause for higher attrition (Diaz and Cartnal 2006; Moore, Sener, and Fetzner 2006; Wang et al. 2003; Diaz 2002). There are a host of

external and internal factors such as well-organized course introduction and overview (Conrad 2002), course and instructor quality (Diaz 2002), or locus of control (Parker 1999) that can adversely affect motivation. Other causes for lack of motivation are ones previously noted – time conflicts with work commitments, cognitive load factors, lack of top-level organizational support, and lack of user proficiency or comfort with technology. Thus it makes more sense to look at causal factors rather than lead to "lack of motivation."

Early attrition in e-Learning: The British Open University found that 35% or more of e-Learners withdraw before submitting their first assignment (Simpson 2004, p. 83), which suggests that a learner's initial experience with e-Learning may well have a significant impact on a decision to drop out (Tyler-Smith, 2006). Another study found higher course dropout rates for online courses prior to instruction but almost identical course completion rates for classroom and online courses once instruction started, indicating that non-instructional factors contributed to early attrition and accounted for all of the difference in dropout rates (Frydenberg, 2007).

Data Collection Methodology

Course completion results were compiled and analyzed for online facilitated courses, using course enrollments, course headcount, and faculty headcount as measures.

An online survey was developed to obtain quantitative and qualitative information from faculty who had enrolled in online facilitated FPD course offerings. The survey questions for this study were derived primarily from a literature review of existing studies and focused on such factors as time-related issues, organizational support, technology proficiency, and learners' initial course experience. Survey questions were also derived from observational analysis of perceived variables in the FPD courses, for example the level of "robustness" designed into the courses and the resulting effect on learning quality and time requirements.

The online survey was sent out via e-mail to 59 out of the 76 faculty who had completed one or more online facilitated FPD courses. Faculty who left the university without current contact information was not included. The target population included some faculty who had completed the classroom version of the course and were subsequently invited to participate in piloting the initial online course offerings. A total of 44 responses were received, for a 75% response rate (58% of the total target population).

Based on the preliminary results of the online survey, an additional 'survey' request was sent out by e-mail to all faculty, asking for responses from faculty who had "thought about and/or wanted to sign up for a online facilitated course but did not." Respondents were asked to explain why they did not sign up and to identify specific obstacle(s) which may have stopped them. A total of 29 narrative responses were received from the second survey.

Findings

Course Completion Results

A total of 44 faculty completed one or more FPD courses. Of these, nine successfully completed two courses and two completed three courses, for a total of 57 successful completions. Course completion rates ranged from 57% to 62% depending on the measure used (course enrollments, course headcount, and faculty headcount (Table 1). Eight faculty took a course more than one time and five of these completed the course successfully on the second try.

Table 1

Course Completion Results for Online Facilitated Courses

Key Variable	Results
Headcount for all course offerings	76
# of enrollments for all course offerings	100
% of completions by course enrollment	57%
Headcount by course	92
% of completions by course headcount	62%
% of faculty who completed any course [headcount]	59%

Online Survey Results

Almost two-thirds of the respondents were male. Over 60% were aged 50 and over, and more than 90% were age 40 and over, reflecting the university's practice of hiring faculty with substantial prior experience in their areas of expertise (Table 2).

Table 2

Respondent Demographic Characteristics

Gender	%	#		
Male	65.91%	29		
Female	34.09%	15		
			Age by Gender:	
Age			***Male***	***Female***
20-29	0.00%	0	0	0
30-39	9.09%	4	2	2
40-49	29.55%	13	9	4
50-59	50.00%	22	13	9
60+	11.36%	5	5	0

Respondents reported a variety of reasons for enrolling in a facilitated online course. Almost one-half cited fit with career goals and/or for other professional development reasons. Over one-third cited convenience and almost one-third cited flexibility of schedule as reasons for enrolling. Over one-third of respondents also reported other reasons for enrolling; the most commonly cited were to meet faculty certification requirements (seven responses) and because the course was only offered in an online format (four responses – Table 3).

Table 3

Reasons for Enrolling in a Facilitated Online Course

Reasons for Enrolling	%	#
Flexibility of schedule	31.82%	14
Convenience of taking the course online	36.36%	16
Fit well with career goals	47.73%	21
Other professional development reasons	45.45%	20
Other (please specify)	36.36%	16
Meet training/certification requirements		8
Only offered in online facilitated format		4
Preparing to develop a similar course		1
Support a curriculum development project		1
Meet rank advancement requirements		1
I am an online instructor		1
[I was] encouraged to take the course		1
Wanted to become familiar with this tool		1

Of the 44 respondents, there were 27 "completers" and 17 non- or partial completers (Table 4). Compared to actual course completion data, it appears that course completers responded to the survey in about the same proportion as non- or partial completers. The reported numbers indicate that 61% of completers responded vs. 46% of non- or partial completers. However, the survey allowed respondents to self-identify as a course completer based on course rather than course offering, which could account for most or all of this variance as there were several faculty who successfully completed a course on the second try after not having completed the first try. Since the survey was anonymous, it is impossible to tell how many of these respondents self-identified as completers or partial completers. Thus there is a high likelihood that respondents were a representative sample of the larger population.

Table 4

Respondent Completion Rates for Facilitated Online Courses

	%	#
Yes, I completed all of the courses I took.	61.36%	27
I completed one or more of the courses I took, but I did not complete one or more of the other courses I took.	20.45%	9
No, I did not complete any of the courses I took.	18.18%	8

Respondents who reported not completing one or more facilitated courses were asked additional questions about their reasons for non-completion. These questions were organized into five categories: job, personal, course, technology, and learning environment (Table 5).

Table 5

Reasons for Non-Completion of Facilitated Online Courses (N=16)

Personal Reasons	**%**	**#**
Lack of time to complete the assignments	43.75%	7
Schedule conflicts with other personal activities	37.50%	6
Family issues	12.50%	2
None of these reasons applies to me.	31.25%	5
Other personal reasons (please specify)		1
Job-Related Reasons	**%**	**#**
Job responsibilities changed during the course	56.25%	9
My supervisor did not support my taking the course.	0.00%	0
My work hours increased while taking the course	37.50%	6
I had to use too much of my personal time to complete the course.	25.00%	4
There were too many distractions at work for me to complete the course.	56.25%	9
I asked for but did not receive comp time to do evening or weekend study.	0.00%	0
I learned what I needed to know for my job before the course ended.	0.00%	0
None of these reasons applies to me.	18.75%	3
Other job-related reasons (please specify)		4
Course-Related Reasons	**%**	**#**
The course was too difficult/demanding	25.00%	4
The course was not demanding enough	0.00%	0
The course was more difficult than a comparable web-based or classroom course	12.50%	2
The group assignments were too difficult	6.25%	1
Lack of one-to-one interaction with the instructor(s)	6.25%	1
Lack of one-to-one interaction with other students	6.25%	1
The course didn't meet my expectations	0.00%	0
None of these reasons applies to me.	75.00%	12
Other course-related reasons (please specify)		2
Technology-Related Reasons	**%**	**#**
The Blackboard learning management system was too complicated	0.00%	0
The online learning environment was too de-personalized	0.00%	0
There was not enough technical support from [university] staff	0.00%	0
There were too many technical problems.	0.00%	0
My technical skills were inadequate to do the program	0.00%	0
None of these reasons applies to me.	100.00%	16
Other technology-related reasons (please specify)		2

Learning Environment-Related Reasons	***%***	***#***
Assignment scheduling	12.50%	2
Figuring out how to find my way in an unfamiliar learning environment	0.00%	0
Having to do the course asynchronously instead of in real time	6.25%	1
Having to do text-based discussions instead of oral discussions	6.25%	1
Presentation of information was too unordered and non-linear for me	6.25%	1
Physical isolation from the instructor and/or other students	25.00%	4
Lack of support when I encountered difficulty	0.00%	0
Longer turnaround time for answering questions	12.50%	2
I did not care for the online instructor	6.25%	1
None of these reasons applies to me.	68.75%	11
Other learning environment-related reasons (please specify)		3

Job-related reasons were cited most frequently by far (32 responses). Changing job responsibilities and work distractions were both cited by more than half of the respondents. Six respondents said that their work hours increased while taking the course, and one-quarter of the respondents said that they had to use too much of their personal time to complete the course. Other responses noted conflicts with other time demands; one respondent noted an increase in work hours because of the course.

Lack of time to complete the assignments (seven responses) and schedule conflicts with other personal activities (six responses) were frequently cited as ***personal reasons*** for course non-completion.

Course-related reasons were a less important factor for most non or partial completers. One-quarter of these respondents said the course was too difficult or demanding, two respondents cited difficulty relative to a comparable web-based or classroom course. One of the "other" responses noted that the assignments were more "time-consuming" than difficult or demanding.

Learning environment-related reasons were also a less important factor for most respondents. One-quarter of respondents cited "physical isolation from the instructor and/or other students" as a factor, while assignment scheduling and longer turnaround time for answering questions were also cited by more than one respondent. Other responses cited a sense of distraction, a lack of time to devote proper attention, and a dislike for technology-mediated learning as reasons.

Technology-related reasons were not a factor at all for non-completions. The two "Other" comments indicated that technology was not a problem.

Survey respondents were also asked to estimate what percentage of the time they worked on the course at work, at home, or somewhere else. The purpose of this question was to determine whether or not faculty spent a significant amount of time studying at home or other venues. The findings indicate that this was indeed the case (Chart 1):

- Many respondents spent a lot of the time working on the course from home.
- A significant proportion of respondents spent most of the time working on the course from home.
- Relatively few respondents spent all of their time doing their course while at work.

- A significant proportion of respondents spent some of their time working on the course from somewhere else.

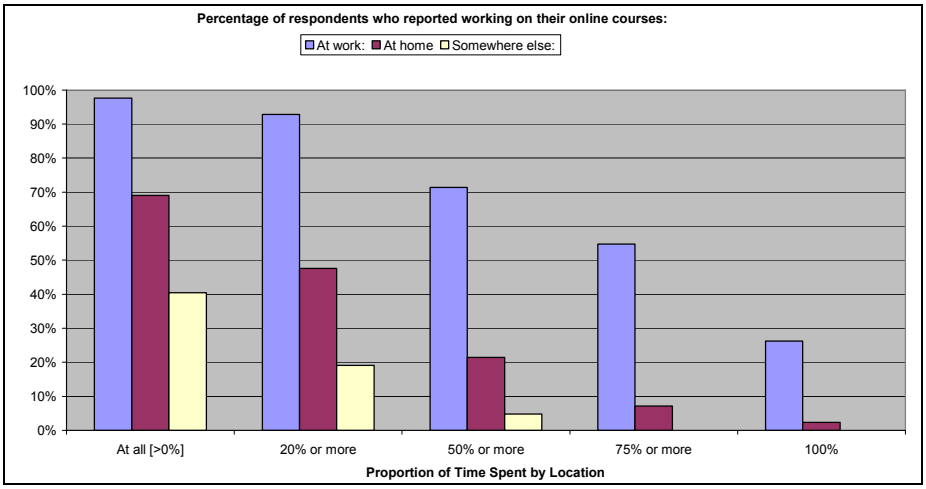

Figure 1. Locations for working on online courses.

All respondents were also asked a series of statements about facilitated courses in general. The purpose of these statements was to obtain more information related to course content, course difficulty, delivery setting, pre-course transparency, and time-related issues. All but one respondent completed this section of the survey (Table 6).

Table 6

Responses to Other Key Statements about Facilitated Online Courses (N=43)

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The [online] course was more difficult than anticipated.	16.3%	32.6%	18.6%	27.9%	4.7%
The course took more time to complete than anticipated.	23.3%	41.9%	14.0%	18.6%	2.3%
Course content was relevant to my job.	48.8%	46.5%	4.7%	0.0%	0.0%
I would prefer to take the course in a classroom setting.	27.9%	27.9%	16.3%	20.9%	7.0%
I had sufficient time during the workday to complete the online coursework.	2.3%	30.2%	9.3%	41.9%	16.3%
I asked for and received comp time during the workday to complete the course.	2.3%	4.7%	32.6%	34.9%	25.6%
I asked for and received comp time evenings and/or weekends to study.	0.0%	4.7%	37.2%	34.9%	23.3%
I was given access to the course before it started so I could figure out how it worked before I began.	9.3%	37.2%	32.6%	16.3%	4.7%
I had a good sense of how the course was structured before I began.	11.6%	39.5%	20.9%	23.3%	4.7%

As expected, time was an issue for faculty. Almost two-thirds (65.2%) of respondents reported

that the course took more time to complete than anticipated. A majority (58.2%) reported that that did not have time during the workday to complete the online coursework, while less than one-third (32.5%) agreed that they had sufficient time. Very few respondents asked for and received comp time during the workday (7.0%) or on evenings and/or weekends (4.7%) to study.

Course difficulty and learners' initial experience with courses were other issues which may have contributed to non-completion for all respondents. Almost half (48.9%) thought that the facilitated course was more difficult than anticipated, while about one-quarter of respondents reported did not have access to the course before it started (21%) and that they did not have a good sense of how the course was structured before it began (28%).

Other responses indicated that relevance of course content was not an issue, but online course delivery might be one. A majority of respondents (55.8%) said that they would prefer to take a course in a classroom setting, and only about one-quarter (27.9%) disagreed with this statement.

In anticipation that this might be an issue, respondents were also asked to indicate whether or not they had a strong preference for classroom courses or asynchronous online courses. A substantial majority (60.5%) expressed a strong preference for classroom courses, while only a few respondents (7.0%) strongly preferred asynchronous online courses, and relatively few (32.6%) did not have a strong preference for either delivery mode (Table 7). Although there were some differences in delivery mode preference by age range and gender, the number of responses is too small to discern any definitive patterns (Table 8).

Table 7

Respondents' Delivery Mode Preference

Delivery Mode Preference (n=43)	*%*	*#*
Strongly prefer asynchronous online course	6.98%	3
Strongly prefer face-to-face classroom course	60.47%	26
No strong preference either way	32.56%	14

Table 8

Respondents' Delivery Mode Preference by Age and Gender

Delivery Mode Preference by Age (n=43)	*30-39*	*40-49*	*50-59*	*60+*	*Male*	*Female*
Strongly prefer asynchronous online course	0	1	2	0	2	1
Strongly prefer face-to-face classroom course	3	5	14	4	16	10
No strong preference either way	1	6	6	1	10	4
N=	4	12	22	5	28	15

Non-Participant Faculty Survey Results

Of the 29 responses received, 27 were from non-participants and two were previous participants in online facilitated courses. Responses from the non-participant faculty were based on prior perceptions but not actual experience with online facilitated courses. However, many responses were clearly based on previous experience with technology-enabled courses, in particular web-based training courses. Their comments yielded more useful information about reasons why

faculty did not sign up for online facilitated courses, as described in the "Responses from Non-Participant Faculty" section below.

Discussion

Age was a factor in this study in that the average age of survey respondents is relatively high. However, there were too few responses in this study to draw conclusions based on age range. Gender did not appear to be a major factor in this study.

Respondents enrolled in these courses for practical reasons such as career goals and professional development, as would be expected with a faculty development program. Convenience and flexibility of schedule were important but secondary reasons for enrollment. Some faculty noted that they enrolled in these courses because they were required, although actual requirements vary as noted previously. Several also reflected respondents' clear preference for classroom delivery; four respondents noted that they were taking the course online because it was only available in that delivery format, and another explicitly noted a preference for "classroom exposure."

Reasons for Non-Completion.

This study asked respondents to differentiate time spent on course work by location rather than by type of time ("work" vs. "personal") because the organization's policies allow faculty to request compensatory time during the workday or on evenings and weekends to do activities such as taking professional development courses. Only four out of 43 survey respondents indicated that they requested and received comp time to work on their course either during the workday or on evenings or weekends, and only one respondent requested and received comp time to work on their course both during the workday and on evenings or weekends. Although it is possible that faculty routinely ignore existing university policies, the pattern of survey responses suggest that the time faculty spent taking these courses was added on to their existing workload rather than compensated for by simply counting time spent doing a course as regular work duty time.

Survey results appear to corroborate other studies' findings that time conflicts with work commitments result in increased course dropout rates.

Infringement on non-work hours. Survey findings indicate that taking these courses infringed on non-work hours for most faculty. About one-quarter (26.1%) of respondents reported that all of their course work time was spent at work. Over two-thirds (69.1%) of respondents reported spending at least some time working on the course from home (Chart 1), which is far higher than the 30.4% reported in the Wang et al. study. Of these, almost one-half (47.6%) reported spending at least 20% of their course work time at home, and almost one-quarter (21.4%) reported that at least 50% of their course work time was spent at home. Similarly, about two-fifths (40.5%) of respondents reported spending at least some time working on the course somewhere else, in most cases while on work travel or other assigned "temporary duty". Less than one-third (32.6%) reported that that they had sufficient time during the workday to complete their coursework.

In terms of relative proportion of time spent by location, respondents reported that they spent over one-third of their time working on the course at home (25%) or somewhere else (9%). While this is less than the 60% reported by Thalheimer (2004), it still represents a relatively large infringement on non-work hours.

Increased work hours. Almost two-fifths (six out of 16, or 37.5%) of non-completers reported that their work hours increased while taking their course, and one narrative response reported work hours increased because of the course. Completers were not asked about increased work hours per se. However, since taking these courses was part of faculty job duties, survey findings clearly indicate that the time required to complete these courses required an increase in ***job hours***. Almost two-thirds (65.1%) of all respondents reported that their course took more time to

complete than anticipated, and almost half of the non-completers (43.8%) reported that they lacked time to complete course assignments. These results suggest that many faculty chose not to complete courses rather than spend the additional time required to complete them.

Survey results also suggest that these courses were frequently assigned as ***an additional responsibility*** on top of regular work duties, which decreases the likelihood of completion (Takiya et al. 2005). Survey responses also strongly suggest that faculty workplaces were not effectively set up as supportive learning environments for taking online facilitated courses, which is another indicator for increased dropout rates.

Learners' initial experience with the course may have been an additional contributing factor to dropout rates, given that about one-quarter of respondents reported issues with prior course access and transparency of course structure. The proportion of respondents who expressed a strong preference for classroom courses, combined with the number who reported that they were required to take these courses, also raises the question of whether ***delivery mode preference*** was also a contributing factor, although the participant survey did not explicitly address this question.

The importance of the above factors is further magnified by the fact that ***user proficiency and comfort with technology*** were non-factors for this population, in contrast to other studies in which these factors were major contributors to dropout rates.

Reasons for Avoidance of Online Facilitated Courses

The non-participant faculty survey asked respondents to identify reasons for not taking online facilitated courses and specific obstacle(s) which may have stopped them from doing so. These open-ended questions allowed respondents to offer responses which were not explicitly solicited. Nevertheless, several themes emerged from their responses which are consistent with the existing literature on attrition rates and with the findings of the faculty participant survey:

Lack of organizational support appeared to be a factor in faculty decisions not to sign up for online facilitated courses. One related issue was *inconsistent policies* about course requirements; in principle, the university mandates faculty professional development, but in practice the application of requirements varies among the regional campuses. As a result, while many online survey respondents reported taking the courses because they were required, several other faculty did not sign up for FPD courses because they were not required. ***Lack of marketing and available information*** about online facilitated courses was also noted in some responses.

Delivery mode preference was another important factor for non-participants, as about one-third of respondents stated or implied a strong preference for traditional classroom instruction. Some of these comments also suggested a broader distaste for all forms of technology-enabled learning, including the web-based training courses which the organization had instituted some years ago to replace classroom offerings.

However, the most important factor, cited by over two-thirds (69%) of respondents, was ***time-related issues*** – lack of time, time management, schedule conflicts, etc. Some respondents cited simple ***time conflicts with work commitments***, while other responses also highlighted an unexpected relationship between delivery mode preference and time issues. In particular, many comments indicated a perception that taking online facilitated courses would require **more** faculty time rather than less. Even more interesting were comments which indicated a dislike of online (or more broadly technology-enabled) courses which were coupled with the time issue. These comments that online facilitated courses required more time to complete directly contradict the prevailing wisdom that online courses save time by increasing convenience and flexibility, which raises the question of why these respondents' perception of time requirements in online courses is so different.

The most striking aspect of these comments was the concern with the amount of time required to complete online courses. These comments indicate that respondents experience the prospect of taking online facilitated courses as an added responsibility, which parallels the findings reported by actual course participants. None of the online courses actually required four weeks' worth of participants' time; in fact, the course instructor estimated that it would take as much or less time to complete an online facilitated course (20-40 hours) relative to the equivalent classroom course (35-40 hours + travel time). However, online courses required some participant time on a daily basis for a four-week time period, which was apparently perceived as additional time. By contrast, the time required for completion of classroom courses was factored into participants' existing workload, so it was already accounted for and occurred within a shorter time frame.

The reason for this perception may be in large part due to the particular (and to some extent peculiar) organizational environment. The corporate university in this study has a well-structured system where faculty allocates their work time into specific work categories several months in advance for the coming year. In almost all cases, faculty time for online facilitated courses was not allocated in advance, so taking an online facilitated course becomes an added responsibility in most cases. In addition, different processes for creating faculty workload schedules and FPDP course schedules often results in schedule conflicts which reduce the ability of faculty to schedule FPD courses.

Other Factors Affecting Completion Rates

There are also other systemic factors that emerged from this study which may help account for the difference in completion rates between classroom and online facilitated courses.

Course completion requirements -- The baseline course completion rate for the FPD classroom courses is very high (~98%). This suggests that, for whatever reasons, being in attendance is the key course completion requirement for these FPD classroom courses, an observation corroborated by anecdotal comments from course instructors. By contrast, in the absence of physical attendance as a criterion, online facilitated course offerings were more likely to use assignment completion (e.g., submission of work products, discussion board participation, completion of other assignments) as a criterion for course completion.

Course entry/exit access -- Classroom students are to large extent captive participants, especially if a course is offered off-site away from work. In this university's case, both enrollment and withdrawal are easier for online facilitated courses than for classroom courses. Signing up for a classroom course required schedule (re-) arrangement to make the time slot available, whereas signing up for an online facilitated course usually did not involve schedule changes since most participants tried to fit the course into their existing schedules. This in turn made it easier for faculty to drop an online course if other time commitments intruded on their schedule while they were taking the course. The absence of negative consequences for dropping an online course also abetted this situation, whereas lost work time and travel expenses were potential negative consequences for failing to complete a classroom course.

Respondents from both participant and non-participant surveys did not mention the presence of *visible top-level administrative support*, implying that its absence was another possible factor. Responses also indicated that *supportive learning environments and policies* were also likely absent, including logistical and cognitive elements such as time allocation, designated "learning space," management of office-related interruptions, etc.

Two other possible factors are worth noting. The course instructor used the re-design process as an opportunity to improve the design of several of the online facilitated courses. Based on an assessment of student work products, the instructor believes that the resulting courses were more robust, with improved quality that produced more reflective and therefore deeper learning. It is not clear whether this factor contributed to the findings that almost half of the survey respondents

found the online facilitated courses more difficult than anticipated, or that several non-/partial completers reported finding the courses to be too difficult. However, other anecdotal evidence suggests that some course participants ***disagreed that improved learning was worth extra time and effort.***

The other factor is related to delivery mode preference which involves several issues, including the belief that role modeling is the best or only appropriate way to learn how to be a teacher, or unwillingness to change or venture out of one's comfort zone, or a lack of understanding of how online facilitated courses work. The common factor is a strongly-held belief that the face-to-face interaction of classroom instruction is preferable to technology-enabled interaction. Many of the reasons for this have legitimate components, some of which have little to do with learning. Attending a classroom course can be a perk: an opportunity to network with colleagues, travel to a new city, or get a much-needed break from the office routine. Other reasons may have more connection with learning, such the belief in modeling as an effective learning strategy or a preference for the affordances of face-to-face interaction. Some comments also suggested an inability to distinguish between online facilitated courses and the web-based training courses with which most respondents were familiar. These experiences may have pre-disposed some faculty to have negative expectations about online facilitated learning.

Despite an ever-growing body of research literature which indicates that online facilitated courses offer all of these affordances – content retention, peer interaction, enhanced interaction with professional educators – non-participant comments illustrate that prior perceptions about online vs. classroom education constitute an obstacle which needs to be overcome in order to attract faculty to take online facilitated courses. Likewise, prior bias against technology-enabled course delivery may also contribute to increased dropout rates in conjunction with other factors.

Conclusion

Comparing completion rates across delivery modes is notoriously difficult. Yet the huge difference between reported completion rates in FPD classroom and online facilitated courses merited a closer examination. In this case, it appears that the disparity in completion rates between classroom and online facilitated courses occurred for systemic reasons. The most likely factor in decreasing course completion rates for online facilitated courses was the creation of ***time conflicts with work commitments***. Most faculty took online facilitated courses as an added responsibility instead of having designated learning time comparable to what typically occurs for classroom courses. The resulting infringement on non-work hours and increase in learners' job hours produced results which corroborate other studies' findings that time conflicts with work commitments result in increased course attrition rates.

Issues with the learners' initial experience with the online courses in terms of prior course access and transparency of course structure may also have contributed to dropout rates. Other organizational support issues such as ***inconsistent policies*** about course requirements and ***lack of appropriate "readiness marketing"*** (for example, informing prospective learners about time estimates to complete online courses) are other possible factors. In addition, less stringent course enrollment and withdrawal policies and more stringent completion requirements for online facilitated courses may also be factors. Finally, ***prior delivery mode preferences*** for some learners may have worked in conjunction with other factors to increase the likelihood of attrition.

Achieving comparable completion rates for online facilitated courses requires the development of support structures which are comparable to those already in place for classroom and web-based training courses. If such structures are not in place, the results of this study and other research findings indicate that a decrease in course completion rates is predictable. Corporate universities and other organizations which are contemplating an initiative which utilizes online facilitated

courses should make sure that they provide adequate organizational support in terms of time allocation, learning space allocation, clear policies, learner readiness, and course design which provides learners with an appropriate initial course experience.

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Editor's Note: The value interaction and collaborative learning is well documented. This article discusses practical steps for community building and poses some communication problems unique to mathematics and how they were solved.

Building Community in an Online Upper-Division Mathematics Course

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Abstract

Learning can be a social experience, and creating a community of learners in a classroom can be an effective teaching tool. This case study suggests ways in which interaction between students in an online upper-division mathematics course can be used to create a virtual community of learners and help students master the concepts of proof in mathematics.

Keywords: real analysis, proof, class community, collaboration, online class.

Introduction

Online courses have become the medium of choice for students who cannot otherwise attend in a traditional classroom setting. Online distance education allows students to take courses in the convenience of their home or office, at their leisure, free of the distractions of campus life, without commute, while at the same time being provided with almost instantaneous access to instruction and an abundance of online resources. The critical reader may conjecture that the internet cannot replace a face-to-face meeting and that the dynamic of relationships between instructor and students (and among students) is not easily replicated in an internet class. Besides adapting course content for delivery in an electronic medium, the online instructor faces the additional task of fostering a sense of community among students who may never see each other face-to-face.

Cothrel and Williams (1999) define a "community" as a "group of people who are willing and able to help each other." In the context of distance education, the necessity for building a community to facilitate learning is discussed extensively in the literature (e.g., Kirschner et al., 2004; Rourke, 2001; Northrup 2000; Weegerif, 1998, Gunawerdana, 1995; Cockburn, 1993). The consensus of this research is that the creation of a class community in online courses is desirable because it is a prerequisite for the social aspect of learning. Kreijns et al. (2004) argue that although social interaction in distance education courses is known to be important, "this aspect is often ignored, denied or forgotten by educators and researchers who tend to concentrate on cognitive processes and on-task contexts." A successful distance education course harnesses the power of technology to create an appealing presentation of course material and utilizes tools of the internet to create an effective group dynamic so students can learn in a social environment.

Effectiveness of group learning in distributed learning groups depends on the social interaction that takes place. Kreijns et al. (2004) write that a "sound social space" has to exist so that learning in an online community can take place. They define a sound social space as one characterized by "effective working relationships, group cohesiveness, trust, respect, belonging, satisfaction, and a strong sense of community."

The advantages of creating a social space and using it to enhance learning applies to all class settings, whether in a traditional classroom or in an online class. The task of creating this social space is conceivably more difficult in an online class, where physical remoteness and the lack of

face-to-face interaction compound the fact that most students are not acquainted with one another. Kirschner et al. (2004) note that "if group members are initially not acquainted with each other and the group has zero history (which is often the case in distance education institutions), group forming, developing a group structure, and group dynamics are very important for developing a learning community. Otherwise, the risk is very high that learners become isolated and depressed because they are confronted with a lonely learning experience." Likewise, Lock (2002) argues that a community is not a rigid entity. It is not in place on the first day of class, nor does it remain unchanged as the term progresses. Community, she argues, is a process, which is fluid in nature. An effective community of learners is nurtured and develops over time. Lock identifies four key aspects – communication, collaboration, interaction and participation – as the cornerstones that make the creation of an online learning community possible.

The purpose of this case study is to provide an account of how content-centered elements and asynchronous interaction between students were structured in an upper-division online mathematics course. The interaction among students allowed building of a sound social space in which students were able to discuss the content of the course. A system of discussion and peer review allowed students to develop the ability to read and write mathematical proofs. The next section describes the context, content and the structure of the course. This is followed by a discussion of the course components that contributed to community-building and further the goals of the course. The last section describes some of the challenges faced in creating this course.

Context and Structure of the Course

The purpose of this article is to present a way of teaching a proof-heavy mathematics course (a first course in *Real Analysis*) in a distance education setting. The course explores the real number system from a rigorous perspective. Topics include Cardinality, Axioms of a Real Number System, Compactness, Sequences, Limits of Functions and Continuity. The course emphasizes formal proofs, both in presentation of the material and in students' work. It is a required course for students majoring in Secondary Education in Mathematics and for students seeking a baccalaureate degree in Mathematics at Indiana University East. This regional campus of 2200 students located in East Central Indiana serves a rural area of seven counties.

Historically, *Real Analysis* has attracted only a handful of students, and more often than not was cancelled due to low enrollment. Offering this course in an online format produced the increased enrollment necessary to offer the course. During Spring 2007, 15 students enrolled – two students from as far away as Hong Kong. Almost all communication between instructor and students and among students was conducted through the internet. Indiana University's course management system (Oncourse) was used to facilitate discussion using an electronic bulletin board. Course participants were technologically savvy and used the internet effectively for communicating. Most students used Microsoft Word Equation Editor for typing the mathematical symbols within their homework assignments. One student chose to submit scanned images of handwritten documents. Most course participants accessed the internet through a computer at home or at school, and most had a high-speed connection. One student reported using the computer at a public library because he found the dial-up connection at his home was too slow for loading course management system pages and sending large documents that contained his scanned pages.

Description of the Course Setup

The author is unaware of any recommendations or best practices specifically designed for web-based upper-division mathematics courses. In the more general context of web-based courses, Hill (1999) suggests (among other strategies) the need to create a "safe on-line environment", an environment that the "learner perceives to be a space where open communication can occur without concern for flaming and non-constructive criticism." Here, "flaming" refers to hostile and

insulting criticism in the social context of the discussion board. This paper focuses on how this web-based course was structured so that a sound social space enabled productive collaboration in a community of learners.

The textbook for the course (Lay, 2005) was chosen because its writing style would enable students to follow most of the reasoning while reading independently. The author shows how a student should develop a proof – beginning with a rough draft, which would be refined until a complete proof was generated.

The material in the textbook was enhanced by instructor-created lectures on PowerPoint. In each PowerPoint presentation, the instructor attempted to recreate a lecture – with the obvious exception that students would not see the lecture develop live on a chalkboard. Each slide in the PowerPoint lecture would start with an empty screen and slowly be filled with text as the voice of the instructor explained what was happening. This mimicked the development of a topic on the blackboard in a physical classroom. The PowerPoint lectures followed the textbook closely and included additional verbal and written explanations.

Some pages contained animations that could not be reproduced in a print or chalkboard medium. The purpose of these animations was to provide students with mental models of the concepts under discussion. For example, a convergent sequence of real numbers could be represented by a "prototypical sequence" plotted in Cartesian coordinates, while an open set could be represented by the union of two open intervals (each represented as a line with hollow end-points). Fischbein (1982) and Thurston (1994) argue that these intuitive representations are a necessary precursor to formal mathematical thought. While the static images of convergent sequence and open set could be represented in print in a textbook (or on a blackboard in a traditional class), PowerPoint features were used to represent dynamic images. One example is an illustration of how an arbitrary open cover (represented by a large number of open sets) can be reduced to a finite subcover (represented by only three of the original open sets). The unneeded open sets migrate away from their original position and then fade into disappearance.

In creating the PowerPoint slides, the instructor continued the textbook author's theme in developing a proof step-by-step, beginning with a review of the applicable definitions, and an analysis of how they would be used in order to prove the theorem at hand.

All discussion of the PowerPoint lectures and the homework problems was conducted on an internet message board. This board was part of a course management program, Indiana University's "Oncourse". Participation in discussions was mandatory and was reinforced by weekly grades assigned for the quality of each participant's postings. Most students chose to discuss strategies for the proofs on the homework problems rather than details of the lecture.

One purpose of the online bulletin board was to create a sense of community in a group of students who may have never met in person. Some authors (Schwier & Balbar, 2002) suggest that a synchronous online discussion forum (for example a chat room) may be more successful in building a sense of community than an asynchronous forum (bulletin board). Schwier acknowledges that asynchronous discussion is superior for in-depth discussion of a topic. Therefore, the instructor chose an asynchronous forum as the only method of communication among the class. This mode of communication also permitted students to compose a comment containing mathematical symbolism in a way that others could read and understand. For example, a typical post might contain the following:

> "I am currently trying to get started on Exercise 11.4. I was trying to follow the proof of theorem 11.7 in the text. However that leads me to a wierd [sic] contrapositive to prove. If x/=0, then x<0 or there exists e>0 such that x>e. (Note that e is epsilon)."

This student clearly understood what the statement asks her to prove. She used makeshift notation (/= instead of ≠, and e instead of ε) and the readers may need some time to decipher this. She has put some effort into finding a valid way of proving the theorem and is asking her peers for advice as to how to continue. Posting this type of question in a synchronous conversation would most likely not be answered satisfactorily because students would have a hard time interpreting the makeshift notation, finding an answer, and then composing their answer in a suitable way. The message above was posted on a discussion forum at 7 pm and was followed up by 7 messages during the next 12 hours. The thread reassured the student that she was indeed on the right path and suggested a possible way to continue the proof.

As mentioned in the introduction, the purpose of the course is to acquaint students with the idea of a rigorous proof in the context of Real Analysis. Accordingly, most homework assignments asked students to contrive a proof of a stated theorem. Other assignments asked students to determine whether a given statement is true or false, and then either prove the statement (if true) or give a counterexample (if false).

When reading a textbook, students are typically presented with a polished version of a proof. This polished version – elegant, in the eyes of a mathematician – assumes that the reader is familiar with the basic proof techniques, that the reader has read the applicable definitions, and will not be surprised to see a proof start with the words "Let $\varepsilon > 0$. Then choose $\delta = \min \{1, \frac{1}{2} \varepsilon^2\}$." While this phrase might spur the interest of a mathematician, an undergraduate student who is just learning how to prove theorems will undoubtedly be lost at the sight of these sentences. Where does the ε come from and why should we choose δ in this particular way? Students typically perceive this kind of proof as "coming out of nowhere" (Raman, 2003). What students don't realize is that the proof went through several iterations before it took this form. In order to show students that the final version of a proof does not readily flow from an author's quill, students were asked to discuss the proof first on the discussion board, then to submit a first draft of each proof, have it reviewed and critiqued by peers from the class, and then submit a final version.

The course syllabus outlined the expectations for the first and the final draft. In the first draft, students had to identify what would need to be done in order to prove the statement. They would also have to explain which definitions would be used in order to prove the theorem at hand. In the case of an ε-δ-limit statement, students would have to identify which quantity has to be less than ε and how a series of estimates can be made to obtain a suitable value for δ. The final version asked for a polished version of the proof – one that could be found in a textbook, which may be one that begins with the phrase "Let $\varepsilon > 0$."

The first draft would be submitted to the instructor, who would forward it to another student for review. For this purpose, there was a fixed due date for every homework assignment. When reviewing a peer's paper, students were asked to evaluate the validity of the argument, suggest corrections if needed, and provide guidance for how the proof could be improved. The expectation for this exercise was that students would learn to appreciate the elegance of a finished proof, and understand that such a proof requires a series of drafts. The reviewing student would have a chance to see another student's attempt at proving a statement, and would learn that there is usually more than one way of framing a valid argument. The instructor would critique all students' proof suggestions and provide additional input for how a correct (or better) proof could be written.

The peer's and the instructor's critique were returned to each student, who would then revise the original draft; it would either become a correct proof, or a more elegant proof.

Besides the homework assignments, critiques and participation in the online discussion, there were no further written assignments. In order to discourage plagiarism, students were expected to

be available for at least one telephone discussion with the instructor at some time during the semester. In this discussion, students were asked to explain their reasoning on a homework assignment. Most students were interviewed twice. Some students enjoyed this personal communication with the instructor and asked for additional interviews.

Examples of Some Course Work

The graphic reproduces some of the PowerPoint Slides from Section 13 of the textbook – "Topology of the Real Numbers". This section was covered at approximately mid-semester. By this time, students were proficient at viewing the PowerPoint lecture. The pictures below are examples of several slides from the lecture. Each slide begins with an empty page. A narration explains what is being done, and the text appears one line at a time. The two slides titled "Example 13.15" are examples of a graphic to which details are added as the explanation progresses. This is to allow students to build a mental model of the Natural Numbers as a subset of the Real Numbers, and of the concept of "not being an accumulation point".

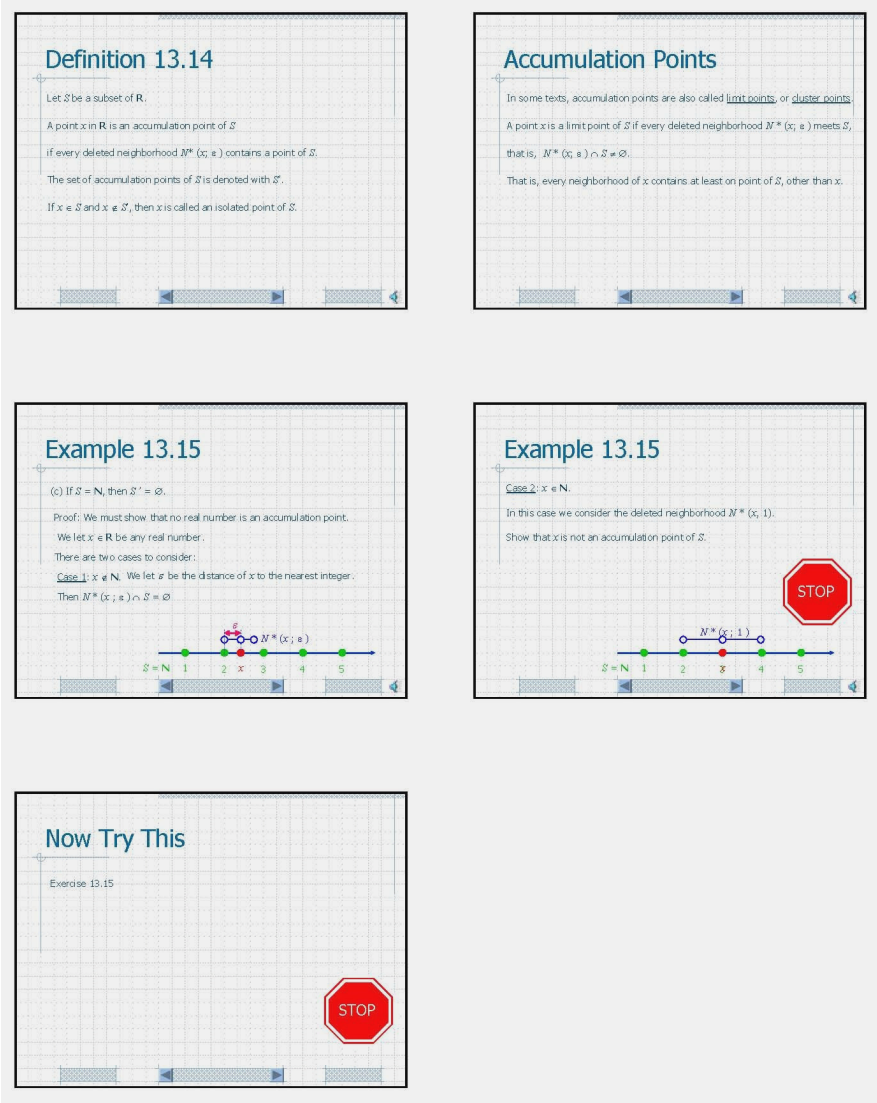

Figure 1. Examples of PowerPoint Slides

The stop signs invite students to perform a task and break the monotony of the PowerPoint lecture. The entire lecture for Section 13 contains 54 slides and takes approximately 60 minutes to play if no breaks are taken. It can be conjectured that students might spend twice this length of time if they replay some portion of the presentation or if they take notes as they watch the presentation. The entire section represents one week's work. The last slide invites the students to try Exercise 13.15 on their own. In fact, this problem was assigned as a homework problem.

Problem 13.15. Prove: *If x is an accumulation point of the set S, then every neighborhood of x contains infinitely many points from S.*

The proof of this statement is not a purely syntactic one, that is, it cannot be achieved merely by an instantiation of a Definition or a previously proved Theorem. It requires some insight topology of the Real Numbers. Weber (2002) argues that undergraduate students often lack the strategic direction for writing a valid proof. In order to help students overcome this hurdle, each problem usually included a hint as to how it could be started. The instructor provided the following guidance on the problem: "Analyze the statement, and then consider a contrapositive or a contradiction".

Students discussed the problem in the online discussion forum in the manner below. (The names of the students have been changed to protect their identities.) Note that the discussion threads span a time of 48 hours, and that most questions are answered within 36 hours of the start of the thread. In this discussion, there was no input from the instructor, however most discussion threads did require some intervention.
In this thread students treat each other cordially and appear to have an interest in answering each others' questions; this is typical for all discussions that took place in the course.

Author: Adam
Posted: 3/9/2007 11:34:21 AM
Subject: 13.15
The consequent is "every neighborhood of x contains infinitely many points of S"
The negation is there exists a neighborhood of x does not contain infinitely many points of S.
Do you know how to write this statement in sentence? I don't know how to translate "infinitely many points of S" to mathematical symbols.

> **Author:** Bryan
> **Posted:** 3/9/2007 11:58:48 AM
> **Subject:** RE: 13.15
> I think you can say "infinitely many points" The negation of this can be a neighborhood that contains a finite number of points. Then demonstrate the neighborhood in set notation.

Author: Cheryl
Posted: 3/9/2007 8:59:47 PM
Subject: 13.15
WE are to prove that if x is an accumulation point of the set S, then every neighborhood of x contains infinitely many points of S.

The hint at the back of the book doesn't' get me started, can anyone drop more hints on this?

> **Author:** Bryan
> **Posted:** 3/9/2007 10:08:05 PM
> **Subject:** RE: 13.15
> Use a contradiction and set up a neighborhood that contains a finite number of points. Pick an arbitrary closest point in the n'hood that is the closest to x and use e to show there is a closer one - a contradiction.

Author: Adam
Posted: 3/10/2007 11:12:40 AM
Subject: RE: RE: 13.15
Or you can consult the hints provided by Markus [the instructor], use ~q impies ~p, it also works.

> **Author:** Donna
> **Posted:** 3/10/2007 7:41:29 PM
> **Subject:** RE: RE: RE: 13.15
> This is what I did, use ~q implies ~p.
>
> From there, you can find a neighborhood of S that contains a finite number of element of the set S. Then show that there exists a deleted neighborhood of x that does not contain a point in S.
>
> Like Bryan said, define a neighborhood which contains a finite number of elements of S and then suppose that x is an accumulation point of S.
>
> Hope this helps you get started. 
>
> > **Author:** Cheryl
> > **Posted:** 3/11/2007 10:31:01 AM
> > **Subject:** RE: RE: RE: RE: 13.15
> > ic. thx everyone!

Below is Donna's first draft of the proof. She followed the instructions for this assignment

Exercise 13.15 Prove: If x is an accumulation point of the set S, then every neighborhood of x contains infinitely many points of S. ☆

Analysis: The statement is of the form $p \Rightarrow q$ where

p: x is an accumulation point of the set S

q: every neighborhood of x contains infinitely many points of S.

The contrapositive would be of the form $\sim q \Rightarrow \sim p$. In this case,

~q: there exists a neighborhood of S which contains a finite number of elements of S.

~p: x is not an accumulation point of the set S

Therefore in order to prove the original statement we can prove the contrapositive which says, "If there exists a neighborhood of S which contains a finite number of elements of S, then x is not an accumulation point of the set S."

In order to prove the contrapositive, we need to find a neighborhood of x that contains a finite number of element of the set S and show that for all $\varepsilon>0$, $N^*(x;\varepsilon)\cap S=\varnothing$. That is, we will show that for a point x, there exists a deleted neighborhood of x that does not contain a point in S.

Proof: Suppose $S\subseteq\mathbb{R}$ and there exists a neighborhood $N(x;\varepsilon)=\{x_1, x_2, x_3, \ldots, x_n\}$ which contains a finite number of elements of S.

Further suppose that x is an accumulation point of S.

If x_1 is the closest point in N(x;ε) to the accumulation point, then $\varepsilon_1=|x-x_1|$ where ε_1 is the radius of the neighborhood by definition 13.1.

Since x_1 is the closest point of N(x;ε) to x, all points in the smaller neighborhood N(x; ε_1) will be within the radius ε_1 from x.

By definition 13.14, a point x in $\mathbb{R}$ is an accumulation point of S if every deleted neighborhood of x contains a point of S.

In this case, $N^*(x; \varepsilon_1)$ does not contain any points of S, and therefore we conclude that $N^*(x;\varepsilon)\cap S=\varnothing$.

Because $N^*(x;\varepsilon)\cap S=\varnothing$, x is not an accumulation point of the set S as required.

This proves the contrapositive of the original statement and we conclude that "If x is an accumulation point of the set S, then every neighborhood of x contains infinitely many points of S". ♦

This first draft was followed by a peer critique. The student commented on Donna's paper:

Critique: You say "Suppose $S\subseteq R$ and there exists a neighborhood $N(x; \varepsilon)=\{x_1, x_2, x_3, \ldots, x_n\}$ which contains a finite number of elements of S." This is ~q. And then you say "Further suppose that x is an accumulation point of S." This is p. In your setup, I think that you are doing $(\neg q \wedge p) \rightarrow c$, or prove by contradiction by not prove by contrapositive.

The instructor's critique commented:

Exercise 13.15 (5 pts)

Make your final draft more concise. Omit the analysis. Begin your proof with the statement "We argue by contradiction: Assume that x is an accumulation point and that there exists a neighborhood N(x, ε) about x that only contains finitely many points."

Correct the statement $N(x, \varepsilon) = \{ x_1, x_2, \ldots x_n \}$. This would mean that the neighborhood itself only contains finitely many points. What you mean is that the neighborhood contains only finitely many **points from S (other than, possibly, x itself)**, which would be $N^*(x, \varepsilon) \cap \mathbf{S} = \{ x_1, x_2, \ldots x_n \}$.

The same correction must be done further down in the proof.

Donna followed up on the recommendations and provided the following proof in her final draft. Note that the proof is more polished than the first draft, but still is not perfect. It is clear that the student incorporated ideas from both her peer and from the instructor. This student also reviewed one of her peers' papers, so it is possible that she used some of the ideas of that paper in guiding her revisions.

We will argue by contradiction:

Suppose x is an accumulation point and that there exists a neighborhood

N(x;ε) about x which contains only finitely many points of S.

That is $N^*(x;\varepsilon)\cap S = \{x_1, x_2, x_3, \ldots, x_n\}$

If x_1 is the closest point in $N(x;\varepsilon)\cap S$ to the point x, then $\varepsilon_1=|x-x_1|$ where ε_1 is the radius of the neighborhood by definition 13.1.

Since x_1 is the closest point of $N(x;\varepsilon)\cap S$ to x, all points in the smaller neighborhood $N(x;\varepsilon_1)$ will be within the radius ε_1 from x.

By definition 13.14, a point x in R is an accumulation point of S if every deleted neighborhood of x contains a point of S.

In this case, $N^*(x;\varepsilon_1)$ does not contain any points of S, and therefore we conclude that $N^*(x;\varepsilon)\cap S=\varnothing$.

Because $N^*(x;\varepsilon)\cap S=\varnothing$, x is not an accumulation point of the set S as required and we conclude that "If x is an accumulation point of the set S, then every neighborhood of x contains infinitely many points of S". ♦

Discussion and Conclusion

In discussing the value of online learning, Kirschner et al. (2004) cite the formula

Valued Learning Experience = *F* (pedagogy, content, community),

where the function *F* has the property that if any of the three independent variables approaches zero, so does the value of dependent variable. The discussion will center on the pedagogy and the community aspects of this formula.

Pedagogy - Textbook and PowerPoint Lectures

The textbook and the PowerPoint lectures provided students with the mathematical content for the course. These two elements alone would have made the course into a glorified independent study – a course where there is no interaction among students, and only limited interaction between student and instructor.

From conversations with students, it appears that most used the textbook and the PowerPoint lecture while studying the material. Some students reported annotating the textbook, while others kept a journal with their notes. One student posted the following message on the discussion board during the first week of classes:

"*If anyone has not yet looked at the PowerPoint slides, I highly recommend you doing so. Everything is pointed out very clearly with good examples. They are easy to read and listen.*"

The comment was followed up by several others, agreeing to the post. In private conversations, students praised the lectures because they could replay individual slides and because the animated diagrams provided them with a mental model that helped them understand the concepts.

The purpose of requiring students to participate in an online discussion forum was to create a sense of community in which learning can take place. With few exceptions, students posted comments and questions during each week of the semester. The most prolific writers posted more than 200 messages throughout the term. The two least prolific writers (of those students who finished the course) posted between 50 and 60 messages.

The instructor participated in the discussion as well, posting over 500 messages during the semester.

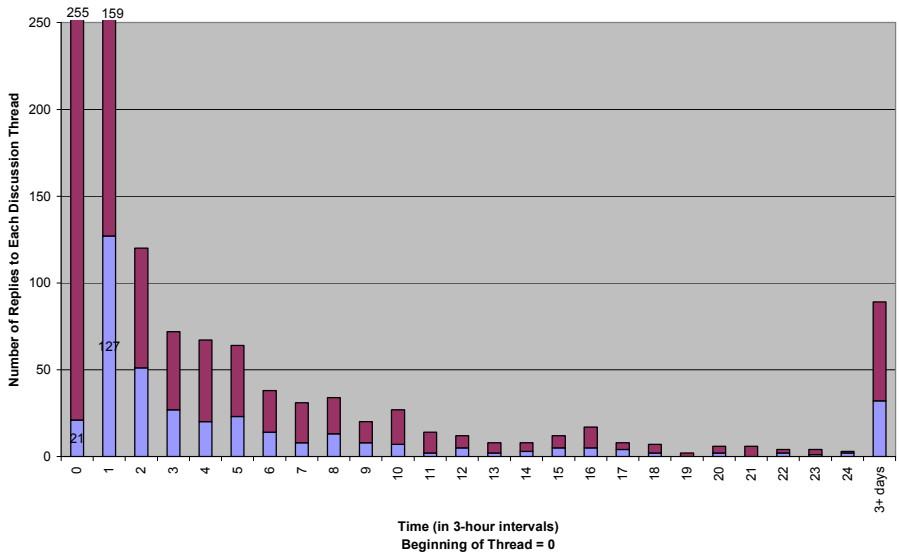

Figure 2. Elapsed Time to responses for each thread in a discussion forum

The graphic displays the elapsed time between the initial posting of a message in the discussion forum and all follow-up postings in response to this initial posting. (Students' postings are in purple, and instructor's postings in blue). The initial posting of a message occurs at time 0. The responses are grouped in intervals of 3 hours. Therefore, Time interval 1 means than an answer was posted within three hours of the initial message, 2 means that the answer was posted between 3 and 6 hours from the original message, etc.

Most of the discussion threads were student-initiated (255 threads versus 21 threads that were instructor initiated). The instructor replied to most initial threads within 12 hours of posting, but this initial interaction was usually intended to clarify the original question, to acknowledge that the question had been read, or to give a minor hint as to where the answer to the question could be found. Most of the discussion occurs within the first 24 hours of the initial posting of the message (the first eight 3-hour blocks). Discussion of the topic almost entirely ceases after the second day. A review of the discussion threads suggests that students were satisfied with the answers they received and hence saw no need to continue the thread. If a wrong attempt was posted in a discussion and students did not continue the discussion (believing that a correct answer had been found), the instructor would revive the thread by pointing out the mistake.

In conclusion, the use of the discussion forum proved an effective tool to involve students in collaborative efforts to understand the course material and to devise mathematical proofs.

A Community of Learners

The concept of a community is one of the central tenets of a valuable experience. The purpose of this section is to discuss whether the course format allowed a community to form. Schwier (2001) enumerates four characteristics of communities as being hospitable, having life cycles, being multifaceted and being resilient. Kreijns et al. (2004) argue that a sound social space is a requisite for the social aspect of learning in a community. The purpose of this section is to illustrate that the online discussion did indeed foster a community. Collaboration among students helped them develop an understanding of the concepts of Real Analysis.

Students who are freshly exposed to a new concept are usually not quite sure whether they fully understand the concept. The discussion forum was intended for students to test and discuss ideas in the context of the course content. It allowed them to overcome the feeling of uncertainty about

a new concept, or clarify any misconceptions. Admitting that one feels uncertain about a new concept puts the student at risk of being ridiculed by his/her classmates. In his initial post (above), Adam asks two questions:

> "Do you know how to write this statement in sentence? I don't know how to translate "infinitely many points of S" to mathematical symbols."

He admits not knowing how to translate a verbal statement into a mathematical one, and potentially opens himself up to criticism. The fact that he nevertheless asks the question is an indication that he trusts that his peers will not ridicule him, "flame" him, or subject him to unconstructive criticism.

The discussion that followed Adam's post is an indication that students did indeed develop a good working relationship in the class. In collaboration they analyzed the statement, found ways how to express a verbal statement into a mathematical one, and then discovered the key idea of the proof, namely that of a neighborhood of a given point x contains only finitely many points from S, then one of those points must have minimum distance to x.

The mathematical aptitudes of the students were quite varied, and some of the questions posed by the weaker students must have appeared trivial to the stronger ones. Nevertheless, there was never any critical or discouraging word posted in reply to a trivial question. In fact, the stronger students readily volunteered to answer (as well as they could) the weaker students' questions.

Consider the following messages regarding a detail that arises in solving a particular problem. Within this problem, students would need to solve the equation

$x = \frac{3y}{2+y}$ for y. The appendix provides students with this solution, $y = \frac{2x}{3-x}$.

Author: Frank
Posted: 1/27/2007 4:40:34 PM
Subject: Exercise 4.5
How does y = (2x) / (3-x) as stated in the back of the book?

I tried solving for y from
x = 3y (2+y), but I can't get it.

Thanks.

> **Author:** Bryan
> **Posted:** 1/27/2007 5:44:11 PM
> **Subject:** RE: Exercise 4.5
> 2x+xy = 3y then 2x=3y-xy then 2x=y(3-x) then
> 2x/(3-x)=y
>
> > **Author:** Bryan
> > **Posted:** 1/27/2007 5:45:46 PM
> > **Subject:** RE: RE: Exercise 4.5
> > I sometimes don't see the factors and staring at it does not help. Then all of a sudden there it is.
> >
> > **Author:** Frank
> > **Posted:** 1/27/2007 7:04:12 PM
> > **Subject:** RE: RE: Exercise 4.5-Thanks
> > Thank you Bryan.
> >
> > I appreciate the help.

Frank clearly has trouble with basic algebra. Nevertheless, Bryan explains how the desired solution can be obtained. He does so without being condescending and – in his second post – offers a few encouraging words to Frank. This thread was posted within the second week of the course. The well-mannered and mutually supportive nature of the discussion remained throughout the semester, even though Frank (and a few other similarly weak students) dropped the course.

Judging by the content of the discussion forum, students clearly took an interest in each others' progress in the course. The discussion forum provided a safe place for conversation – students could (and indeed did) ask questions and participated in discussion without being "flamed" or subjected to other non-constructive criticism. As such, the discussion forum met the standards of one of Hill's (1999) best practices for creating a community of online learners, and one of the characteristics of Kreijns' et al. (2004) "sound social spaces". The discussion in the course provided a hospitable environment where students could test their ideas.

An unexpected side effect of the online discussion was that some students began to communicate with one another outside of the discussion forum. This phenomenon has been observed before. Schwier and Balbar (2002) compare these out-of-sight conversations to students whispering to each other during class, or passing notes. The instructor became aware of the "whispering" because students referenced their study-buddy's help when handing in the homework assignments. At least two such virtual study-buddy pairs formed, which is considerable, given the class size of 9 students after mid-semester. Those students also continued their participation in the discussion forum, so the rest of the class did not lose their input after the study-buddies formed.

Kreijns et al. (2004) argues that a sound social space enables effective collaboration. They define a social space as the network of social relationships between members. Thus, the development of study-buddy pairs who collaboratively work on course assignments indicates that the online discussion format was successful in creating a sound social space. In Schwier's (2001) terms, this forming of study-buddy pairs reaffirms that communities tend to find ways organize and redefine themselves – they find ways to adapt to external constraints. In this class, some members of the group found that the discussion in the online forum did not suit their needs. They overcome this hurdle by mutating and finding a way to bypass this perceived obstacle: In this example, the students chose to communicate via email and telephone, in addition to the discussion forum.

Naturally, most of the discussion in the forum centered about course content. Some discussion threads, however, branched off and took on a different perspective. Consider the discussion between two students:

Author: Adam
Posted: 1/24/2007 4:30:22 AM
Subject: general question
The text says that we need to prove a theorem (the relationship between hypothesis and conclusion). However, what I learn in statistics is that a hypothesis cannot be confirmed or proved but only not to be rejected.

Any ideas?

> **Author:** Cheryl
> **Posted:** 1/24/2007 4:52:38 AM
> **Subject:** RE: general question
> http://en.wikipedia.org/wiki/Theorem
>
> notice that hypothesis means different things in different contexts.
>
> > **Author:** Adam
> > **Posted:** 1/24/2007 7:47:25 AM

Subject: RE: RE: general question
Why? If I remember correctly, according to K. Popper, we cannot confirm a hypothesis but only not to reject it.

Author: Cheryl
Posted: 1/24/2007 7:55:25 AM
Subject: RE: RE: RE: general question
Direct quotes from wikipedia:

On "hypothesis" in theorems
"A key property of theorems is that they possess proofs, not merely that they are true. Logically speaking, everything that is proved is something in the form: if A, so B. In other words, only implications are proved, its impossible to prove that B is always true, but what may be possible to prove is that B is true if A is true. In this case A is called the HYPOTHESIS of the theorem (note that "hypothesis" here is something very different from Conjecture)."

"Hypothesis" in hypothesis testings
"A statement which is believed to be true but has not been proven is known as a Conjecture (sometimes conjectures are also called HYPOTHESIS, but, of course, with a different meaning from the one already defined here)."

Author: Adam
Posted: 1/24/2007 8:01:44 AM
Subject: RE: RE: RE: RE: general question
I give you an example. In regression analysis, if prices increases, then quantity demanded decreases. This is a theorem according to the text's definition, right? But this is also a hypothesis according to your above reference. However, we do not prove but not only to reject this "hypothesis".

Here, students discuss the meaning of the word “hypothesis”. In doing so, they consider economics and statistics; they use a Wikipedia reference in clarifying the term “Hypothesis”. In a sense, the discussion about the meaning of the term “hypothesis” is irrelevant to content of the course. It did, however, appear important to the students and they took the time to discuss the term. This slight off-topic discussion is an indication that students feel that the discussion forum is a place to discuss topics that are important to *them*, and that they feel safe at doing so.

As the semester ended, students posted these comments on the discussion board:

Author: Bryan
Posted: 4/21/2007 9:52:44 AM
Subject: Thank you
I have to work this weekend and will not be on the board anymore. I want to thank all of you for your help on the discussions. I have learned something from each of you in critiquing your papers. Your comments on the board and your papers have been a huge help to me in completing this class. Thank you, Bryan

Author: Cheryl
Posted: 4/21/2007 10:06:48 AM
Subject: RE: Thank you
Thanks for your always helpful critiques, too. I learned a lot from you. I hope you get your a teaching cert. in math soon. 

Author: Adam
Posted: 4/21/2007 11:06:47 AM
Subject: RE: RE: Thank you

> Frankly, I enjoy this course very much. I put a lot of time in this course and finally I learned a lot. Thank you Markus and my classmates for your critiques on my works!

The discussion here illustrates that students – in some way – cared about each other. Bryan takes the time to wish his classmates farewell, while Cheryl takes a personal interest in Bryan's career aspirations. The two discussions suggest that the nature of the discussion in the group is not only focused on Real Analysis, but takes on other albeit less prominent facets.

It appears that these students valued each other's presence in the online class; their messages are personal and might even express some sort of melancholy about the imminent end of the course. It may be conjectured that student interaction through peer review and online collaboration created cohesiveness among the group. Indeed, some of the students kept up their collaboration for some time after the official end of the course, which suggests that the collaboration did not only occur because it was a course requirement, but because students took an interest in working with their peers.

Synchronous or Asynchronous Discussion?

One might ask whether a synchronous discussion might have been more advantageous in creating such an online community. The technological limitations of the course management software used here would not have allowed for writing mathematical symbols in "real-time". Even though this technical difficulty might be overcome in the future, a more philosophical issue is whether finding a quick response to a hastily posed question (as would be the case in a chat room) is desirable in mathematics. After all, mathematicians pride themselves in finding concise ways of asking a question and in polishing their proofs. This, of course, takes time, and an online discussion forum might be the preferable way of teaching students a mathematician's way of thinking.

A more practical perspective arises from the convenience an online course offers students. They are not bound by a particular class schedule and may complete the assignments when their schedule permits. The table below shows the number of postings to the discussion board as a function of the time of the day. With the exception of the early morning hours, there is no specific time of day during which students prefer to participate in class. Setting a specific time at which the entire class would participate in an online chat would therefore take away some of the freedom students gained by taking the online class.

Given that the asynchronous discussion forum was able to generate a community of learners, the practical and philosophical disadvantages appear to outweigh the benefits (Schwier & Balbar, 2002) of synchronous discussion.

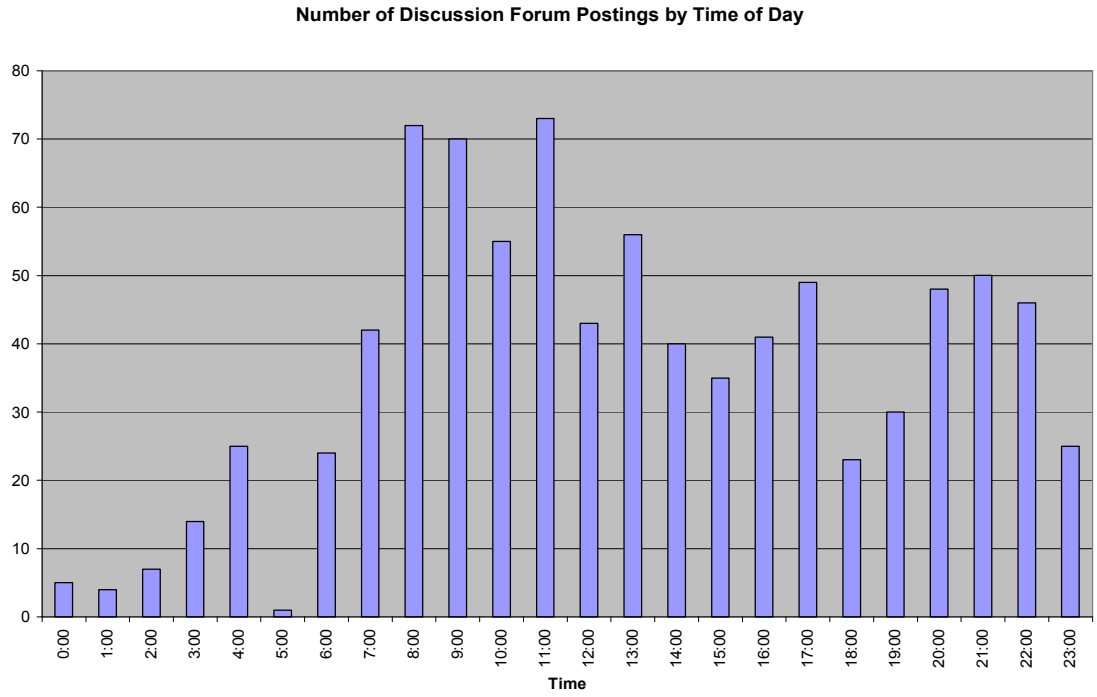

Figure 3. Time of access

Challenges

One of the challenges in this course was that not all students participated equally well in the discussion forum. As explained earlier, there were two students who only contributed between 50 and 60 times to the discussion forum during the semester, while all other students contributed more than 150 times. This lack of participation is not due to the fact that students had no access to the internet: One of those students accessed the course website more frequently than some of the most prolific writers. The other student spent more time logged into the course website than most other students. A review of the content of the messages these two writers posted does suggest that they did not grasp the material well enough to even formulate a valid question. (Frank's posting above is one of them). That is, those students did not participate in discussions because they likely had nothing significant to contribute. In fact many of these students' postings contain trivialities like "I understand now," despite the fact that their homework assignment suggests otherwise.

Lack of preparation and inability to understand content are of course challenges in every class, online or not. As in a traditional format, those difficulties manifest themselves in lack of participation and poor performance on assignments.

Another challenge in this course was a high non-completion rate. Of an initial enrollment of 15 students, only 8 completed the course with a passing grade. The remaining seven withdrew officially (5), were administratively withdrawn for financial reasons (1), or gave up without officially withdrawing (1). Those students who withdrew typically stated or implied that they were underprepared and could not find the time to make up for this lack of preparation. Even those students who remained enrolled contended that the time required to succeed in this course was more than they had anticipated. The investment of time for interacting in an online environment can be 2-3 times higher than in a face-to-face course (Palloff & Pratt, 1999), and in

this regard the course at hand was not an exception. The course setup may therefore be well in line with other distance education courses. Nevertheless, a high non-completion rate is unsatisfying to the instructor. Providing more guidelines for time-management could help students in this situation. The learning community was effective in supporting the work of academically prepared students. Their work suggests that discussion and collaboration helped them achieve the goals of the course. The community was not able to remediate the deficiencies of the academically underprepared students. Those students contributed little to the group's efforts at solving problems. It may be argued that the community marginalized those two students, or that those two distanced themselves from the community.

Conclusion

In summary, it appears as if the course structure was successful in creating a community of learners – a group of persons who are willing and able to assist each other in their learning. The structure was equally successful at creating a safe learning environment, where students could contribute to the discussion without fear of non-constructive criticism. The group dynamic was used successfully in helping students understand Real Analysis and gain an initial understanding of how to write a formal proof. Of course, this study only relies on one instantiation of this course, and can therefore not easily be generalized. Nevertheless, it is clear that community can be created in an on-line upper-division math course, while maintaining the academic standards of the course.

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