CUSTOMIZING THE CLASSROOM LEARNING ENVIRONMENT – A PHASED EXPERIMENT

Sandra Poindexter, Northern Michigan University, spoindex@nmu.edu
David Allen, Northern Michigan University, dallen@nmu.edu

ABSTRACT

Information Systems is one of the fastest changing disciplines and trying to stay abreast of new technologies is a strain for both students and faculty. Once graduated and employed, an IS worker is most valuable if able to locate resources for new trends, analyze them for relevancy, train themselves in new skills, appropriately apply new skills, and share knowledge with colleagues. The question prevails: is there a "best way" to teach IS courses?

Keywords: innovative teaching, collaborative learning, instructional technology, teaching and learning, technology integration, laptops

BACKGROUND

Various approaches have been used in teaching IS: pure lecture, lab units, integration of instructional technology, tutorials, teamwork, project-based assignments, and interactive settings. Reasons for perceived successes and failures of these methods vary with the instructor, course, students, and institutional environment. Shifts in the competencies of incoming students have impacted the type of material covered in the standard class period – a higher percentage of students enter knowing the basic mechanics of the computer, but not how to effectively apply that skill. While it varies with the course, these changes can lead to more time for "why" topics in place of "how to" topics. Rapid changes in technology have affected both course content and options for course delivery.

In Fall 2000, Northern Michigan University, a regional institution with approximately 8,000 students, established a campus-wide laptop policy. This mandatory program standardized a set of technology tools (laptop, software, and Internet access) for all full-time students and faculty (5). Infrastructure changes over the last five years have provided network ports in lounges, study rooms, labs, campus residence hall rooms, and faculty offices. All classrooms have a network port for an instructor workstation and 30 classrooms accommodate electrical and network outlets at each student seat. This policy opened the door for a significant increase in projects during class time, an opportunity to consider alternatives in teaching and learning, and a shift to a 20/80 model (4) of education (20% lecture/ 80% interaction with high demands of student preparation and participation, aided by technology integration).

From the instructor's view, the positive anecdotal evidence from reducing lecture time seemed strong enough to continue teaching with this blend of teamwork, technology, and interactive exercises. As researchers, though, the missing piece was the validation of the anecdotal evidence. Were the positive responses from earlier experiments with the 20/80 model due to other variables, such as student composition and their prior knowledge/aptitude, or could they be contributed to the learning environment?

In order to conduct controlled testing on these approaches, a yearlong experiment was planned and implemented in an introduction to programming course. The premise of this study was that a full integration of a technology, interactivity, and teams was needed in order to optimize student performance. Specifically, this study was created to determine a) is there factual evidence to support that a technically enhanced, highly interactive, and integrated teaching approach actually increases student performance, and b) is there a threshold in the use of these techniques at which this approach works well and a higher investment of time and effort does not produce significant additional gains.

Techniques to control the study's variables included gathering pre-test and post-test knowledge data, demographics, pre-attitudinal information, learning styles, and personality types. Methods of assessment were programming assignments, written content exams, lab skills test, and participation. This paper presents the details and outcomes of the study and provides a starting point for their discussion.

STUDY DETAILS

The course chosen for the study was Software Development I (an introduction to Visual Basic programming) taught as a two credit, eight-week course. Taken by CIS majors during their late freshman or early sophomore year, this course serves as a gateway to the upper division courses and has a diverse group of students. The enrollments were 23, 23, 24, and 24 students, respectively. During the Fall 2000 and Winter 2001 semesters, four sections were taught in sequence (Fall 2000 – first and second eight weeks, Winter 2001 – first and second eight weeks) permitting a testing of four phases of integration levels.

Phase I = Traditional classroom environment + course website

- Standard lab classroom configuration with rows of desks facing forward and a laptop computer positioned at each student desk
- Instructor is focal point during class with ~100% lecture using large screen projection
- Textbook tutorials and assignments are done outside of class time
- No scheduled student interaction time
- No permitted student collaboration
- Participation included attendance, asking questions, offering comments
- Course website posted a syllabus, outline, handouts, files, and assignment instructions

Phase II = Phase I + interactive class time + peer learning

- Scheduled interactive class time: 50% and 50% experimentation with practice exercises
- Peer interaction encouraged
- Assignment collaboration permitted; students could work on assignments in pairs and submit one program solution with multiple names
- Course website now includes voice annotated presentation slides for outside lecture material

Phase III = Phase II + group, rather than traditional, classroom setting

- Tables (seating 4) arranged in conference-room style with network and electrical connections for four laptops at each table

- Scheduled interactive class time: 40% lecture and 60% student experimentation
- Peer interaction expected; discussions were held regarding the value of peer learning and its importance in this class to student success
- Assignment collaboration encouraged, but not required; student pairs could submit one solution.
- Course website now includes posting of "good" assignment solutions for peer review
- Participation grade now includes evidence of helping peers in and out of class time, such as emails between students asking for help or clarification.

Phase IV = Phase III + expanded interactivity and creativity

- Scheduled interactive class time: 30% lecture and 70% student experimentation
- Sharing of food/snacks permitted while working, sometimes offered by instructor, to encourage a casual learning environment where people feel free to talk
- Assignment creativity and solution variation encouraged by telling students they could alter assignments or expand exercises by programming additional features or improving the look of the program's screens. Students could share ideas on variations. Being creative earned more participation points, but did not add to the assignment score.

The interactive exercise concept requires more careful explanation. In Phases III and IV, and to a lesser extent Phase II, students were told they must come to class prepared to do a short, ungraded exercise based upon the textbook tutorials. During a typical class, there would be an introduction of the day's topics followed by a short lecture using presentation slides and sample Visual Basic programs to cover the most complex portions of the textbook material or to give an overview to put the textbook items into a broader perspective. Either during the presentation or after it, students would be told to download an exercise to be completed immediately. Typically, the exercise involved modifying or completing a program shell according to general guidelines; specific steps to complete the work were not provided, reinforcing to students the need for preparation prior to class. Completed solutions were emailed as file attachments to the instructor as a record of attendance and participation, but not graded.

The classroom setting also needs further clarification. In Phase I, students were stationary at their individual seats facing forward. In Phase II, students worked alone or with a person sitting next to them in the rows facing forward. In Phase III, students tended to work with others at their table of four. In Phase IV, students were encouraged to seek or get help at another table.

To control for other variables, students took several surveys at the outset of the class and one repeat survey at its completion. The initial surveys logged prior knowledge using a 30 question content quiz, collected basic demographic information, categorized personality temperaments with a Keirsey Temperament Sorter instrument (modified Myers-Briggs) (2) and learning styles with the Kolb inventory (3), and documented student attitudes towards computers with the Gressard and Loyd attitude survey (1). At the conclusion of the course, students retook the 30 question content quiz. In statistical analysis, grades for assignments, tests, and participation, as well as the overall scores for the course, were matched with the student survey information.

STUDY OUTCOMES

Quantitative Results

The letter grades, average overall grade percentage, and component scores are means of determining student performance. Table 1 provides the numerical results.

Table 1. Distribution of Overall Grades by Phase

Grade	I	II	III	IV
A	1	7	7	6
B	8	6	6	6
C	4	1	4	4
D	2	1	5	5
F	4	3	1	1
Withdrew	4	5	1	2
Total # of students	23	23	24	24

Based upon these measures, Phase I stands out with lower values with Phases II, III, and IV relatively similar in results. In Figure 1, the X-axis reflects the letter score, including a value of "W" for the number of students who withdrew from the course after completing at least ½ of the course's duration. The trends in Figure 1 indicate that letter grades were higher and fewer people withdrew, particularly during Phases III and IV, as more interactivity was added to the course. Figure 2 confirms the linear graph by showing that the overall average grades for Phase I was lower than the other phases.

The overall grade was broken down into its three components – assignments (40%), participation (10%), and tests (50%) – and is graphed in Figure 3. Phase I has lower scores across all three components with the other three phases similar to each other. In all four phases, students were given three tests. Two were written exams testing on terminology, programming concepts, and syntax recognition and error resolution. The format was short answer or short problem, but did not involve use of the software or computer. The third test, given the last week of class, was a software and skills test where students applied their knowledge by programming a fully working solution for a given program specification. Figure 4 indicates that there was not a wide variation in learning terms and basic concepts (written tests) between the Phases. Written text scores for students in the Phase I full lecture were not significantly different from those with less lecture and more self-learning from the text and handouts (Phases II-IV). However, students in all

Figure 1. Phase Comparison by Grade

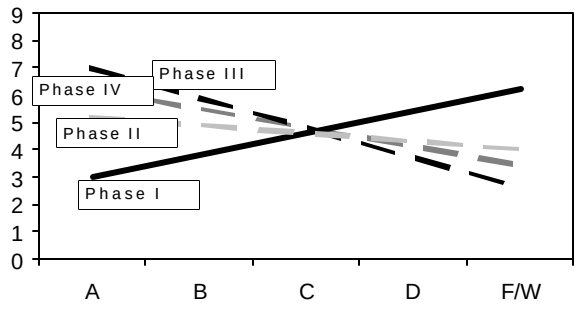
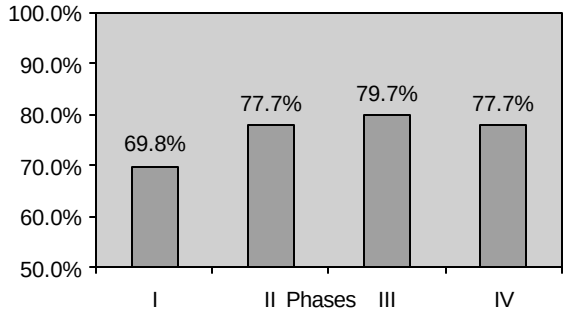


Figure 2. Phase Comparision by Average Overall Grade



phases that had in-classexercises, peer learning, and less lecture scored significantly higher on the software skills test that involved active problem solving.

Figure 3. Phase Comparison by Average Grades

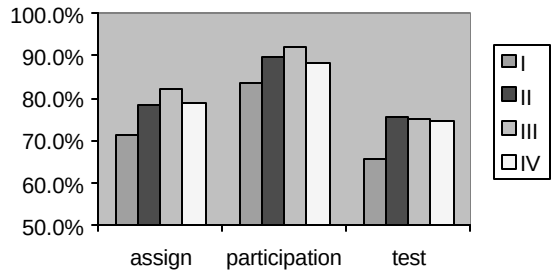
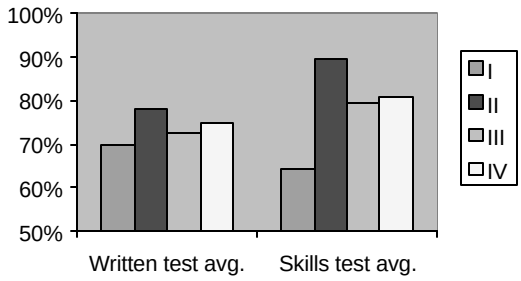


Figure 4. Phase Comparison by Test Scores



Perceptions, via student course evaluations indicate satisfaction increased as the phases progressed. Students answered 11 questions relating to their perception of the course and four questions pertaining to their perception of their contribution/effort towards the course. Table 2 lists the numeric results of these evaluations.

Table 2. Mean Evaluation Scores by Phase (4.0 maximum)

Evaluation Done	I	II	III	IV
Student evaluation of course	3.08	3.38	3.29	3.32
Student evaluation of self-effort	3.13	3.50	3.41	3.23

While not significantly different, the same pattern repeats from the other course outcomes – Phase I is lower than the other three phases. It is interesting to note that even the students' perception of their own effort was lower in Phase I. These numbers correlate with the qualitative responses. In Phase I, numerous comments were given such as "it was not very exciting and did not hold my attention," "needs better examples and showing how to do specific things," "if there was more time, maybe get into groups and do a simulation of a real business programming project," and "more student interaction needed." Most students liked learning to program, but not the method of delivery. Motivating the students during lecture was difficult to accomplish; apathy and fatigue existed. Phase II was essentially void of written comment. Class time was more alive, though some students did not comfortably accept working in teams and physically distanced themselves from others to avoid having to team up with another student. The issue was not forced; students were permitted to work alone. Phases III and IV, had numerous comments, of a positive nature, such as "The class was fun and I learned a lot," "I liked having the syllabus, files, etc. available online," "I learned a lot in a short period of time," and "learned great organization skills in respect to the course."

Statistical Analyses

The primary hypothesis being tested was that phase has no effect on grade. When Overall Grade Percentage is compared over four phases there is insufficient evidence to reject the hypothesis—it cannot be said that variations in teaching methods between phases had an effect on Overall Grade Percentage. Even when the results for Phases 2, 3 and 4 are combined, the evidence is slight ($F = 3.12$; Prob = 0.081). The charts presented in Figures 1 and 2 seemed to visually indicate otherwise, but with small sample sizes the statistical results were not significant.

However, the evidence is far stronger when we compare letter grades. Phases 2, 3 and 4 do not differ, but Phase 1 differs from the other three based on a Kolmogorov-Smirnov test comparing Phase 1 to the combined other three phases (D = .833, Prob = 0.009).

Overall Grade is calculated from scores for Assignments, Participation, two written tests (Test1 and Test2) and a skills test (Test3). A principal components analysis supported the concept of a summated scale; the coefficients of the first component were all of the same sign and very nearly of the same value. However, only the skills test (Test3) was correlated with the second component, suggesting that something else was being measured as well. All of the five grade variables showed a similar pattern, but only Test3, the skills test, adequately discriminated amongst the four phases. A stepwise multiple discriminate analysis was conducted (approximate F = 6.4719 with 3 and 75 degrees of freedom; prob = 0.0006). Table 3 shows the matrix of pairwise F-values. As can be seen, Phase 1 differs highly significantly from Phase 2, and somewhat less so from Phases 3 and 4. Phase 2 differs weakly (10% level) from Phases 3 and 4, while Phase 3 and 4 do not differ.

Table 3. F-matrix Between Phases F-values with 1 & 75 degrees of freedom

Phase	I	II	III
II	18.277		
III	7.952	3.191	
IV	9.249	2.338	0.070

As mentioned above in "Study Details," data was collected on a number of other variables such as GPA, prior knowledge, age, etc. These were subjected to statistical scrutiny to see if they had a statistically significant impact on the grade - phase relationships. Very few of these other variables were related to phase; those that were related to phase were unrelated to Overall Grade or its components, and vice versus.

DISCUSSION

The extensive use of the Internet for course content delivery and course management freed class time for programming exercises and assignment startups. Programming requires practice and students are not likely to spend time outside of class doing "extra" ungraded exercises. They are, however, more apt to read and outline the text content and complete graded assignments. Using this 20/80 model plays upon those tendencies by reversing the activities in and out of class. Students quickly realized that they could not do the in-class exercises if they had not read the text – there would be no lecture to make up for not doing so and they became accountable. In a lecture based environment, students often feel that they understand the material and what the assignment requires until they actually begin the assignment. By doing in-class exercises and starting assignments in class, students had an opportunity to identify items they did not comprehend before leaving. The skills test (Test3) was significantly lower for Phase I where the primary method of instruction was lecture and a tutorial textbook. The distinctions between this study's setting and the tutorial-based lab setting used by many computer courses are the peer learning emphasis rather than independent lab work, and the expectation that textbook tutorials were done prior to class so that class time would extend those tutorials with more practice.

The group table setting for the last two phases significantly increased discussion and peer learning. Physical movement increased – students got up to see how others were doing or to help

someone else. Noise level increased – students were more willing to first ask one another a question, asking the instructor when none of the peers knew either. Clock watching – determining how much time was left – was not evident in Phases III and IV as it was in Phase I with more lecture. It is probable that physically facing their peers rather than the front of the class, together with verbal reminders to assist each other, enabled the students to change their behavior. Since there was no difference between the phases in student population for learning styles, personality types, or attitudes, it leads one to believe the learning environment affected the willingness to work with peers in class.

CONCLUSIONS AND SUMMARY

To restate the intent of the experiment, this study was created to determine a) is there factual evidence to support that a technically enhanced, highly interactive, and integrated teaching approach actually increases student performance, and b) is there a threshold in the use of these techniques at which this approach works well and a higher investment of time and effort does not produce significant additional gains.

Due to the small sample sizes and fixed nature of the experiment, it is premature to state conclusive results regarding student performance, but there was a perceived and significant upward shift in attendance, interest, resourcefulness, and attitude as each phase was added. Course evaluations also improved. Quantitatively, conceptual test scores were similar, but the skills test scores were higher for the non-traditional phases.

Faculty may welcome the chance to improve the learning environment in their classrooms if they could predict the return on their investment of their limited resources. There did appear to be a threshold effect. From the knowledge gain perspective, in this experiment it did not appear necessary to spend inordinate amounts of preparation time and teaching energy creating a team atmosphere with extensive interactivity during class. The level of interaction and technology enhancement provided in Phase II was sufficient in this introductory programming course. However, from the instructor's self-fulfillment measure, class was more enjoyable the more interactive it became. Depending upon the personality of the instructor, this fulfillment may be benefit enough to cover the additional costs of preparing group activities and the costs of change to a mentor/consultant role.

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