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Comparing Effectiveness of Instructional Delivery Modalities in an Engineering Course

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The effectiveness of four instructional delivery modalities, (i) traditional lecture, (ii) Web-enhanced lecture, (iii) Web-based self-study and (iv) Web-based self-study and classroom discussion, was investigated for a single instructional unit (Non-linear Equations) over separate administrations of an undergraduate engineering course in Numerical Methods. Two assessment instruments—student performance on a multiple-choice examination and a student satisfaction survey—were used to gather relevant data to compare the delivery modalities. Statistical analysis of the assessment data indicates that the second modality, in which Web-based modules for instruction were used during face-to-face lecture delivery mode, resulted in higher levels of student performance and satisfaction.

Keywords: assessment; distance learning; instructional modes; numerical methods; web-based resources

INTRODUCTION

WEB MODULES have been developed for a junior-level Numerical Methods course delivered in the College of Engineering at University of South Florida, Tampa.

The unique features of the Web-based modules are that they are both holistic and customized (Fig. 1). Holistically, the Web-based modules review essential course background information; present numerical methods through several options—textbook, lecture videos, PowerPoint presentations, simulations and assessments; show how course content covered is applied in real life; tell stories to illustrate special topics and pitfalls; and give historical perspectives to the material [1, 2]. Faculty and students are able to choose a customized view based on their preferred computational system—MAPLE [3], MATHCAD [4], MATHEMATICA [5], MATLAB [6] and choice of engineering major—chemical, civil, computer, electrical, general, industrial and mechanical.

The focus of this research is to compare four different instructional delivery modalities, namely:

- traditional lecture;
- Web-enhanced lecture;
- Web-based self-study;
- Web-based self-study/discussion.

The present study is a follow-up of findings reported in a previous paper [7], where we addressed the first two modalities. Since the completion of the previous study, the course has been delivered twice more, once with a Web-based self-study and another with combined Web-based self-study followed by a classroom discussion.

In recent years, there has been a substantial amount of research exploring how to enhance student learning across disciplines, including science, mathematics, engineering and technology (SMET) courses. Research in this area spans academic disciplines and professional preparation, from medicine [8] to education [9] and computing to business [10]. Furthermore, the research base is exploring how e-learning, as internet-based education is often referred to, has different benefits based on characteristics of the individual student. The *British Journal of International Technology* devoted an entire issue [11] to this topic alone. Among other things, the journal content [11] discussed the need to be aware that distance learning has a unique ability to provide students with different learning choices via varied resources and strategies. Techniques and tools to enhance learning using the Web include effective and adaptive navigation as well as addressing multiple and diverse needs and interests of the student [12].

The text, *How People Learn* [13], provides a foundation for many of the issues facing current educators who are encountering an increasingly diverse and multi-faceted student population. This literature was foundational to the exploration of various modalities of course delivery considered in this study. According to *How People Learn*, experts (in this case, faculty) 'often forget what is easy and what is difficult for students' [13, p. 32]. Relative to this issue, the modules and instructional materials developed through this study offer both students and faculty a comprehensive instructional package for simplifying and enhancing the

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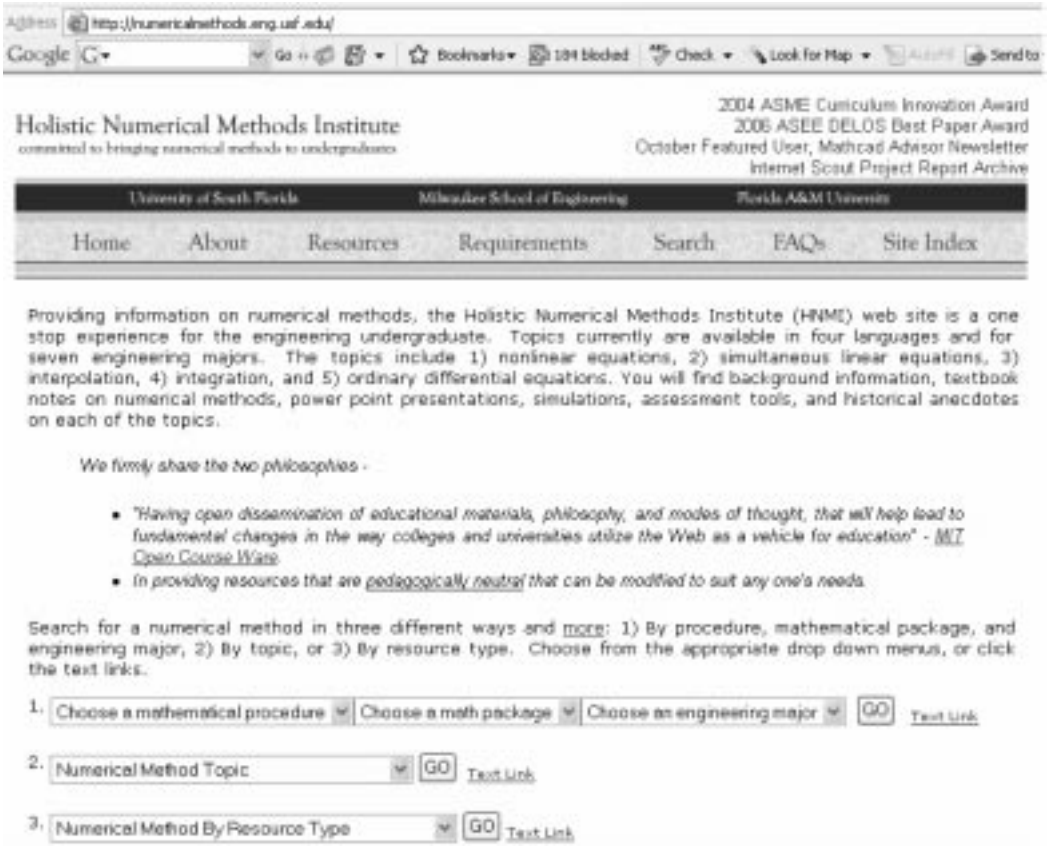

Fig. 1. Home page of the Holistic Numerical Methods Institute—committed to bringing customized numerical methods holistically to undergraduates.

teaching of numerical methods across the engineering curriculum.

Further, research has demonstrated that it is beneficial to provide 'instruction that enables students to see models of how experts organize and solve problems' and that 'the level of complexity of the models must be tailored to the learners' current levels of knowledge and skills' [13, p. 37]. The design and format of the Web-based modules helps students see how experts apply fundamental numerical methods to solve real world engineering problems both within and across different engineering disciplines.

And finally, citing again from this same synthesis of research findings, we know that 'a major goal of schooling is to prepare students for flexible adaptation to new problems and settings' [13, p. 65] and that 'knowledge that is taught in only a single context is less likely to support flexible knowledge transfer than is knowledge that is taught in multiple contexts' [13, p. 66]. Our effort was to provide diverse instruction opportunity to suit different learning styles [14]. By enabling students to select both a preferred computational system and one or more illustrative examples drawn from seven popular engineering majors within each topic area, these interactive instructional modules maximize the likelihood of lasting and flexible learning transfer of course content.

IMPLEMENTATION

The previous study [7] compared the first two delivery modalities:

- traditional lecture
- Web-enhanced lecture
- for the two topics of non-linear equations and interpolation.

In this paper, the focus is narrowed to the topic of non-linear equations, but the scope of data is broadened by looking at four delivery modalities. The four modalities were implemented in four separate summer semesters—Summer 2002, Summer 2003, Summer 2004 and Summer 2006 semesters, respectively. The same instructor (first author) taught the course in all the four semesters. One may question that the students taking classes during summer semester may not represent a true sample of the student population, but at USF the demographics of students taking summer classes are not significantly different [7] from those in the regular academic semesters of fall and spring. This is because:

- USF is an urban university and half of the students are part-time students (taking less than 12 credit hours per semester) who take courses throughout the calendar year;

- all students at USF are required to take at least 9 credit hours of coursework in summer semester during their undergraduate program;
- the Numerical Methods course is offered only during the spring and summer semesters and both semesters have nearly equal enrollment.

In the Summer 2002 semester, students in the Numerical Methods course were instructed on non-linear equations using the traditional, face-to-face lecture method without the use of the Web-based modules, hereafter referred to as the traditional lecture mode of delivery. We used a popular engineering numerical methods textbook [15] for reading assignments and problem sets.

In the Summer 2003 semester, students were instructed on the same topic of non-linear equations using both lecture and the Web-based resources developed for the course, hereafter referred to as the Web-enhanced lecture. Before discussing numerical methods for a mathematical procedure, we conducted an in-class and informal diagnostic test on the background information via several multiple-choice questions. This allowed us to review the specific material with which most students struggle. We used PowerPoint presentations to present the topics. These presentations were supplemented continually with discussions based on spontaneous instructor and student questions. Several times during the presentation, students were also paired in class to work out iteration or two for a numerical problem. We also met during the weekly computer laboratory session where each student had access to a computer. Simulations for various numerical methods were conducted. Reading assignments were based on textbook written by the first author and problem sets included questions based on Bloom's taxonomy [16].

In the Summer 2004 semester, students received instruction through a distance format without a classroom lecture component, hereafter called the Web-based self-study mode. The same resources were available to students as they were in Summer 2003. In addition, lecture videos that were recorded in a studio were available online. Since the students were learning the material themselves, regular class periods and the weekly laboratory session devoted to the topic of non-linear equations as in Summer 2003 were cancelled. At the end of the week, as part of their graded homework assignment, students were asked to submit answers to 18 short questions (six on each of the three subtopics of background, bisection method and Newton–Raphson method) that were based on the six levels of Bloom's taxonomy. The reading assignments and problem sets were the same as in Summer 2003.

In the Summer 2006 semester, students used the same self-study methods as those in Summer 2004, but were required to meet in the weekly laboratory session to discuss the lesson. This mode thereafter was called the Web-based self-study/class discussion. Although attending the weekly lab session was mandatory, they were not required to ask questions. Before the weekly laboratory session, as part of their graded homework assignment, students were asked to submit answers to nine short questions (three on each of the three subtopics) based on the lower three levels of Bloom's taxonomy (knowledge, comprehension and application). After the weekly laboratory session, they were asked to submit answers to nine more short questions (three on each of the three subtopics) based on the upper three levels of Bloom's taxonomy (analysis, synthesis and evaluation). The reading assignments and problem sets were the same as in Summer 2003.

ASSESSMENT INSTRUMENTS

To measure the student performance, four questions were asked in the non-linear equations portion of the final examination (consisting of 32 questions on eight topics). Two of the four questions were selected at the lower levels of Bloom's taxonomy, while the other two were chosen from the upper levels of Bloom's taxonomy. Student performance on these four questions was examined as a function of the four course delivery modes. In the previous study [7] that examined results from two of the four delivery modalities, student performance was measured using results from 12 multiple choice questions (six questions each from non-linear equations and interpolation) as part of the final examination. The six questions from each topic were based on the corresponding six levels of Bloom's taxonomy [16]. Since Summer 2004, only four questions are asked in the final examination on each topic, two at the lower level of Bloom's taxonomy and two at the higher level of Bloom's taxonomy. This was changed because the whole final examination was made multiple-choice from Summer 2003.

To measure student satisfaction, a survey that gathered information on students' perceptions of the presentation and how it affected their learning of the material was developed. These data were both quantitative and qualitative in nature, thus permitting exploration of the reasons behind student ratings. The instrument consisted of eight Likert [17] items (see Table 4) using a scale from 1 (truly inadequate) to 7 (truly outstanding). Instruments for the selected response options were consistent across semesters, however, qualitative data varied based on the mode of delivery. No qualitative data were gathered in the initial (Summer 2002) year of course delivery. For the other three years, questions varied slightly, based on delivery mode. While in Summer 2003, only one open-ended question was asked, 'In what way can the class presentations be improved for non-linear equations'. In Summer 2004 and Summer 2006, four questions were asked. In addition to the

question asked in 2003, the other three questions for 2006 were:

- How did you learn the material for non-linear equations?
- What did you like most about the Web-based and class presentation for non-linear equations?
- What did you like least about the Web-based and class presentations for non-linear equations?

The 2004 questions were similar but did not address class presentations, since they were not a part of the instruction in 2004. The answers were analysed thematically to identify trends, strengths and weaknesses of the course as perceived by the students.

To evaluate the effectiveness of the various modes of delivery, the same sources of assessment data were used across the four years as well as the survey data previously discussed. Student performances were examined relative to their starting abilities, as reflected in their mean prerequisite grade point average (MPGPA) in the four prerequisite courses, namely, calculus I, calculus II, calculus III and differential equations.

ASSESSMENT RESULTS

Students in each of the four classes were typically upper level undergraduates and were identified as coming from three different backgrounds—transfer students from the Community College (CC), first time in College (FTIC) or other (OT). Other (OT) category includes students transferring from other universities or community colleges without having received a formal degree from those institutions. Since the MPGPA was of interest as a predictor, there was a concern about the equity of class composition of where the students might have taken the four prerequisite courses. Chi-square goodness of fit tests were conducted to determine if each of the four classes contained similar students. These analyses revealed that there were no statistically significant differences (using a Type I error rate of 0.05) among the four classes based on gender or background ($\chi^2 = 1.12$, $p = 0.7732$ for gender and $\chi^2 = 10.56$, $p = 0.1030$ for background).

Two assessment instruments [7] were used to explore the impact of course delivery mode on student achievement and satisfaction:

- multiple choice question final examination based on Bloom's taxonomy;
- student satisfaction survey.

The summer semesters in 2002 and 2003 were 6 weeks long, the summer semesters in 2004 and 2006 semesters were 10 weeks long. As such, this potentially influential factor of difference of semester length should be considered.

Multiple-choice final examination based on Bloom's taxonomy

Four multiple-choice questions were used to assess student performance in the non-linear equations topic of the course delivered under the four different modalities. Two questions were asked at lower levels (knowledge, comprehension and application) of Bloom's taxonomy and two questions were asked at upper levels (analysis, synthesis and evaluation) of Bloom's taxonomy.

Each correct answer was given a score of one while an incorrect answer was scored as a zero, for two possible points for each of the lower and upper level sets of questions. For each of the four classes, Table 1 contains the sample size and the MPGPA as well as the mean scores on the upper and lower Bloom's taxonomy questions. For three of the four classes, the sample size was similar ($n = 42$ in 2002, $n = 49$ in 2004 and $n = 56$ in 2006) while the other class was notably smaller ($n = 27$ in 2003). Incoming MPGPA also varied, with the lowest MPGPA of 2.14 in the 2002 group and the highest MPGPA of 2.68 in the 2006. Additionally, the variability for MPGPA, as noted by the standard deviation, was more pronounced in the 2003 student group (SD = 1.12) than in the other three, which should be expected with a smaller sample size.

To test different modalities of delivery impacting student performance, a two-factor analysis of variance (ANOVA) was conducted. Based on MPGPA, students were classified into one of three categories: low, medium and high ability. The low category was comprised of students in the 25th percentile of the sample (MPGPA ≤ 2.25); the medium category was comprised of students who scored in the middle half of the percentile

Table 1. Sample size and means of MPGPA and final examination score

		MPGPA		Upper Bloom		Lower Bloom	
Class	*n*	Mean (max = 4)	SD	Mean (max = 2)	SD	Mean (max = 2)	SD
2002	42	2.14	0.814	0.86	0.647	1.29	0.457
2003	27	2.51	1.122	0.96	0.808	1.56	0.506
2004	49	2.27	0.953	0.80	0.707	1.47	0.581
2006	56	2.68	1.01	1.05	0.699	1.63	0.489
Total	174						

Table 2. Sample size of students in each ability category by classes

	2002	2003	2004	2006
Low	18	11	13	18
Medium	10	5	15	14
High	14	11	21	24

scores ($2.25 < \text{MPGPA} \leq 2.75$) and the high category was comprised of students in the 75th percentile or higher (MPGPA > 2.75). The distribution of these students is presented in Table 2. Chi-square analysis of the distribution showed no statistically significant differences (using a type I error rate of 0.05) among the classes ($\chi^2 = 5.93$, $p = 0.4313$) in their ability as measured by MPGPA.

Table 3 presents the results of the two-factor ANOVA using the MPGPA and the course delivery modality to examine student performance on the two sets of questions representing the lower and upper levels of Bloom's taxonomy. The F statistics used in the ANOVA analysis were used to draw conclusions about mean differences in the population based upon the observed data. Each F statistic is the ratio of a variance estimate based upon differences among group means and an estimate based upon differences among scores within groups. Large values of F are associated with group mean differences that are greater than would be expected from only sampling error. The p-value is the probability of obtaining an F statistic as large as the one observed or larger, if the null hypothesis (that is, equal means in the population) is true. The smaller the p-value is, the less we believe that the null hypothesis is true. When the p-value is smaller than a pre-specified criterion (called α), we officially declare the null hypothesis false and conclude that the population means are not the same. Conversely, if the p-value is larger than α, we declare that we fail to reject the null hypothesis. The pre-specified value, α, is the probability of rejecting a null hypothesis when it is true (a decision that is called a type I error).

These results of the two-factor with interaction are interpreted relative to a level of confidence of $\alpha = 0.10$ (or 90% confidence that the claim can be made) in the results [18, chapter 10]. This type I error rate is consistent with the baseline study [7] to determine statistical significance of findings. Similar to the previous study [7] and as might be expected, the MPGPA was a significant predictor of student performance. The method of delivery was not statistically significant as a main effect. However, an interaction between MPGPA and mode of delivery was evident for the scores on the lower level taxonomy questions. Further, follow-up contrast tests identified that students in the 2003 and 2006 classes performed similarly and the 2002 and 2004 students performed similarly. The 2003 and 2006 classes used a mixture of delivery methods whereas the 2002 and 2004 classes used either face-to-face (year 2002) or distance (year 2004) as a stand-alone delivery mode for this unit.

The results in Table 3 are summarized as follows:

- Effect of MPGPA (Factor A)—The effect of the MPGPA on the final examination score is significant with a 90% confidence level ($\alpha = 0.10$) for non-linear equations upper level Bloom scores. Students with higher MPGPA perform better on these scores although MPGPA did not appear to have a significant impact on students' scores on the lower Bloom taxonomy items.
- Effect of course delivery mode (Factor B)—the effect of course delivery mode on the final examination score was not significant at the 90% confidence level ($\alpha = 0.10$) for non-linear equations upper level Bloom's taxonomy items but it did appear to have an impact on students' scores on lower level Bloom's taxonomy items.
- Effect of MPGPA and course delivery mode interaction—the effect of the interaction between MPGPA and delivery modality on the lower level Bloom questions was significant for both levels of Bloom's taxonomy items ($\alpha = 0.10$). This indicates that different ability level students may perform better based on mode of course delivery.

Based on the findings reported above, as well as an examination of the mean examination performance scores (see Table 1), there is support that the use of Web-based module delivery positively affected student performance. Although not all statistical analyses had statistically significant findings, students in the 2003 and 2006 classes consistently outscored their peers in the other two classes. Furthermore, the interaction between mode of delivery and incoming ability level suggests that the use of Web-based modules

Table 3. Results for a two-factor ANOVA design of experiments

Final examination score	Source of variation	F	p-value
Upper level bloom	Course delivery	0.40	0.7520
	MPGPA	2.51	0.0054*
	MPGPA and course delivery	1.51	0.0605*
Low level bloom	Course delivery	3.51	0.0172*
	MPGPA	1.22	0.2732
	MPGPA and course delivery	1.47	0.0740*

* Statistically significant at $\alpha = 0.10$.

provides students of lower incoming ability level with an enhanced capacity to be successful on the material presented.

Student satisfaction survey

Student satisfaction surveys were given on the presentations used to teach non-linear equations. The survey consisted of eight selected response questions and, depending on the class, included zero to four open-ended questions.

Quantitative analysis

A seven-point Likert scale was used for the eight selected response items, ranging from 1 (Truly Inadequate) to 7 (truly outstanding). In addition, an analysis of variance was conducted on each of the items. The results of these analyses are provided in Table 4. The results of all eight items are statistically significant at the set type I error rate of 0.10. In all cases, students in the 2003 class had notably higher scores than in the other three classes of delivery modality. Contrast statements support the contention that this group of students rated these items higher than their peers in the other classes at an alpha level of 0.05. The 2002 class tended to have the next highest mean scores, followed by students in 2006 and 2004 classes, respectively.

Qualitative analysis

A series of open-ended questions were asked each year. In two of the four years (2004 and 2006), there were four similar items. In 2003, there was only one item and in 2002, no qualitative data were gathered. The responses to these items were reviewed and thematically analysed.

- Question 1 (2004 and 2006): How did you learn the material for non-linear equations?

There were three common resources or methods identified by students as strategies for learning the non-linear equations material: textbook, lecture videos and activities (including simulations). Only 12% students in 2004 and 8% students in 2006 identified only one method of learning the material, typically either the textbook or lecture videos. The majority of other students cited some mixture of methods, with the most prevalent listed in Table 5. Additionally, 9% students in 2004 and 13% in 2006 commented that they had used online quizzes as a learning method.

Often, students cited the variety of resources as beneficial or related a specific process that they followed utilizing multiple resources. For example, one student in 2004 wrote, 'I watched the videos first and then I went back and read over the notes. I then proceeded to do the homework and then checked my answers with the online quizzes'. Other students explained how they used the different resources to back up weak areas. One student (also in 2004) stated, 'First, I watched the videos and then I looked over the text that pertained to the material I was still a little 'murky' on'. Similar

Table 4. Results of presentation items on surveys on non-linear equations (number of samples, means, *F*-values and *p*-values)

	Mean* (SD)					
Questions	2002 ($n = 38$)	2003 ($n = 27$)	2004 ($n = 43$)	2006 ($n = 56$)	F	p
In terms of their value in helping me acquire foundational knowledge and skills, I'd say that the presentations were . . .	4.63 (1.21)	5.86 (1.06)	4.53 (1.32)	4.60 (1.06)	9.68	<0.0001
In terms of their value in reinforcing information presented both in the reading assignments and in the problem sets, I would say that the presentations were . . .	4.71 (1.19)	5.86 (1.03)	4.49 (1.25)	4.94 (0.96)	8.70	<0.0001
In terms of their value in helping me learn to formulate clearly a specific problem and then work it through to completion, I would say that the presentations were . . .	4.37 (1.40)	5.86 (1.09)	4.30 (1.25)	4.72 (1.10)	10.66	<0.0001
In terms of their value in helping me develop generic higher-order thinking (e.g. analysis, synthesis and evaluation from Bloom's taxonomy brochure I gave you) and problem solving skills, I would say that the presentations were . . .	4.34 (1.27)	5.61 (0.98)	4.14 (1.37)	4.30 (0.98)	11.31	<0.0001
In terms of their value in helping me develop a sense of competence and confidence, I would say that the presentations were . . .	4.58 (1.25)	5.68 (1.20)	3.95 (1.24)	4.39 (1.00)	13.54	<0.0001
Overall, I would say that the clarity of the explanations contained in the presentations were . . .	4.55 (1.32)	6.04 (0.94)	4.35 (1.33)	4.79 (1.08)	17.58	<0.0001
In terms of helping me see the relevance of the course material to my major, I would say the presentations were . . .	4.18 (1.27)	5.79 (1.08)	4.02 (1.37)	4.68 (1.16)	8.47	<0.0001
Overall, I would say that the helpfulness of the illustrative examples and practical applications contained in the presentations were . . .	4.47 (1.40)	5.71 (0.96)	4.28 (1.25)	4.89 (1.13)	9.25	<0.0001

* 1 = Truly inadequate; 2 = Poor; 3 = Adequate; 4 = Good; 5 = Very good; 6 = Excellent; 7 = Truly outstanding.

Table 5. Results of how students learned material for nonlinear equations

Method/source	2004	2006
Textbook and lecture videos	42%	25%
Textbook, lecture videos and assignments/ simulations	23%	29%

tendencies about using the varied resources were noted in 2006, as illustrated by this response: 'I learned the material from the pro-copy book [textbook]. I read through it once, then proceeded to do the homework and while doing the homework, I read through the parts that I thought were tricky'. Another student in 2006 outlined an extensive seven-step process he followed, concluding that if he still did not understand, he would 'usually go to a classmate for help'.

- Question 2 (2004 and 2006): What did you like most about the Web-based (and class-2006 only) presentation for non-linear equations?

Students in both classes consistently identified two major features that they liked about the course presentations. The first was the ability to review the materials and work at their own pace (20% in 2004 and 26% in 2006) and the second was the quality, relevance and utility of the materials (31% in 2004 and 36% in 2006). Other features mentioned by more than one person included convenience (16% in 2004 and 11% in 2006), examples/simulations (7% in 2004 and 15% in 2006), not having to come to class on site (7% in 2004) and the organization/ navigation online (7% in 2004).

Convenience as well as the ability to reinforce learning was prevalent and obvious responses across both years. For example, in 2004 one student wrote 'I could do it at any time and at my own pace' and another stated, 'Nice to watch the videos instead of being in class, could play it again if there was something you did not understand'. Similar comments were provided from the students in the 2006 class. One student in this class replied, 'I liked the fact that I could go back and review a topic if I didn't understand it fully the first time. This was a good thing for me'.

- Question 3 (2004 and 2006): What did you like least about the Web-based (and class-2006 only) presentation for non-linear equations?

A small but notable number of students (9% in 2004 and 17% in 2006) stated that there was nothing that they liked least about the class. Few strong themes among responses were noted although there were some common features. The most prevalent feature noted was a concern about not being able to ask questions real-time, with 24% and 17% students citing this as an area of concern in 2004 and 2006, respectively. The other area that spanned both classes was the lack of sufficient numbers of examples (11% in 2004 and 9% in 2006). Other features noted by more than one person in a class included needing more time (7% in 2004 and 4% in 2006), the quality of the audio or video (9% in 2004 and 4% in 2006) and size/type of files to be downloaded (7% in 2004). Four individuals in 2006 noted that the need to stay by a computer and the passivity of the activity was a problem for them. Another student noted that he/she did not like the class 'at all'; however, they went on to note that they had attention deficit disorder.

The issue of not being able to ask questions was obvious and, at times, the responses relayed frustration over this issue. One student in 2004 wrote, 'It was hard to motivate yourself to go through it. There was no chance to ask a question while watching the videos. If you could have asked questions it would have been nicer, but there is no way that is possible'. The students in both classes of 2004 and 2006 had similar concerns with availability of timely feedback with one 2004 student stating 'No instant feedback in case of a problem or concern' and another in 2006 stating, 'If I had a question then it would have to wait until the next class period'.

- Question 4 (2003, 2004 and 2006): In what way can the (Web-based, class) presentations be improved for non-linear equations?

Similar to the question on what they liked least about the course, many of the respondents answered that there was nothing that they would suggest to improve presentations. This was especially notable in the responses from students enrolled in the 2003 group of students who received instruction through the Web-enhanced lecture modality. Of the 26 students who responded to this question, 50% answered either nothing or made a laudable comment. For example, one student wrote, 'Certainly no improvements are necessary as far as I can see. I always feel very well prepared to do the homework after class. I think that the class presentations are very clear'. Of the remaining 13 students, one simply wrote 'not sure'. Although not as strong in the other delivery modalities, a few students also replied with no suggestions for improvement (20% in 2004 and 11% in 2006).

Of those who did provide feedback, there was one dominating theme, regardless of delivery modality, and that was a request for more examples. Approximately one-third of students in each class identified this as an area of potential improvement, including comments about variation and quantity of examples (29% in 2003 and 35% in 2004 and 34% in 2006). In 2006, three students suggested having more one-on-one time with the instructor. Many suggestions were very specific in nature and only one student addressed the subject. For example, in 2003 one student expressed interest in learning more about MAPLE [3], in 2004, a student suggested making hard copies available on CD and in 2005 an individual suggested adding a 'Frequently Asked Questions' section. However,

with the exception of the request for more and varied examples, there were no other notable themes across the classes.

CONCLUSIONS

The findings of the examination performance data as well as the survey data suggest that Web-based modules enhance student success in the course. Students consistently in the 2003 and 2006 classes performed better on examination performance and students in the 2003 class tended to have more favorable survey ratings as compared to the other three groups of students. However, even though the use of the distance learning modality was generally considered to be positive by most respondents, one area that was suggested by a student in 2006 seemed to address indirectly individual's special needs (e.g. attention deficit disorder). Students in the 2002 class that received their instruction in the more traditional, face-to-face mode, without benefit of either supplementary or primary Web-based materials, consistently performed lower than the other three groups, both on examination performance as well as satisfaction measures. Those students in the Web-delivery only class (2004) also scored lower on the achievement measures. The two classes that consistently perform better consisted of a mixture of delivery methods, both face-to-face and via distance.

The findings of the qualitative data support that students find different and varied resources helpful. The use of multiple methods within the Web modules created, e.g., textbook, notes, lecture videos, simulations and exercises, provides a variety of resources that maybe more or less helpful to specific student depending on their learning style. Furthermore, the findings of the examination performance data seems to be supported by some students who were very comfortable with the distance modalities and liked the flexibility it provided. However, the need for personal interaction with the professor was also evident. This seems to indicate that a mix of two modalities, in some form or another, may be most beneficial to many students.

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