Study of Suitability of Studio Model for Introductory Computing

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Abstract

The School of Engineering at Vanderbilt University requires all engineering students in their first semester to take a course that introduces computers in engineering. The question always arises about the best setting in which to teach this type of material; a combination of lecture and laboratory, or all laboratory. For two years the course was organized with two different modalities of instruction. One was the lecture/laboratory and the other the all laboratory structure. At the end of the semester an in-depth questionnaire with quantitative ratings was given to the students to determine if there were differences in learning preferences. Contingency tables were used to compare responses. There were several statistically significant differences in student responses favoring the all laboratory structure. Several of them are: the students are much more comfortable with computers at the end of the semester; either laboratory or working by oneself were the preferred settings for learning; and lecture was not a preferred setting for learning any topic.

Introduction

As in many universities, the School of Engineering at Vanderbilt University (VUSE) requires all engineering students in their first semester to take a course that introduces computers in engineering. It is named "Introduction to Computing in Engineering". The particular goals of the course are to: introduce the computer as an engineering tool; develop a familiarity with Internet resources; begin to develop communication skills; and to develop an appreciation of working in teams. Part of the communications component is that the students are required to submit a laboratory report each week. The reports are written individually. Also for the latter two-thirds of the course, the students are divided into four person teams and required to develop and present a computer-based project. When organizing this type of course the question arises, "Which is the best modality for instruction, a combination of lecture and computer laboratory or an integrated setting in a computer laboratory?". The former will be called the combined structure and the latter the laboratory structure. The laboratory structure is actually the studio model whose main purpose is to provide a student-centered learning environment[1,3].

For four years this course had been offered and conducted with the combined structure. For the fall semesters of 1999 and 2000, we reorganized our facilities so that this course could be offered in both modalities so that we could assess the influence of the modality on learning preference and the perception of engineering.

Method

The Myers-Briggs Type Indicator (MBTI) was administered to all students at the beginning of the semester [2]. The MBTI provides a measure of psychological type and of preferred modes of learning new information.

The course was organized with two different modalities of instruction. One was the combined structure in which 40 students meet with their instructor in a classroom twice a week for 50 minutes and in groups of 20 meet with the instructor and teaching assistant in the instructional computing laboratory for 75 minutes. The other modality was the laboratory structure. All 40 students meet with their instructor and teaching assistant twice a week for 110 minutes each meeting in the instructional computing laboratory. A minimal amount of lecturing was done in the beginning of the laboratory periods. Every week all students are required to produce a laboratory report demonstrating that they have achieved a level of mastery of specified topics. This comprises 60% of the course grade. All of the students used the same course materials that were provided on-line. The web site is http://www.vuse.vanderbilt.edu/es130/.

VUSE has 320 first year students. They were divided into nine sections. The students pre-registered during the summer for one of the sections and had no knowledge that there would be different modalities of instruction. So this is essentially a random assignment to sections. Three sections had the laboratory structure and six had the combined structure in 1999 and five sections had the laboratory structure and four had the combined structure in 2000. We were limited to the number of laboratory sections by facilities. Several training workshops were provided to instructors and teaching assistants before and during the semester. All instructors and teaching assistants met weekly to biweekly with the course coordinator. This was to insure that all sections covered the same material in approximately the same time frame and to provide assistance where needed.

At the end of the semester an in-depth questionnaire containing 48 questions with quantitative responses was given to the students to determine if there were differences in learning effectiveness. The instructors developed this questionnaire with the assistance of the staff at the university's Teaching and Learning Center. The categories of questions were focused on: general information, materials, learning practice, teamwork and learning preferences. Representative samples of questions are shown in the appendix. The questionnaire was administered on-line during the last laboratory period of the semester. There were approximately 260 responders each year. The responses were compiled for the entire sample of students and separately for students in the combined and laboratory modalities. The responses of the students in the combined and laboratory modalities were compared using contingency tables [4].

Results

The responses to only a subset of the questions will be reported. These are the ones germane to the comparison and are shown in the appendix.

a. General – Questions 1 to 3

Over 95% of the students agreed that we accomplished the course goals and felt that they really learned something. The comfort level with computers increased dramatically as well. At the end 83% of the students felt comfortable with computers, an increase from 31%. However, the level of comfort was significantly higher in the laboratory sections, p-value = 0.028.

b. Materials – Questions 4 to 6

Almost all of the students liked having the course materials on-line, 87%. As one would expect almost all of the students reported using the on-line material at least once a week. Question 6 was designed to get general feedback on the degree of difficulty posed by the various topics. The average challenge scores are shown in Table 1 because there were not any statistically significant differences between the modalities. The introduction and the Internet material were thought to be quite easy. Web page design, Excel, and working in a team were thought to be a medium challenge. The topics receiving a high challenge rating were 3D modeling, MATLAB, and the project.

Table 1 – Challenge Scores

TOPICS	Introduction	Internet	Web	3D	Excel	MATLAB	Project	Team
SCORES	1.84	2.03	3.04	3.88	3.06	4.17	3.82	3.01

c. Learning Practice – question 7

There are five major topics in the course: Internet, Web Page Design, 3D Modeling, Excel, and MATLAB. For these topics, we asked the students what is the preferred learning setting; why, and what would have enhanced the learning. Question 7 is an example of one of them. Figure 1 shows the results in percentages of responses of all students for the year 1999. The following can be observed from the figure:

1. laboratory was by far the preferred setting for the computational topics;
2. lecture and group work were not preferred settings for any topic;
3. working by oneself was preferred equally with laboratory for the less computationally intense topics.

For the material on the internet and 3D modeling there was a statistically significant difference in preferred learning setting between the students in the combined and laboratory modalities, p-values = 0.014 and 0.044 respectively. The students in the combined modality preferred to learn these materials less in the laboratory and more on their own. Nonetheless, the laboratory is still preferred by the plurality of students except for the Internet and Web page material.

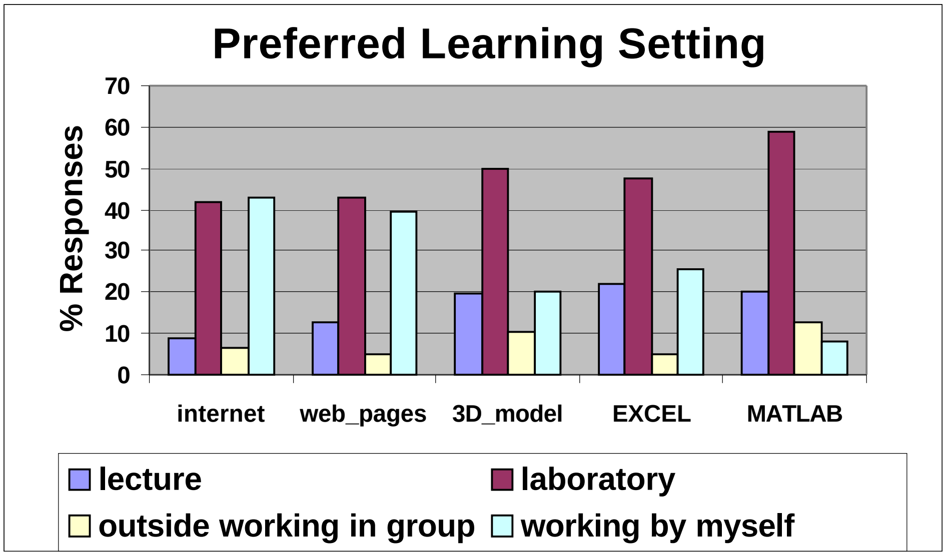

Figure 1. Preferred Learning Setting of all Students for Year 1999

As with all open-ended, subjective responses, they were difficult to organize. The responses were separated by the modality of structure to determine if there were any differences. There were some. In the combined group the students, who selected either lecture or laboratory as their preferred learning mode, stated that having the lectures in the laboratory would enhance their learning. This paralleled the response of the students in the laboratory group who chose laboratory as the preferred setting because the material is more "hands-on" [5].

For the year 2000 the results of all students are shown in Figure 2. There were not any statistically significant differences in responses between the combined and laboratory modalities. There were two major changes across years. Working by oneself became more preferable across all topics and the dominant mode of learning for Internet and Web material. To determine an explanation we considered the MBTI profiles in the two groups. The proportions of students in each profile pair are shown in Table 2. The bold letter in each category is used in the acronym expressions. The class of 2000 has on average the stereotypical engineering profile of **INTJ** while the class of 1999 has a group profile of **ESTJ**. We tested for the difference of **IE** and **NS** components. The **IE** differences were statistically significant, p-value = 0.05 and the **NS** differences were not significantly different.

The subjective responses of these students also gave some clarification to the numerical results. Those who preferred the laboratory setting liked learning by doing and having the instructor and teaching assistant readily available for answering questions. Those who preferred working by themselves already had familiarity with the topic and could work more efficiently that way. Those who preferred lecture were mostly those who had not seen the material before and preferred a lecture as the first exposure to the material.

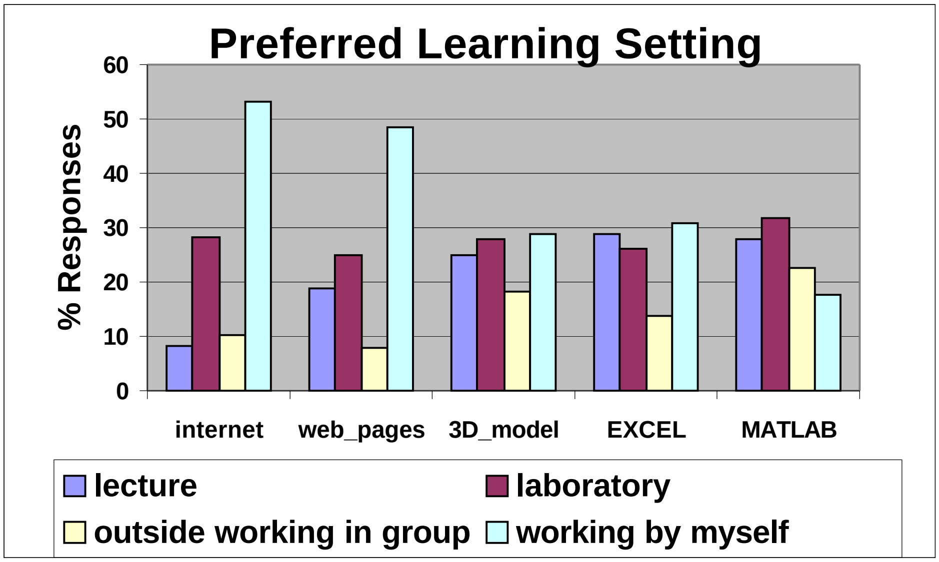

Figure 2. Preferred Learning Setting of all Students for Year 2000

Table 2 – MBTI Preferences

MBTI Preferences	**I**ntroversion	i**N**tuitive	**T**hinking	**J**udgment
	Extraversion	**S**ensing	**F**eeling	**P**erception
Year 2000	0.59	0.63	0.74	0.55
	0.41	0.37	0.26	0.45
Year 1999	0.41	0.48	0.64	0.54
	0.59	0.52	0.36	0.46

In summary there were several statistically significant differences in student responses favoring the laboratory structure. Four of them are:

1. The students are much more comfortable with computers at the end of the semester;
2. The preferred settings for the computational topics were either the laboratory or working by oneself; those with the **E**xtroversion/**S**ensing profile preferred the former and those with **I**ntroversion/I**N**tuitive profile preferred the latter;
3. Lecture and group work were not preferred settings for any topic;
4. Working by oneself was preferred equally with laboratory for the less computationally intense topics and for topics in which students had some familiarity.

Discussion And Conclusion

Through a random assignment of students into two groups learning introductory computing by two different modalities, we were able to learn about the relative effectiveness of the two environments. Students in both the combined and laboratory modalities had the same responses statistically when they responded that they: learned the material well, increased their comfort level with computers, and liked using on-line materials for learning. Each of the topics in the course had different levels of difficulty but there was no difference between the two student groups. Thus the students had the "same" course and the instructors did not have a differential impact. The instructional modality did have a significant positive impact on certain areas. The students in the laboratory sections felt more comfortable with computers and liked the "hands-on" approach to learning. This is consistent with the comments of the students in the combined group who stated that having the lectures in the laboratory would enhance their learning.

The indications of the preferred learning setting as shown in Figures 1 and 2 were the most remarkable. The laboratory modality is more preferable than a lecture modality for most students. The other mode comparable in preference is learning by oneself. For both years learning by oneself is strong for the Internet and web page material. The dominant reason was that the students had already learned some of this material in high school and felt that they could work more efficiently by themselves. For the mathematically complex and code rich topic such as MATLAB, the students preferred to learn in the laboratory because they could have their questions answered immediately. For 3D modeling and Excel, the preferred setting changed from laboratory in year 1999 to learning by oneself in year 2000. The year 2000 group being more introversion than extraversion, that is more reflective and focusing on inner ideas, found that it was more efficient to learn the simpler mathematical concepts and coding by themselves.

Our conclusion is that for all courses involving a high degree of computer usage, a laboratory/studio modality combined with a short introductory lecture is the preferred learning environment. Students will tend to work by themselves for material with which they already have familiarity. Based on these results, VUSE adopted for the 2001-2002 academic year this structure for all sections of this course.

References

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Appendix

Sample Questions

1. At the end of the course, I felt that I had really learned something.
   strongly agree agree disagree strongly disagree
2. At the beginning of the course, I was not very comfortable using the computer.
   strongly agree agree disagree strongly disagree

3. At the end of the course, I was much more comfortable using a computer.
   strongly agree   agree   disagree   strongly disagree
4. Do you like having course materials on-line?
   yes   uncertain   no
5. How often have you used the on-line materials?
   every day   every week   infrequently   never
6. Please rate with a score from 1 to 5 the extent to which you were challenged by the following material: (1 is lowest, 5 is highest) introductory material, internet activities, creating web pages, 3D modeling, Excel MATLAB, project, working as a team
7. For learning material about Excel, activities in which setting helped you learn the materials best: lecture, laboratory, outside working in groups, working by myself.
   Why?
   What would have enhanced your learning more?

Biographies

RICHARD SHIAVI is Professor of Biomedical Engineering. His main professional interests are in applied signal processing and innovations in engineering education. He is serving presently as Associate Editor for the IEEE Transactions on Biomedical Engineering.

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