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Comparison of Teaching Java in a Computer Classroom / Traditional Classroom vs. Smart E-Classroom and its Effect on Critical Thinking: A Case Study

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Abstract

In this paper, the results of a study conducted to assess the impact on students' critical thinking, performance and perceptions, of different types of technology access in a Java graduate Computer Science course, are presented. The results indicate that students in a smart e-classroom perceived better support for the acquisition of various analytical skills, including critical thinking, than those supported by a traditional computer classroom. In addition, these graduate students achieved higher critical thinking scores, as evidenced by the California Critical Thinking Skills Test (CCTST) assessment tool, and marginally higher grades in the technology rich smart e-classroom than in the standard computer classroom.

Keywords: E-classrooms, computer lab classroom, computer classrooms, critical thinking, computer classroom design, electronic classrooms, interactive learning technology.

1. INTRODUCTION

The current curriculum standard for technology integration in graduate courses in computer science implies student access to a computer classroom with networked stand-alone computers and, in some cases, course management software such as Blackboard. In addition to these resources, technology access can take the form of sophisticated "smart e-classrooms" in which computers can be used independently by students or in a group-mode. These facilities allow for the sharing of screens and keyboards and the iterative development of the same project on the same computer by a group of students. Other features include the ability to project from the instructor station or student stations, to selected stations or all stations, full multimedia capability, seamless integration of video player, projection screens, computer, electronic whiteboard, and electronic writing pad (Coppola & Thomas, 2000).

In the teaching of a programming language, specifically Java in this study, the smart e-classroom enabled the instructor and students to share work interactively. The instructor used the facilities available to project students' questions and solutions of computer programs to the whole class and sometimes to another individual student. Moreover, the instructor projected the solutions or other material to the class and/or individual students. The real-time broadcast-on-demand and interactive learning technology really helped to make the class dynamic, and hold the students' attention and interest, as well as enhance learning. In addition, every student in the classroom could clearly read the code as it was projected to his individual computer screens without degradation of video quality. This clarity of materials allows students to see the exact syntax with confidence. This may not be the case in some classrooms if students have vision problems and/or are seated on a far side of the room away from the projected image or have a poor angle in relation to the image.

This paper presents the results of this case study, designed to examine the impact on the student acquisition of critical thinking skills, performance, and perceptions that these two types of technology access, traditional computer classroom vs. a smart e-classroom, have in the learning process. The acquisition of critical thinking skills is highly valued and a central goal in education, though believed difficult to teach effectively, is an essential skill in a wide variety of professions (Facione, 1998; van Gelder 2001). The intended audience is for higher educational administrators with limited funds that must make tough decisions in deciding the sophistication level of the technology in the classroom. Though smart electronic classrooms are expensive to install, maintain, and require faculty training to ensure effective use of the advanced features of the system, it is perceived that it could positively affect learning outcomes of students. Results from this study are useful for evaluating the major impact and contributions these classrooms may have to the learning process relative to the less expensive traditional computer classrooms, as well as providing insightful information for replication of this study.

2. STUDY

One section of the study was held alternatively in a traditional classroom and an ordinary computer classroom, supplemented with course-management software (Blackboard®), while the other section utilized a smart e-classroom for all classes, also with Blackboard support. Both sections were taught by the same instructor to ensure content equivalence. In both sections, students used the same Java textbook (Java Software Solutions, Lewis & Loftus) and met on a weekly basis. In both classes, there was a combination of lecture and practical programming exercises, as well as two-team projects. Also in both classes, students worked on team projects in groups of 3-4, with assignments both outside and inside the classroom. The major difference in the demonstrations to the students was that in the traditional classroom, using table-top computers, presentations were done from the teacher console via an overhead projector, whereas in the smart e-classroom, presentations were projected from individual students' consoles to the entire class.

Assuming that, in general, instructors choose textbooks, cases, assignments, etc. to foster the development of critical thinking skills in their students, we were interested in whether, by augmenting the instruction with the features of an electronic classroom, these skills would show marked improvement as measure by grades and critical thinking assessment, and in perceptions.

Final course grades were examined for both sections. As well, students were given the opportunity to indicate their perceptions of the support offered in the course to developing analytical skills through the textbook, team activities, Blackboard, online discussions and documents. Analytical skills were defined as conducting research, problem-solving, critical thinking and creative idea generation, which support students rated as either: a lot, somewhat, or not at all. This survey was developed by one of the authors who felt that a 3-point scale would adequately differentiate the students' perceptions for comparison across the two classroom treatments. Any higher scale would impose too fine-grained an assessment on the student and not provide any additional, meaningful information, as we were interested in extremes of support perceived in the both conditions.

In addition to these, critical thinking skills were accessed via the California Critical Thinking Skills Test (CCTST) (Facione, 2004), at the beginning and the end of the course. These were a battery of brainteaser-type questions designed to elicit these skills. These scores are not meaningful in themselves, except in regard to the extent of change attained from pre- to post-test.

The research questions of interest included the following:

- Is there a difference in student performance as a result of the different types of technology access?
- Is there a difference in student perceptions as a result of the different types of technology access?
- Is there a difference in students' critical thinking skills as a result of the different types of technology access?

3. RESULTS

Demographics

In the traditional computer classroom (TCC), there were 20 students, while there were 25 in the smart electronic classroom (SEC). There were more males than females in both sections, 65% vs. 35% in the traditional classroom and 64% vs. 36% in the e-classroom. In both sections, most students were in the 20-29-age category, 45% and 68%, respectively. There was an approximately equal mix of those with moderate and extensive computer experience in both sections. In the traditional lab, 50% reported moderate experience and 45% reported extensive experience. In the e-classroom, this was reported as 57% and 43%, respectively. (See Table 1, below).

4. PERFORMANCE

The average grade of students in the traditional computer classroom was 94% compared to 95.7% in the Smart E-Classroom2. (See Table 2, below).

5. PERCEPTIONS

Perceptions – Textbook Support

There were a higher percentage of those who perceived more support for analytical skills by the textbook in the e-classroom than in the traditional computer classroom. Conducting research, problem-solving, critical thinking, and creative idea generation was perceived as having a lot of support from the textbook by 39%, 48%, 44%, 36%, respectively, of those in the e-classroom, compared to 30%, 25%, 15%, 10%, respectively in the traditional computer classroom. (See Table 3, below).

Perceptions – Cases

With respect to the support offered by cases used in the course to the acquisition of analytical skills, those in the e-classroom generally perceived more support than those in the traditional computer classroom. Conducting research, problem-solving, critical thinking and creative idea generation, was perceived as getting a lot of support by 50%, 48%, 37%, 42%, respectively, for the e-classroom, compared to 16%, 11%, 22%, 16%, respectively, in the traditional computer classroom. (See Table 4, below).

Perceptions – Assignments/ Activities

The support offered by assignments and course activities to the acquisition of analytical skills was perceived by those in the e-classroom generally as providing more support than those in the traditional computer classroom. Conducting research, problem-solving, critical thinking and creative idea generation, was perceived as getting a lot of support by 26%, 37%, 47%, 42%, respectively, for the e-classroom, compared to 44%, 62%, 54%, 52%, respectively, in the traditional lab. (See Table 5, below).

Perceptions – Team Activity

Those in the e-classroom generally perceived more support than those in the traditional computer classroom for the acquisition of analytical skills by classroom team activities. Conducting research, problem-solving, critical thinking and creative idea generation, was perceived as getting a lot of support by 23%, 33%, 24%, 33%, respectively, for the smart e-classroom, compared to 5%, 17%, 22%, 22%, respectively, in the traditional computer classroom. (See Table 6, below). It should be noted that collaborative group activities in the e-classroom were supported by an integrated network which had team-mode capabilities allowing students grouped by furniture to work as one system with each student obtaining charge of a function such as the keyboard, mouse, audio, and/or application control.

Perceptions – Blackboard Overall

Once again, students in the e-classroom perceived more support of analytical skills by the course management system, Blackboard, than those in the traditional computer classroom. Conducting research, problem-solving, critical thinking, creative idea generation, was perceived as having a lot of support by 38%, 40%, 37%, 37%, respectively, by those in the e-classroom, compared to 17%, 17%, 16%, 17%, respectively, in the traditional computer classroom. (See Table 7, below).

Perceptions – Blackboard Documents

For conducting research, problem-solving, critical thinking, creative idea generation, 56%, 52%, 40%, 32%, respectively, in the e-classroom, and 21%, 21%, 21%, 21%, respectively, in the traditional computer classroom, perceived a lot of support from documents stored on Blackboard. (See Table 8, below).

Perceptions – Blackboard Discussion

Those students in the e-classroom also perceived more support for analytical skills from online discussions held on Blackboard. For analytical skills – conducting research, problem-solving, critical thinking, creative ideas, 23%, 24%, 29%, 24%, respectively, in the e-classroom and 7%, 13%, 6%, 13%, respectively, in the traditional computer classroom, perceived a lot of support from these discussions. (See Table 9, below).

Critical Thinking Skills

The outcomes observed from the CCTST in this case study, show that the use of smart e-classrooms had a positive effect on students' acquisition of critical thinking skills from the beginning to the end of the course with a p-value of .004. (See Table 10, below). The traditional computer classroom, in comparison, did not yield an increase in critical thinking skills, having a p-value of 0.38. It should also be noted that only half of this class, 12 of the 24 students, participated in the post-test as it was voluntary.

6. CONCLUSION

This study examined different types of computer access in a Java Computer Science course and found that overall it would seem that students in the e-classroom perceived more support for the acquisition of analytical skills by the various course resources and activities than those in the traditional computer classroom. They also seemed to score a few percentage points higher on their final grades, though this was marginal. With respect to critical thinking skills, students in the smart e-classroom showed a greater increase in their scores than did those in the traditional computer classroom. However, it is to be noted that effective teacher skills, room characteristics, collaborative assignments, and student interactions contributes to student acquisition of critical thinking skillls (Facione, Facione, et al., 2000; Hass, 1998). Future studies will compare statistical analyses of graduate students, undergraduate students and their significance. In addition, similar research will be conducted with other fields of study but still maintaining a single instructor with equivalent syllabi to determine the stability of results across the disciplines. The indication is, however, that smart electronic classrooms can have a positive impact on actual and perceived acquisition of higher-order thinking skills which is, after all, the aim of the academic profession for its students. Additional longitudinal studies could also be conducted to assess student skill acquisition and perception over several years.

7. ACKNOWLEDGMENTS

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		Gender %		Age %				Computer Experience %		
	No. of Students	Male	Female	<20	20-29	30-39	39+	Mini mum	Mod erate	Exten sive
Traditional Computer Classroom	20	65	35	20	45	35	0	5	50	45
Smart E-Classroom	25	64	36	8	68	24	0	0	57	43

Table 1. Demographic Distributions

	Traditional Computer Classroom	Smart E-Classroom
Final – Average	94	95.7

Table 2. Grades

%	Traditional Computer Classroom			Smart E-Classroom		
TEXTBOOK	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	25	45	30	15	46	39
Problem Solving	10	65	25	0	52	48
Critical Thinking	15	70	15	12	44	44
Creative Ideas	30	60	10	4	60	36

Table 3. Perceptions – Analytical Skills

%	Traditional Computer Classroom			Smart E-Classroom		
CASES	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	28	56	16	28	22	50
Problem Solving	22	67	11	26	26	48
Critical Thinking	28	50	22	26	37	37
Creative Ideas	28	56	16	26	32	42

Table 4. Perceptions – Analytical Skills

%	Traditional Computer Classroom			Smart E-Classroom		
ASSIGNMENTS/ACTIVITIES	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	11	63	26	12	44	44
Problem Solving	5	58	37	0	38	62
Critical Thinking	11	42	47	4	42	54
Creative Ideas	16	42	42	4	44	52

Table 5. Perceptions – Analytical Skills

%	Traditional Computer Classroom			Smart E-Classroom		
TEAM ACTIVITIES	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	39	56	5	36	41	23
Problem Solving	28	55	17	33	34	33
Critical Thinking	22	56	22	38	38	24
Creative Ideas	22	56	22	38	29	33

Table 6. Perceptions – Analytical Skills

%	Traditional Computer Classroom			Smart E-Classroom		
BLACKBOARD OVERALL	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	44	39	17	31	31	38
Problem Solving	50	33	17	24	36	40
Critical Thinking	42	42	16	21	42	37
Creative Ideas	44	39	17	21	42	37

Table 7. Perceptions – Analytical Skills

%	Traditional Computer Classroom			Smart E-Classroom		
BLACKBOARD DOCUMENTS	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	16	63	21	12	32	56
Problem Solving	32	47	21	8	40	52
Critical Thinking	21	58	21	12	48	40
Creative Ideas	21	58	21	12	56	32

Table 8. Perceptions – Analytical Skills

%	Traditional Computer Classroom			Smart E-Classroom		
BLACKBOARD DISCUSSION	Not at All	Somewhat	A Lot	Not at All	Somewhat	A Lot
Conducting Research	73	20	7	50	27	23
Problem Solving	74	13	13	52	24	24
Critical Thinking	67	27	6	52	19	29
Creative Ideas	67	20	13	57	19	24

Table 9. Perceptions – Analytical Skills

	Traditional Computer Classroom		Smart E-Classroom	
	Pre	**Post**	**Pre**	**Post**
N	24	12	26	21
Mean	16.5	15.2	13.1	17.1
Mode	16	10	12	15
Median	16	14	13	17
SD	5.3	4.2	4.4	4.7
Significance	P= 0.38		P=0.004	

Table 10. Critical Thinking Skills Test Scores