Computer-based Collaboration in Student Work: Does a Preference for using Technology Affect Performance?

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Abstract

This study reports the results from an empirical study focusing on student preference for computer-based collaboration. This study involved collecting data from 144 university students who were required to do a computer-based collaborative task. The study examined perceptions of, preferences for, and performance in, computer-based collaboration. The researchers had expected that a predilection for such technologies would result in improved performance where their use was required. This did not turn out to be the case. A preference for computer-based collaboration did not necessarily result in an improved performance in a computer based collaborative task. Student characteristics examined included previous experience, gender, age, perceived performance, group history, perceptions of collaboration, and preferences for individual versus group work. These factors were not found to influence results. This suggests that such perceptions and preferences may not be important to performance.

Keywords: Collaboration, education.

1 Introduction

Over the last four years, the NSW state government has invested $260 million in technology resources for NSW public schools. This funding has been used to provide over 77, 000 computers to NSW schools (Dwyer 2003). With plans to provide a further 25, 000 computers to schools over the next three years, the NSW state government is investing in the 'Computers in Schools' Program, aimed at ensuring Australia's future as an "equitable, imaginative and economically strong knowledge society" (Harriman 2002). Whilst it is important that current technological advancements are continually being implemented in the classroom, it would be reckless to do so without justifying such implementation with endorsement from the research community, and in particular, with research regarding the likely effect of these advancements on student performance in the classroom. Further, with the never ending advancement of technology and its many possible implementations, the amount of un-researched implementations will only increase, which in turn increases this need for more research. As Clark (2000) states, resolving the "problems" associated with computer based learning is now "critical to today's educators", especially with the drive for online learning being fueled by the increasing access to, and use of, the internet by students (Stallings 2002). The primary motivation for this study is thus to provide a contribution that existing researchers and current practitioners can use, and to begin to bridge this growing gap between implementation and research of computer based learning with particular emphasis on how perceptions and characteristics might affect performance in the classroom by the use of the technology..

There is a movement in computer-based learning technologies used in education from being tools that assist us to our being "reliant on their use" (Harriman 2002). These developments are being driven by "political, commercial and … inevitability pressures" (Harriman 2002), instead of researched knowledge. It's no wonder that researchers are finding it difficult to keep up with the pace of technological advances. As organisations and educational institutions race "to adopt educational techniques", they find they are doing so "without completely understanding them" (Dunstan and Dick 2004). It is commonly accepted that new technologies have advantages for classroom learning however further analysis is required to identify strategies that will ensure that the "maximum potential this new technology offers" is reached (Clark 2000). In their paper on technology-mediated learning, Alavi and Leidner (2001) have called for more depth and breadth of research, as they have identified this to be the biggest gap in this domain. Thus researchers and practitioners need to work together to investigate and harness the benefits from these "innovations in practice" (Harriman 2002) by moving from studies that focus on "Does technology influence learning?" to asking "How can technology enhance learning?" (Alavi and Leidner 2001). This research attempts to take this approach in part by focusing on student preferences and the effect they have on performance in computer-based learning.

2 Background

There have been several studies investigating the differences between Computer Based Learning (CBL) and face-to-face (FTF) learning environments. In one such study, Warschauer (1997) found CBL to differ from

FTF discussion in relation to "turn-taking, interruption, balance, equality, consensus, and decision-making". In another study, Althaus (1997) identified these distinctions to be "place dependence, time dependence, structure of communication, and richness of communication". He explains each of these distinctions by highlighting their respective advantages of CBL over FTF with reference to these distinctions. CBL environments have advantages in time and place dependence, in that CBL can occur "just as easily across the continent as across the table" and "student participation is self-paced" whereby they have "more time to read messages posted by others" and "interruptions are made impossible". In terms of structure, CBL provides on-line discussion that is "naturally interactive and collaborative"; and finally, computer-based discussion provides a richness which makes it "more reflective than verbal communication", where students become "more attentive to the messages of others" and students are placed on "more equal social footing with one another" (Althaus 1997).

To integrate computer technologies into education, it is not enough to simply purchase the technology and expect teachers to use it in the classroom. Investigations need to be carried out to develop understandings of the best ways to use technology in teaching and learning (Alavi 1997; Leidner and Jarvenpaa 1993). As Dwyer (2003) states, "if technology has the potential to really change children's learning at school, teachers now need to reassess and redesign the way in which they teach so that computers can be used to their full potential". To provide teachers with this guidance and information on how to successfully implement these technologies in the classroom, a more investigative type of research is needed (Warschauer 1997; Althaus 1997).

CBL has had a rapid uptake in schools and universities (Harriman 2002), and this is partly attributable to the perceived advantages that CBL environments have over FTF environments. Documented advantages and disadvantages for face-to-face learning versus computer-based learning can be grouped into four categories:

- benefits for learners – equal social footing, intellectual environment, helping disabled (Althaus 1997) and a sense of group knowledge (Warschauer 1997);
- performance – there are mixed results in prior studies. Some, for example Althaus (1997) claim improved performance, and others, for example Hiltz (1993) report no difference;
- communication – again some authors point out advantages such as "communal process of knowledge making" (Barker and Kemp 1990) fostering "critical awareness about how communication, or miscommunication, occurs" (DiMatteo 1991) and being "more reflective" than verbal communication found in the classroom (Althaus 1997) while others suggest it is "more difficult to achieve consensus in online discussion than face-to-face" and "information overload" (Warschauer 1997) and conversation becomes "a set of asocial monologues" (Moran 1991); and
- time – advantages include the "convenience of asynchronous participation" (Clark 2000), "a permanent record of the class" for analysis and comment (Clark 2000) and as Berge and Collins (1995) noted, CBL is "not bound by prescribed meeting times or by geographic proximity". In some cases however, CBL environments can encourage students to "procrastinate in their responses or withdraw entirely from the discussion" (Althaus 1997).

"Students' perceptions of the learning-assessment environment, based on former learning experiences and their recent experiences, have an important influence on their learning strategies and affect the quality of their learning outcomes" (Segers and Dochy, 2001) When looking into a model of future oriented motivation and self-regulation, Miller and Brickman (2004) found out that "perceptions of instrumentality help determine the individual's level of engagement" in tasks. Studies by Compeau and Higgins (1995), Gist et al. (1989), Webster and Martocchio (1992) have examined the influence of self-efficacy in the context of computer training. In particular, Compeau and Higgins (1995) researched the influence of self-efficacy, prior performance, and outcome expectations on performance. They hypothesised that "individuals who expect positive outcomes from their use of computers will exhibit higher performance than those who do not expect positive outcomes". They found that individuals with higher computer self-efficacy performed better than those with lower computer self-efficacy. They concluded that student perceptions of self-efficacy potentially play a very important role in student performance.

Studies into student perceptions of online collaboration have found that collaboration generally increases learning. In an experiment with online discussions, Althaus (1997) found "92% of system users … said participation in a [computer mediated discussion] group helped them learn the ideas and theories covered in class". When researching organisation support of computer-based learning, Dunstan and Dick (2004) looked into the perception of organisation support, finding that learner perception of this support was important for learning effectiveness. Piccoli et al. (2001) found even when students reported dissatisfaction with the learning process at times; they reported increase self-efficacy when involved in CBL environments. Lockyer et al. (2001) also studied learner perceptions of the effectiveness of web based and FTF learning environments in a study on health education.

There is evidence that student characteristics may also affect performance. Such issues as experience (Althaus 1997), gender (Mowbray and Dick, 2003; Bhattacherjee and Premkumar 2004), age (Althaus 1997), and learning styles (Brookfield, 1990; Hill 1971) all have been reported or assumed to have had some influence.

The above suggests the following research questions and the research model in Figure 1.

RQ1: What factors influence student preferences for face-to-face versus computer-based collaboration?

RQ2: Does student preference for face-to-face versus computer-based collaboration influence student performance in computer-based collaboration?

RQ3: What factors influence student performance in computer-based collaboration?

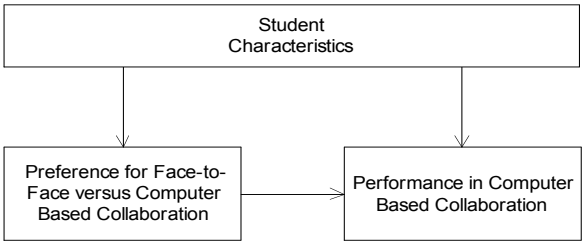

Figure 1: Research Model

3 Methodology

Students enrolled in a particular course at the University of New South Wales were selected as participants for this study. This course was selected as the target population primarily because computer-based collaboration was one of the lecture topics and as part of the course work, students would be completing tutorial work with the use of collaborative software. Students participating in the main study were asked to do the following:

- complete a pre-collaboration questionnaire during their week six tutorial;
- allow marks from their week seven collaborative tutorial to be used in the study;
- provide the transcript from their week seven collaborative tutorial to be used in the study; and
- complete a post-collaboration questionnaire to be included with their week seven submission.

The questionnaires were developed, piloted and validated. Validation was achieved by a combination of reliability tests (test-retest and Cronbach alpha – the test-retests were highly correlated and the alpha scores were well into the "good" range) and validity tests (face validity, by expert, peer and subject reviews, sampling validity by sampling all students in the class and convergent and discriminant validity by correlational analysis –all scores were satisfactory). Only minor modifications were made to the pilot instrument – again subjected to face validity review – and as a result of this review it was decided re-piloting was not necessary prior to the main study. Data was manually entered into SPSS and accuracy tests found the data to be satisfactorily accurate. This set of reliability assessments were repeated on data collected for the main study with satisfactory results.

The collaborative task was designed for all levels of student competency as it was directed at assessing a student's ability to collaboratively produce a report, not their intelligence or inherent academic ability. In line with this objective, the task was simple and relied on a collaborative effort by the students. Students were required to produce an individual report before collaborating online with a fellow student to produce a joint report. A marking guide was prepared for the class tutors to ensure consistency of performance evaluation. Marks from this tutorial work were collected from the tutors and tied to responses to the individual questionnaires. 144 students participated in the study at some level – due to the large number of data collection items the numbers participating for each test varied but overall response rates were satisfactory.

4 Results

RQ1: What factors influence student preferences for face-to-face versus computer-based collaboration?

Factors examined were experience, gender, age, performance in computer-based collaborative activity, perception of usefulness of computer-based collaboration, perception of ease of computer-based collaboration, and preference for individual versus collaborative learning. Usefulness and ease of use were measured by using similar constructs as those developed for the TAM model (Davis 1989). Performance (as a perception) was measured by administering a pre- and post-task questionnaire. Data analysis for each hypothesis was conducted by measuring the potential influence of each factor on student preference for face-to-face versus computer-based collaboration by a Chi-Square test. If the factor and student preference for face-to-face versus computer-based collaboration were found to be independent, analysis was complete. Otherwise, the potential relationships were analysed by calculating Spearman's correlational coefficient and then with a linear regressions in order to ascertain the strength of the potential relationship.

Experience, gender, age and performance were not found to affect preference for face-to-face versus computer based collaboration. Perceptions of usefulness, ease of use and preference for collaborative work over individual work were all found to at least partially influence preference for face-to-face collaboration versus computer-based collaboration.

In regard to the factor perception of usefulness, all correlations between measures of perception of usefulness and preference for face-to-face versus computer-based collaboration were significant (all above 0.01) – see Table 1. Linear regression gave an R^2 value of 0.289 with significance of .000. That is, the predictors (being the six measures for perception of the usefulness of computer-based collaboration) were found to explain almost 30% of the variance in student preference for face-to-face versus computer-based collaboration.

N=129		Pre-collaboration perceptions of usefulness					
Pre-Collaboration Preference for FTF versus CBC		Q1	Q2	Q3	Q4	Q5	Q6
Q1	Coefficient	-.402***	-.335***	-.323***	-.272**	-.358***	-.390***
	Sig. (2-tailed)	.000	.000	.000	.002	.000	.000
Q2	Coefficient	-.317***	-.445***	-.319***	-.358***	-.445***	-.412***
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

Table 1: Correlations for Perception of Usefulness of Computer-Based Collaboration and Preference for Face-to-Face versus Computer-Based Collaboration

N=129		Pre-collaboration perceptions of ease of computer-based collaboration					
Pre-Collaboration Preference for FTF versus CBC		Q1	Q2	Q3	Q4	Q5	Q6
Q1	Coefficient	-.189*	-.373***	-.238**	-.109	-.025	-.221*
	Sig. (2-tailed)	.030	.000	.006	.216	.774	.011
Q2	Coefficient	-.157	-.355***	-.332***	-.222*	-.184*	-.381***
	Sig. (2-tailed)	.074	.000	.000	.011	.036	.000

Table 2: Correlations for Perception of Ease of Computer-Based Collaboration and Preference for Face-to-Face versus Computer-Based Collaboration

In regard to the factor perception of ease of use, nine of the twelve correlations with preference for face-to-face versus computer based collaboration were significant. Those that were significant were all between -.184 and -.381. See Table 2. Thus the result indicates student perception of the ease of computer-based collaboration is only partially correlated with student preference for face-to-face versus computer-based collaboration. The negativity of the correlation indicates that students who tended to perceive computer-based collaboration as easy to use partially tended to prefer computer-based collaboration to face-to-face collaboration. The regression yielded an R^2 of .193 with significance of .000. This was interpreted to mean that student perception of the ease of computer-based collaboration influenced 19% of student preferences for face-to-face versus computer-based collaboration.

Student preferences for individual versus collaborative work was found to influence preferences for face-to-face versus computer-based collaboration. Table 3 gives details of the correlations. An R^2 of 0.148 with significance of .003 indicated the strong influence that pre-collaboration preference for individual versus group work has on pre-collaboration preference for face-to-face versus computer-based collaboration. That is, the predictors (being the six questions on preference for face-to-face versus computer-based collaboration) were found to explain 14.8% of the variance in student preference for face-to-face versus computer-based collaboration.

RQ2: Does student preference for face-to-face versus computer-based collaboration influence student performance in computer-based collaboration?

Similar analysis to that outlined above was conducted for this research question. (see table 4)

Bivariate correlations between student preference for face-to-face versus computer-based collaboration and performance in a computer-based collaborative task revealed a generally negative correlation with significances ranging from non-significant to 0.002. This negative correlation is surprising as it means that students who prefer face-to-face communication performed better in the computer-based task than students who prefer computer-based collaboration. The analysis was testing for an influence in the opposite direction to this, thus the analysis reveals there is at least no positive influence.

N=129		Pre-collaboration perceptions of ease of computer-based collaboration					
Pre-Collaboration Preference for FTF versus CBC		Q1	Q2	Q3	Q4	Q5	Q6
Q1	Coefficient	.206*	.079	.123	-.045	.070	.213*
	Sig. (2-tailed)	.018	.370	.160	.613	.427	.015
Q2	Coefficient	.080	.047	.278***	.180*	.275**	.131
	Sig. (2-tailed)	.368	.593	.001	.040	.002	.139

Table 3: Correlations for Preference for Individual versus Collaborative Work and Preference for Face-to-Face versus Computer-Based Collaboration

		Pre-collaboration Preference for FTF versus CBC		Post-collaboration Preference for FTF versus CBC	
		Q1	Q2 (rev)	Q1	Q2
Performance in CBC Task	Coefficient	-.091	-.281**	-.122	-.262*
	Significance	.338	.002	.272	.017
Change in Performance from Individual Task to CBC Task	Coefficient	-.010	-.236*	-.060	-.064
	Significance	.916	.013	.595	.568

Table 4: Correlation for Preference for Face-to-Face versus Computer-Based Collaboration and Performance in a Computer-Based Collaboration Task

Relationship	R-Square	Significance (2-tailed)
Individual performance on collaborative performance.	0.106	0.001
Pre-collaboration preference for computer-based collaboration on collaborative performance.	0.055	0.012
Post-collaboration preference for computer-based collaboration on collaborative performance.	0.054	0.034
Combined pre- and post-collaboration preference for computer-based collaboration on collaborative performance.	0.101	0.014

Table 5: Regression Results

Measurement of the change between students' individual marks and computer-based collaborative mark was calculated to determine whether it was influenced by student preferences. The changes that did occur between the individual task and the computer-based collaborative task were correlated with student preference for face-to-face versus online collaboration. From this correlation, there was no evidence to suggest preference for face-to-face versus online collaboration influenced performance (as measured by performance change between the two marks). A correlational coefficient of -0.164 and a 2-tailed significance of 0.087 indicate the correlation was negative and not significant.

Regression analysis was conducted to calculate the r-squares and their significances for the relationships between individual performance, collaborative performance and student preferences. Results from the regressions are contained in table 5.

As evidenced in table 5, there is a stronger relationship between individual performance and computer-based collaborative performance than student preference for computer-based collaboration and computer-based collaborative performance.

RQ3: What factors influence student performance in computer-based collaboration?

By using similar statistical analysis to that outlined above it was determined that none of the following factors examined in the study influenced performance – experience, gender, age, history of working in groups, or preferences for individual versus collaborative work. The only factor that did have an influence was individual performance – students who did better in the individual task also did well in the collaborative mark.

5 Discussion

The major finding of this study is that student preference for or against computer-based collaboration did not significantly influence their performance in a computer-based collaborative task. Whilst further research is needed, this information, as well as the other findings of this study, can be used by educators in the design of educational programs to ensure a better implementation and better outcomes for students.

Given student experience, gender, age and individual performance were not found to influence student preferences for face-to-face versus computer-based collaboration or performance in computer-based collaboration, educators planning collaborative courses with components similar to that used in this study can decide on implementing face-to-face or computer-based components without regard to students' previous experience, gender, age or individual performance.

Similarly, student perception of computer-based collaboration was not found to influence student performance in computer-based collaboration. With this information, educators can assume that when they are being assessed, students will not perform better or worse due to their perception of computer-based collaboration. This of course should not prevent educators from striving to create enjoyable learning experiences for students.

There may be implications in this study for the workplace. Whilst managers will have to cater for people from potentially very different demographics to those who participated in this study (given participants were students who participated in this study were university students with experience using computer-based collaborative tools and from within a limited age bracket), there are indications here that experience and gender do not play as big a part as previously thought. This may also be true for the preference or non-preference for computer-based collaborative work.

Limitations to this study should be noted. They include that a particular area of research that was not included in this study – learning styles; the fact that participants were sampled from one course at one university; the specification of the computer-based collaborative task; and that data from students performing the same task in a face-to-face environment would have supplemented the findings of this study.

6 Conclusion

Educators and managers alike can use this study to aid in the design and deployment of computer based learning or training modules – in particular, where computer based collaboration is needed. The finding in this study that experience, gender, age, perceived performance, and group history did not influence preference for or performance in computer-based collaboration implies that computer-based learning modules can be implemented regardless of the target population demographic in these areas. Caution is advisable however, as not all factors that influence preference and performance are known nor researched. More research in student preferences for and performance in computer-based collaboration should try and identify further influencing factors.

Interestingly, it was found that students are already using computer-based collaborative tools on a daily basis and the majority already uses these tools to assist in the completion of university assignments. Researchers and practitioners need to work together to investigate and harness benefits from these "innovations in practice" (Harriman 2002) in order to make our students' learning experiences more relevant and effective.

7 References

Alavi, M 1994 'Computer-mediated collaborative learning: an empirical evaluation', MIS Quarterly, vol. 18, no. 2, pp. 159-174

Alavi, M and Leidner, D E 2001 'Research commentary: technology-mediated learning - a call for greater depth and breadth of research', Information Systems Research, vol. 12, no. 1, pp. 1-10

Althaus, S L 1997 'Computer-mediated communication in the university classroom: an experiment with on-line discussions', Communications Education, vol. 46, no. 3, pp. 158-174

Barker, T and Kemp, F 1990 'Network theory: a postmodern pedagogy for the written classroom', In C. Handa (Ed.), Computers and community: Teaching composition in the twenty-first century, pp. 1-27, Portsmouth, NH: Heinemann.

Berge, Z and Collins, M 1995 'Computer-mediated communication and the online classroom in higher education', Computer-Mediated Communication Magazine, vol. 2, no. 3

Bhattacherjee, A and Premkumar, G 2004 'Understanding changes in belief and attitude toward information

technology usage: a theoretical model and longitudinal test', MIS Quarterly, vol. 28, no. 2, pp. 229-254

Brookfield, S 1990 The Skilful Teacher: On Technique, Trust and Responsiveness in the Classroom, Jossey-Bass Publishing, San Francisco

Clark, J 2000 'Collaboration tools in online learning environments', ALN Magazine, vol. 4, no. 1

Compeau, D R and Higgins, C A 1995 'Application of social cognitive theory to training for computer skills', Information Systems Research, vol. 6, no. 2, pp. 118-143

Cronbach, L J 1951 'Coefficient alpha and the internal structure of tests', Psychometrika, vol. 16, pp. 297-334

Davis, F D 1989 'Perceived usefulness, perceived ease of use and user acceptance of information technology', MIS Quarterly, vol. 13, no. 3, pp. 319-340

DiMatteo, A 1991 'Communication, writing, learning: an anti-instrumentalist view of network writing', Computers and Composition, vol. 8, no. 3, pp. 5-19

Dunstan, S and Dick, G 2004 'Developing a framework for evaluating the effectiveness of e-learning in organisations', Proceedings of the International Conference on Informatics Education Research, Washington, December 2004

Dwyer, J 2003 'Computers in schools: are they helping our children to learn?', Effects Project, University of Technology Sydney and NSW Department of Education and Training, viewed 12 May 2004, <effectsproject.uts.edu.au/paper.html >

Gist, M, Schwoerer, C and Rosen, B 1989 'Effects of alternative training methods on self-efficacy and performance in computer software training', Journal of Applied Psychology, vol. 74, no. 6, pp. 884-891

Harriman, S 2002 'Going online: review of practices and emerging trends in NSW', Australian Association for Research in Education Conference, Brisbane, QLD, 1-5 December, 2002

Hill, J E 1971 'Personalising educational programs using cognitive style mapping', Bloomfield Hills, MI: Oakland Community College (from Brookfield 1990)

Hiltz, S R 1993 'Correlates of learning in a virtual classroom', International Journal of Man-Machine Studies, vol. 39, pp. 71-98

Leidner, D and Jarvenpaa, S 1993 'The information age confronts education: case studies on electronic classrooms', Information Systems Research, vol. 4, no. 1, pp. 25-54

Lockyer, L, Patterson, J and Harper, B 2001 'ICT in higher education: evaluating outcomes for health education', Journal of Computer Assisted Learning, vol. 17, no. 3, pp. 275-283

Miller, R B and Brickman, S J 2004 'A model of future oriented motivation and self-regulation', Educational Psychology Review, vol. 16, no. 1, pp. 9-33

Moran, C 1991 'We write, but do we read?', Computers and Composition, vol. 8, no. 3, pp. 51-61

Mowbray, K A and Dick, G 2003 'E-learning in organisations: a research model of perceptions and a study of demographic influences', University of New South Wales, Working Paper

Piccoli, G, Ahmad, R and Ives, B 2001 'Web-based virtual learning environments: a research framework and a preliminary assessment of effectiveness in basic IT skills training', MIS Quarterly, vol. 25, no. 4, pp. 401-426

Segers, M and Dochy, F 2001 'New assessment forms in problem-based learning: the value-added of the students' perspective', Studies in Higher Education, vol. 26, no. 3, pp. 327-343

Stallings, D 2002 'Measuring success in the virtual university', Journal of Academic Librarianship, vol. 28, no. 2, pp. 47-53

Warschauer, J 1997 'Computer-mediated collaborative learning: theory and practice', Modern Language Journal, vol. 81, no. 3, pp. 470-481

Webster, J and Martocchio, J 1992 'Microcomputer playfulness: development of a measure with workforce implications', MIS Quarterly, vol. 15, no. 1, pp. 201-226