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AUTHOR	Inoue, Yukiko
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ABSTRACT

The purpose of this study was to identify and prioritize the factors influencing the university faculty's use of computer-assisted instruction (CAI). A survey questionnaire was constructed and administered to faculty members of a leading university in Singapore. The subjects were 62 respondents representing two groups: 26 from education and 36 from business (36 male and 26 female). The results indicated that the two most important inhibitors were: lack of teachers' time, and lack of technical support. The results may be attributed to Singapore's favorable climate for the instructional use of computers. (Contains 14 references.) (Author)

Determinants of the Use of Computer-Assisted Instruction at a University in Singapore

by Yukiko Inoue

DETERMINANTS OF THE USE OF COMPUTER-ASSISTED INSTRUCTION AT A UNIVERSITY IN SINGAPORE

YUKIKO INOUE
UNIVERSITY OF MEMPHIS, MEMPHIS, TN 38152

Abstract. The purpose of this study was to identify and to prioritize the factors influencing the university faculty's use of computer-assisted instruction (CAI). A survey questionnaire was constructed and administered to faculty members of a leading university in Singapore. The subjects were 62 respondents representing two groups: 26 from education and 36 from business (36 male and 26 female). The results indicated that the two most important facilitators were: teachers' knowledge of and skills in CAI technology, and availability of hardware and software. The two most important inhibitors were: lack of teachers' time, and lack of technical support. The results may be attributed to Singapore's favorable climate for the instructional use of computers.

As computers become smaller, more powerful, and more cost-effective, their use in education has increased. Computer assisted instruction (CAI) is being used to teach students as well as to train instructors. CAI will be a powerful complement to traditional instruction; teachers may help keep students' interest by using CAI to provide a variety of instructional methods and presentations. Many teachers are reluctant to adopt CAI in their teaching even when they believe that computer use improves the quality and quantity of teaching. Marcinkiewicz (1993-94) has likened the situation to corn farmers who do not adopt a new corn seed which improves the amount and quality of yields.

The purpose of this study was to identify and to prioritize determinants of the faculty's use of CAI. Like any other technological innovation used for teaching purposes, CAI needs to be accepted by the faculty before it can be utilized productively (Mackowiak, 1990-91). The CAI literature review resulted in identification of potential factors for the use of CAI, and a survey questionnaire was constructed and administered to faculty members of Nanyang Technological University in Singapore.

SELECTING SINGAPORE AS A SITE FOR THE SURVEY

The Republic of Singapore is a small country (2.7 million people), and almost the entire educational system is public and subject to the control of government agencies. According to A Vision of an Intelligent Island: The IT2000 Report (NCB, 1992), over half of Singapore's teachers will have received intensive training in information technology (IT) by the year 2000. If everything goes as planned, Singapore will be one of the first countries in the world to have a national information infrastructure capable of connecting computers in every home to any office, school, or factory (Sponder & Hilgenfeld, 1993).

A pioneering CAI program with twenty-two networked microcomputers started in a secondary school in 1986 (Barker, 1988; Yip & Sim, 1990). The mission of the program was to evaluate CAI modes (e.g., tutoring and problem-solving) and to examine the effectiveness of the network as a CAI delivery mechanism. Published studies on the effect of CAI in Singapore's schools have shown positive results in Mathematics (Ong & Lee-Leck, 1986), Geography (Low, 1988), and Geometry (Woo-Tan, 1989). Nevertheless, little attention has been given to a fundamental issue, specifically, how faculty members feel about the use of CAI.

DETERMINANTS OF THE USE OF CAI

In this study, determinants of the use of CAI were divided into two categories: facilitators and inhibitors. The following 15 potential facilitators and 18 potential inhibitors were identified:

Facilitators for the use of CAI

1 Universities' formal policy for computer use.
2 Support from the government.
3 Teachers' knowledge and skills in technology.
4 Availability of hardware (and software).
5 Availability of teachers' time.
6 Commitment by those involved in CAI.
7 Support from higher administration.
8 Systematic planning for the use of CAI.

9 Recognition and motivation of the faculty.
10 Collaboration among CAI developers and users.
11 Integration of CAI with the university' goals.
12 Demonstration of other universities' CAI use.
13 Availability of software information.
14 Availability of CAI authoring tools.
15 Availability of commercial software.

Inhibitors for the use of CAI

1 Lack of administrative support.
2 Cost of hardware (financial resources).
3 Teachers' resistance to change.
4 Apprehension of teachers regarding change in teaching.
5 Lack of teacher training for computer use.
6 Lack of teachers' time for CAI.
7 Incompatibility of teaching methods with CAI.
8 Skepticism on the effectiveness of CAI.
9 Scheduling problems in computer use of CAI.
10 Assumption that CAI demands a special curriculum.
11 Lack of quality and suitable software.
12 Lack of appropriate hardware for students .
13 Lack of technical support for the faculty and staff.
14 Lack of information about the potential of CAI.
15 Rapid changes in both hardware and software.
16 Lack of achievement tests to evaluate CAI.
17 Lack of access to software information.
18 Lack of suitably equipped classrooms.

METHOD

Subjects

The subjects were 62 respondents representing two groups: 26 from the faculty of education and 36 from the faculty of business (36 male and 26 female). The subjects were drawn from two entities at Nanyang Technological University (NTU): Nanyang Business School (NBS), and the division of Education, which is part of the National Institute of Education (NIE). The Division of Education has 59 faculty members (60% female and 40% male). Of 208 faculty members in NBS, 25 percent were female and 75 percent were male. All the faculty members of the Division of Education received a copy of the questionnaire. In order to match this sample size, 59 faculty members of NBS were randomly selected to participate.

Instrument

The preliminary survey questionnaire was pilot-tested through a personal interview with four Singaporian faculty members. Based

upon the pilot test, the final version of the questionnaire was structured consisting of 15 facilitators and 18 inhibitors. Factors in each category were arranged in a random order to avoid any possible bias. Each item on the 33-item questionnaire consisted of a statement and a 5-point Likert-type scale possible answer (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). The survey also contained a section in which respondents provided demographic information about themselves and a section for an open-ended comments on CAI.

Data Collection and Analysis

One faculty member from each entity agreed to serve as a contact person for the study. Each contact person received a packet containing an explanatory letter, directions for administering the survey, and 59 copies of the questionnaire. The survey was conducted with the permission of the deans of both schools. The contact person point at each school distributed, collected, and returned all questionnaires to the researcher during the Summer Term of 1995.

In prioretizing the determinants, the overall mean scores and standard deviations for all the respondents by each factor, were calculated and were arranged in descending order. In comparing users and non-users of CAI, as well as education and business faculty, the overall mean scores for each of facilitators and inhibitors by groups were calculated; t-tests were used to check for significant differences, for all individual factors, between the two groups in the two comparisons.

RESULTS AND DISCUSSION

The final usable response rate was 54 percent: it should be adequate for studies of this nature. Most respondents were over thirty-one years of age (91%). Seventy-seven percent of the

education faculty and 56 percent of the business faculty reported that they had more than six years of college teaching experience. Interestingly enough, the majority of the business faculty (89%) had no pre-college teaching experience, whereas the majority of the education faculty (88%) had pre-college teaching experience.

Within Group Comparisons

The alpha reliability coefficient across all 33 factors was .93. Mean scores were 4.06 (SD = .61) for all the facilitators and 3.74 (SD = .63) for all the inhibitors. The respondents agreed significantly more strongly with the facilitators than with the inhibitors, $t = -4.37$, $p = .000$. Singapore's CAI experts expressed an opinion on this: there is less need to enhance the facilitators than depress the inhibitors in Singapore because the government is supporting the instructional use of computers. Table 1 shows mean scores and standard deviations on a 5-point scale. The three most important facilitators identified by respondents were:

1 Teachers' knowledge of and skills in technology.
2 Availability of hardware (and software).
3 Commitment by those involved in CAI.

The fact that teachers' knowledge of and skills in technology is the most important facilitator confirms that Singapore Government is using an appropriate strategy of providing teachers with instructional technology knowledge through training programs. The next two factors point out the importance of adequate hardware and software, and the need for commitment by CAI users. These factors were also identified by Wild (1990) as the most important ones influencing the use of CAI. The four most important inhibitors were:

1 Lack of teachers' time for CAI.
2 Lack of technical support.
3 Cost of hardware (financial resources).
4 Lack of teacher training for computer use.

All four factors appear often in the literature as prime inhibitors for computer use in general. The first factor is consistent with the finding of Dupagne and Krendl's study (1992); the second factor is consistent with the finding of Hammond et al. (1992), and the third factor is the same as was found by Rosenberg (1992). The fourth factor stresses the importance of teacher training for stimulating their CAI use in fostering favorable attitudes toward the instructional use of computers.

Table 1. Priorities of facilitators and inhibitors

Rank	Factor	M	SD
	(Facilitators)		
1	Teachers' knowledge/skills in technology.	4.32	.95
2	Availability of hardware (and software).	4.29	1.05
3	Commitment by those involved in CAI.	4.26	.96
4	Availability of software information.	4.23	.78
5	Systematic planning for the use of CAI.	4.21	.83
6	Support from higher administration.	4.16	.96
7	Availability of teachers' time.	4.13	.97
8	Availability of commercial software.	4.11	.96
9	Universities' formal policy for computer use.	4.03	1.04
10	Availability of CAI authoring tools.	4.00	.94
11	Collaboration among developers and users.	3.98	1.05
12	Support from the government.	3.94	.74
13	Demonstration of other schools' CAI uses.	3.84	.85
14	Integration of CAI with schools' goals.	3.81	.96
15	Recognition/motivation of the faculty.	3.53	.92
	Average	4.06	.61
	(Inhibitors)		
1	Lack of teachers' time for CAI.	4.08	.95
2	Lack of technical support.	4.06	.94
3	Cost of hardware (financial resources).	3.98	1.11
4	Lack of teacher training for computer use.	3.97	.97
5	Teachers' resistance to change.	3.92	1.03
6	Lack of quality and suitable software	3.90	1.13
7	Incompatibility:teaching method with CAI.	3.89	.89
8	Lack of administrative support.	3.85	1.02
9	Scheduling problems to use computers.	3.76	1.07
10	Lack of appropriate hardware.	3.74	1.19
11	Lack of suitably equipped classrooms.	3.71	1.14
12	Skepticism on the effectiveness of CAI.	3.56	1.11
13	Lack of access to software information.	3.55	.99
14	Apprehension of teachers in teaching	3.55	1.04
15	Rapid changes in hardware and software	3.52	.82
14	Lack of information on CAI potentiality	3.45	1.05
17	Lack of tests to evaluate CAI.	3.45	.86
18	Assumption: CAI needs special curricula.	3.40	1.09
	Average	3.74	.63

Between Group Comparisons

Education (NIE) versus business (NBS). The NIE group agreed significantly more strongly with the facilitators, $t = -2.28$, $p = .03$, and the inhibitors, $t = -3.45$, $p = .001$, than did the NBS group. In addition, the specific ranking of the facilitators and the inhibitors differed between the two groups. As indicated in Table 2, six facilitators and eight inhibitors are significantly different between the two groups at the alpha level of .05.

The highest ranking facilitators for the NIE group are 1) availability of hardware and software, 2) commitment by those involved in CAI, and 3) teachers' knowledge of and skills in technology, compared with 1) availability of software information, and 2) teachers' knowledge of and skills in technology for the NBS group. The highest ranking inhibitors for the NIE group are 1) the lack of technical support, 2) the lack of teacher training for computer use, and 3) the lack of teachers' time for CAI. In contrast, 1) the lack of administrative supports, and 2) the cost of hardware rank are the highest for the NBS group.

Table 2. Priorities of factors: NIE versus NBS.

Item Number		NIE N = 26	NBS N = 36
	(Facilitators)		
1	Universities' policy for computer use.	4.12	3.97
2	Support from the government.	4.27	3.86
3	Teachers' knowledge/skills in technology.	4.54	4.17
4	Availability of hardware (and software).	4.62*	4.06*
5	Availability of teachers' time.	4.42*	3.92*
6	Commitment by those who involved in CAI.	4.62*	4.00*
7	Support from higher administration.	4.31	4.06
8	Systematic planning for the use of CAI.	4.42	4.06
9	Recognition/motivation of the faculty.	3.81*	3.33*
10	Collaboration among developers and users.	4.15*	3.77*
11	Integration of CAI with schools' goals.	3.92	3.72
12	Demonstration of other schools' CAI uses.	4.12*	3.64*
13	Availability of software information.	4.19	4.25
14	Availability of CAI authoring tools.	4.04	3.97
15	Availability of commercial software.	4.35	3.94
	Average	4.26*	3.91*
	(Inhibitors)		
1	Lack of administrative supports.	3.92	3.81
2	Cost of hardware (financial resources).	4.23	3.80
3	Teachers' resistance to change.	4.35	3.61
4	Apprehension of teachers in teaching.	4.20*	3.08*
5	Lack of teacher training for computer use.	4.38*	3.67*
6	Lack of teachers' time for CAI.	4.38*	3.86*
7	Incompatibility:teaching method with CAI.	4.04	3.78
8	Skepticism on the effectiveness of CAI.	3.69	3.47
9	Scheduling problems to use computers.	4.00	3.58
10	Assumption: CAI needs special curricula.	3.81*	3.11*
11	Lack of quality and suitable software.	4.12	3.75
12	Lack of appropriate hardware.	4.04	3.53
13	Lack of technical support.	4.46*	3.78*
14	Lack of information on CAI potentiality.	3.79*	3.22*
15	Rapid changes in hardware and software.	3.89*	3.25*
16	Lack of tests to evaluate CAI.	3.54	3.39
17	Lack of access to software information.	3.76	3.39
18	Lack of suitably equipped classrooms.	4.15*	3.39*
	Average	4.04*	3.53*

* Indicates a statistically significant difference between the two groups (1 = strong disagree, 5 = strongly agree), $p < .05$.

A detailed profile was constructed to compare the two groups, due to the above differences. The results for the facilitators and the inhibitors are shown in Tables 3 and 4.

Interpretation of facilitators profile. There is a fairly good agreement on four items of the six higher ranking

facilitators. While only one item, "recognition," received an identical ranking, and "teachers' knowledge" and "adequate hardware" received close ranking. Major disagreements include: commitment by those involved in CAI (ranked as first at NIE but sixth at NBS) and availability of software information (ranked as first at NBS but ninth at NIE). The results may be attributed to education faculty members being more behavior-oriented, while business faculty members are more technology-oriented.

Table 3. Profile of NIE and NBS - Facilitators.

Rank	NIE (education)	Rank	NBS (business)
1	Adequate hardware	1	Software information
1	Commitment	2	Teachers' knowledge
3	Teachers' knowledge	3	Adequate hardware
4	Teachers' time	3	Administrative support
4	Systematic planning	3	Systematic planning
6	Commercial software	6	Commitment
7	Administrative support	7	Formal policy
8	Government support	8	Authoring tools
9	Software information	9	Commercial software
10	Collaboration	10	Teachers' time
11	Formal policy	11	Government support
12	Demonstration	12	Collaboration
13	Authoring tools	13	Integration
14	Integration	14	Demonstration
15	Recognition	15	Recognition

Interpretation of Inhibitors profile. A similar pattern to the facilitators is observed in the inhibitors, but to a lesser degree. There is an agreement on three of the five higher-ranking inhibitors and on three of the five lower-ranking inhibitors. Major differences are "apprehension" which is much more important for the NIE group than for the NBS group. Perhaps, one explanation for the finding is that computerization is newer in schools of education than in schools of business.

Table 4. Profile of NIE and NBS - Inhibitors.

Rank	NIE (education)	Rank	NBS (business)
1	Technical support	1	Teachers' time
2	Teacher training	2	Administration
2	Teachers' time	3	Hardware cost
4	Resistance	4	Incompatibility
5	Hardware cost	4	Technical support
6	Apprehension	6	Quality software
7	Equipped rooms	7	Resistance
8	Quality software	7	Teacher training
9	Incompatibility	9	Scheduling problem
9	Lack of hardware	10	Lack of hardware
11	Scheduling problem	11	Skepticism
12	Administration	12	Evaluation test
13	Rapid change	12	Software information
14	Assumption	12	Equipped rooms
15	Potentiality	15	Rapid change
16	Software information	16	Potentiality
17	Skepticism	17	Assumption
18	Evaluation tests	18	Apprehension

Users versus non-users. The overall mean scores for both facilitators (t = -.03, p = .98) and inhibitors (t = -.28, p = .78) were not significantly different between users and non-users; yet, the sequences of ranking were different. "Availability of hardware and software" and "commitment by those involved " were important facilitators for users, compared with "teachers' knowledge and skills" and "systematic planning" for non-users. As important inhibitors, users named "hardware cost" and "lack of teachers' time," while non-users named "lack of teachers' time" and "lack of technical support." Surprisingly, no significant difference in the mean scores of any factor was found between the two groups.

Comments on CAI. The respondents' open-ended comments on CAI in the questionnaire include:

1) University faculty need to underpin the use of CAI with a higher level of teaching skills than they generally have.
2) CAI must be improved greatly in order to be utilized as an instructional tool in higher education.
3) CAI is not a solution for all courses and promoting CAI adoptions by using a top-down approach should be avoided.
4) CAI may work for practical studies more than for theoretical studies.

5) CAI is very important because its software programs can enhance students' critical and analytical thinking.
6) The fact that older students have less computer knowledge and experience makes the use of CAI more difficult that is the problem in the college of education.

Limitations of the Study

To compare users and non-users, it was necessary to ask participants to indicate to which category they belong. Talisayon (1990) depicted three computer uses: as a learning tool, as itself the object of study, and as a management tool. "The use of CAI" has many definitions and each person may have had a different interpretation. Furthermore, it was not clear to what extent the respondents used CAI when they reported it themselves.

The second limitation is the exploratory nature of the study. This approach was taken to make single item comparisons rather than defining specific constructs with multiple item measures in order to investigate differences in the perception regarding each potential factor for the use of CAI.

The third limitation is the validity of the questionnaire. The questionnaire was developed because it was not possible to use an existing one. Although the questionnaire was pre-tested, it might still not be as valid as the existing one.

The fourth limitation is the possibility that the sample does not fully represent the population, especially regarding the faculty of business. The survey was conducted during summer because this was the only chance for the researcher to make a trip to Singapore, but some teachers might have been on vacation.

CONCLUSIONS AND RECOMMENDATIONS

This study attempted to rank the determinants of the use of CAI as perceived by faculty members of two schools at a leading university in Singapore. The education faculty agreed

significantly more with all the factors than did business faculty. This phenomenon should be further investigated. A 7-point scale yields more accurate results because the mean scores of the factors measured on a 5-point scale are too close to each other.

Another difference between the two groups is the ranking of factors. It is recommended to replicate the survey when the entire faculty is on board, and then the findings can be treated with more confidence. If a difference still exists, it will be pertinent to explore the implication of the difference and to take corrective actions. The Singapore Government's goal is to increase the use of CAI, and the deans of each school at NTU should promote vital facilitators and reduce vital inhibitors.

Singapore's faculty named teachers' knowledge and skills in technology (M = 4.32, SD = .95) as the most important facilitator for the use of CAI. Significant difference between users and non-users of CAI was not detected regarding all the factors, although the priorities of facilitators and inhibitors were assessed differently. Singapore is making an investment in information technology. The findings may be attributed to the Singapore's favorable climate for the instructional use of computers.

To generalize the results of the study to other universities, especially in different countries, replications of the study are needed. Cultural, social, economical, and political differences could provide a different set of facilitators and inhibitors. If other studies confirm the same results, then the question should be raised as to what are the indication that students can get optimal benefits from CAI. Eventually, the option of mixing CAI and traditional instruction in higher education is an intriguing topic for research.

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