**Addressing Individual Differences in Computer Ability, Attitudes and Use: The Laptop Effect**

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## Purpose

The purpose of this study is to explore differences in computer attitudes, abilities, and use with respect to gender, socio-economic status (SES), and culture for preservice teachers.

## Theoretical Framework

*Gender Differences*

The sheer volume of research examining gender differences in computer-related behaviour is, at first glance, quite intimidating (see Kay 1992b for a review of the literature). The morass of conflicting results and conclusions permits confusion to reign. Researchers have focused on differences regarding attitudes toward computers (confidence, interest, motivation, perceived usefulness, locus of control), aptitude (general ability, programming, applications software), and use (ownership, experience, courses taken, games, style) in a variety of sub-populations (pre-schoolers, primary, middle school, secondary, and university students, teachers, and office employees). The results are conflicting and confusing, with the exceptions standing out more than the rules.

For example, with respect to attitudes, males and females are most alike. Out of 98 instances of attitude measurement (two or more attitude measures may occur in a single study), males had more positive attitudes in 48 studies, females had more positive attitudes in 14 studies, and males and females had similar attitudes in 36 studies (Kay, 1992b). With respect to computer aptitude, researchers reported that males performed better than females in 15 out of 32 studies, although 13 out of 32 measures showed no difference between males and females (Kay, 1992b). On only five occasions did females surpass males in computer aptitude (Kay, 1992b). Finally, males overwhelmingly use computers more often than females (30 out of 38 occasions) (Kay, 1992b).

In short, there are clear measurement concerns with assessing gender difference in computer ability, attitude and use (Kay, 1989a, 1989b, 1992a, 1993a, 1993b, 1993c, 1994), but the overall picture indicates that males have more positive attitudes, higher ability, and use computers more. This issue needs to be addressed, particularly for preservice teachers who have considerable influence on future students.

*SES differences*

While considerable research has been done on the effect of SES on educational achievement (Haller & Davis, 1980; Majoribanks, 1990; Sewell & Shah, 1968), very little research has been done looking at the effect of SES on computer attitude, ability, and use. In one study of 1730 high school students, SES had a significant effect on attitudes toward computers, with gender differences being more pronounced in lower socio-economic groups. SES had a stronger effect on females than males (Shashaani, 1994). On the other hand, no differences in computer attitude were observed in Nolan's (1992) study of 250 secondary students.

Research on the effect of SES on preservice teacher's ability, attitudes, and use of computers is noticeably absent. However, accessibility, which may be indirectly related to SES, has been examined. Becker and Ravitz (1999), for example, noted that home computer use builds teacher motivation and confidence for infusing technology into the classroom. Honey, McMillan and Carrigg (2000) reported that teachers need good access to technology while they plan. Certainly, it is reasonable to speculate that readily available access to a computer and the Internet might have an impact on computer attitudes, ability, and use.

*Culture Differences*

There is some evidence to suggest that culture can have an impact on computer attitude, ability, and use, although published articles in this are relatively sparse. One survey of 55,000 American households reported that 25%

of African Americans were using computers and interacting with technology compared to 38% of Caucasian Americans (Evans, 1995). Hoffman and Novak (1998) found that over 70% of Caucasian students owned a computer while only a little over 32% of African American students owned a computer. The differences remained when the results were adjusted for household income. Wilkinson, Buboltz, Cook, Matthew, and Thomas (2000) speculate that the current technological revolution is opening up a wide range of information and opportunities, but perhaps not for all cultures.  It is worthwhile to note that most computers and software are produced by Western countries, particularly the United States, and that differences in acceptance of computers and particularly computer interfaces have been observed between cultures (Cagiltay, 1999).

**Method**

*Sample*

The sample consisted of preservice teachers (22 males, 29 females) from a variety of cultural backgrounds (63% reported that their first language was not English) with a mean age of 35 (*SD =8.7).*  Participation in the study was voluntary.

*Description of the Learning Environment*

Every student in the preservice program was given an IBM R40 ThinkPad at the beginning of the year loaded with a wide range of educational and application-based programs.  All classrooms were wired with high-speed Internet access through cable or a wireless network.  In addition, students had access to a wireless network throughout the whole university.

*Survey Description*

The survey consisted of 16 sections (215 items) described in Table 1. The survey was based on previous research done on computer attitudes (Kay, 1989a, 1993a) and computer ability (Kay, 1989b, 1992, 1993b, 1994).  The survey was modified to incorporate a number of the standards developed by the International Technology Education Association/Council on Technology Teacher Education (NCATE, 2003). Specifically, the scales in the study focused on the nature of technology (standard 1), curriculum abilities for a technological world (standard 4), instructional strategies (standard 7), and learning environments (standard 8).

Table 1.  Description of Survey

| Scale Construct Measure | No. of Items | Type of Question | Reliability |
|---|---|---|---|
| 1.   Attitude (Affective) | 10 | 7 pt, Semantic Differential Scale | $r$ = .94 |
| 2.   Attitude (Cognitive) | 15 | 7 pt Likert Scale | $r$ = .77 |
| 3.   Attitude (Behavioural) | 10 | 7 pt Likert Scale | $r$ = .87 |
| 4.   Attitude (Perceived Control) | 7 | 7 pt Likert Scale | $r$ = .86 |
|  |  |  |  |
| 5.   Ability (OS Skills) | 17 | 5 pt Likert Scale | $r$ = .96 |
| 6.   Ability (Communication) | 12 | 5 pt Likert Scale | $r$ = .93 |
| 7.   Ability (WWW skills) | 14 | 5 pt Likert Scale | $r$ = .95 |
| 8.   Ability (Word Processing) | 15 | 5 pt Likert Scale | $r$ = .94 |
| 9.   Ability (Spreadsheet) | 6 | 5 pt Likert Scale | $r$ = .94 |
| 10. Ability (Database) | 6 | 5 pt Likert Scale | $r$ = .98 |
| 11. Ability (Graphics) | 6 | 5 pt Likert Scale | $r$ = .96 |
| 12. Ability (Multimedia) | 6 | 5 pt Likert Scale | $r$ = .91 |
| 13. Ability (Create Web Page) | 15 | 5 pt Likert Scale | $r$ = .98 |
| 14. Ability (Programming) | 12 | 5 pt Likert Scale | $r$ = .99 |
|  |  |  |  |
| 15. Pre Program Use | 31 | 5 pt Likert Scale | $r$ = .93 |
| 16. Post University Use | 32 | 5 pt Likert Scale | $r$ = .93 |
| 17. Post Filed Placement Use | 31 | 5 pt Likert Scale | $r$ = .94 |

* Use in field placement was only administered in April.

**Procedure**

Subjects were told the purpose of the study and asked to give written consent if they wished to participate. The survey was administered at the beginning of the year (September) and at the end of the year (April). It took most subjects 25 -35 minutes to complete the survey.

**Data Source**

*Independent Variables*

Three independent variables were measured in this study: **gender** (male, female), **SES** (dialup vs. high speed access to computers), and **culture** (English as first language – yes or no).

It is understood that the measure of SES is quite narrow. This metric was used because (a) the speed of Internet access can greatly increase the speed with which information is gathered (accessibility issue noted by Becker & Ravitz (1999) and Honey, McMillan and Carrigg (2000)) and (b) dialup access is almost five times less expensive than high speed access. It was assumed, then, that choosing a slower access speed is partially dependent on SES and that students who had dialup access were limited with respect to using Internet resources.

It is also understood that the measure of culture is quite broad and obscures possible differences among different cultures. However, the sample size was relatively small, so between culture differences could not be adequately assessed.

*Dependent Variables*

There were three main dependent variables assessed in this study: **computer attitude**, **computer ability**, and **computer use**. The principle data source was the 16 (17 post-program) section, 215 item survey described in Table 1. Overall, the internal reliability of these measures was high ranging from .77 to .99.

**Results**

**Gender Differences**

*Before Laptop Program*

From Table 2, it can be seen that males had significantly more positive behavioural attitudes (e.g., intentions to use computers). All other attitude constructs showed no significant difference. With respect to ability, males reported significantly stronger skills in operating systems, databases, graphics, creating a web page, and programming. Finally, there were no significant differences with respect to overall use of computers between males and females.

*After Laptop Program*

There were no significant differences between males and females with respect to computer attitude after the laptop program (Table 3). There were no significant differences between males and females with respect to computer ability either, with one exception. Males reported being significantly stronger programmers. Finally, the difference between males and females regarding computer use remained non-significant in both university and field placement environments.

*Table 2. Gender Difference in Computer Ability, Attitudes and Use **Before** the Laptop Program*

| Measure | Females M | SD | Males M | SD | df | t |
|---|---|---|---|---|---|---|
| Affective Attitude | 51.9 | 7.6 | 51.0 | 13.1 | 62 | -0.34 |
| Cognitive Attitude | 79.2 | 10.9 | 81.7 | 9.8 | 63 | 0.97 |
| Behavioural Attitude | 51.1 | 15.8 | 58.3 | 9.5 | 63 | 2.18 * |
| Perceived Control | 30.4 | 10.2 | 34.0 | 10.3 | 63 | 1.42 |
| Operating Systems | 54.8 | 18.6 | 67.6 | 17.5 | 63 | 2.84 * |
| Communication | 38.8 | 12.3 | 44.2 | 13.3 | 62 | 1.69 |
| WWW Skills | 41.3 | 15.1 | 48.6 | 14.7 | 63 | 1.97 |
| Word Processing | 51.1 | 14.1 | 51.8 | 18.0 | 63 | 0.17 |
| Spreadsheets | 19.3 | 7.4 | 21.2 | 6.4 | 63 | 1.08 |
| Database | 11.7 | 6.7 | 16.9 | 8.6 | 63 | 2.76 * |
| Graphics | 11.7 | 6.4 | 16.2 | 7.4 | 63 | 2.62 ** |
| Multimedia | 12.3 | 6.5 | 15.0 | 6.0 | 63 | 1.67 |
| Create Web Page | 21.4 | 12.5 | 29.3 | 15.1 | 63 | 2.31 ** |
| Programming | 19.3 | 12.5 | 31.5 | 16.4 | 62 | 3.35 * |
| Overall Use | 66.6 | 20.4 | 76.2 | 18.7 | 63 | 1.96 |

\* $p < .01$
\*\* $p < .05$

*Table 3. Gender Difference in Computer Ability, Attitudes and Use **After** the Laptop Program*

| Measure | Females M | SD | Males M | SD | df | t |
|---|---|---|---|---|---|---|
| Affective Attitude | 52.8 | 9.7 | 55.1 | 11.4 | 50 | 0.78 |
| Cognitive Attitude | 80.3 | 11.3 | 84.7 | 10.3 | 50 | 1.47 |
| Behavioural Attitude | 58.8 | 8.4 | 60.9 | 9.6 | 49 | 0.82 |
| Perceived Control | 38.0 | 7.0 | 39.3 | 8.3 | 50 | 0.58 |
| Operating Systems | 72.1 | 10.6 | 75.3 | 13.4 | 50 | 0.96 |
| Communication | 51.7 | 6.8 | 51.9 | 9.4 | 50 | 0.08 |
| WWW Skills | 59.8 | 8.2 | 59.6 | 11.6 | 50 | -0.12 |
| Word Processing | 66.3 | 8.4 | 65.9 | 10.3 | 50 | -0.17 |
| Spreadsheets | 25.9 | 4.3 | 26.1 | 5.4 | 49 | 0.17 |
| Database | 16.9 | 7.5 | 20.3 | 8.0 | 49 | 1.59 |
| Graphics | 21.5 | 7.0 | 22.5 | 7.2 | 48 | 0.51 |
| Multimedia | 24.0 | 5.4 | 24.1 | 5.5 | 48 | 0.05 |
| Create Web Page | 56.6 | 16.2 | 58.0 | 15.2 | 49 | 0.31 |
| Programming | 24.9 | 16.5 | 36.7 | 18.2 | 49 | 2.41 ** |
| University Use | 99.0 | 15.1 | 100.2 | 28.9 | 49 | 0.22 |
| Field Use | 74.2 | 25.7 | 79.9 | 26.7 | 46 | 0.71 |

\* $p < .01$
\*\* $p < .05$

**SES Differences**

*Before Laptop Program*
     SES, as measured by connection speed to the Web, showed significant differences in affective attitudes, computer abilities, and overall use of computers, always in favour of students who had a high speed connection (see Table 5).

Table 4. *SES (Internet Access) Differences in Computer Ability, Attitudes and Use Before the Laptop Program*

|  | Dialup | | High Speed | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Measure | M | SD | M | SD | df | t |
| Affective Attitude | 47.2 | 8.2 | 54.2 | 11.1 | 60 | -2.63 * |
| Cognitive Attitude | 78.5 | 11.6 | 81.7 | 9.8 | 61 | -1.18 |
| Behavioural Attitude | 51.8 | 13.4 | 56.0 | 18.8 | 61 | -1.15 |
| Perceived Control | 29.6 | 9.4 | 33.8 | 10.8 | 61 | -1.58 |
| Operating Systems | 56.1 | 16.6 | 63.5 | 20.1 | 61 | -1.50 |
| Communication | 34.6 | 11.8 | 45.7 | 12.1 | 60 | -3.58 ** |
| WWW Skills | 38.9 | 13.5 | 48.6 | 15.4 | 61 | -2.54 * |
| Word Processing | 47.3 | 12.8 | 54.4 | 17.4 | 61 | -1.71 |
| Spreadsheets | 18.3 | 6.2 | 21.3 | 7.4 | 61 | -1.67 |
| Database | 11.3 | 5.5 | 16.1 | 9.0 | 61 | -2.33 * |
| Graphics | 11.2 | 6.0 | 15.3 | 7.6 | 61 | -2.26 * |
| Multimedia | 11.6 | 5.6 | 14.9 | 6.6 | 61 | -2.04 * |
| Create Web Page | 19.7 | 8.1 | 28.7 | 16.5 | 61 | -2.50 * |
| Programming | 19.2 | 10.7 | 29.0 | 17.4 | 60 | -2.44 * |
| Overall Use | 61.8 | 15.1 | 76.7 | 21.2 | 61 | -3.00 ** |

\*    $p < .05$
\*\*   $p < .01$

*After Laptop Program*

     Differences between student with and without high speed connections appeared to increase after participation in the laptop program.  In other words, both computer attitude and ability improved more for students with high speed connections.  The one exception to this finding is that there were no significant differences with respect to use of computers at the university or in the field placement (see Table 5).

Table 5

*SES (Internet Access) Differences in Computer Ability, Attitudes and Use After the Laptop Program*

|  | Dialup | | High Speed | | | |
| Measure | M | SD | M | SD | df | t |
| --- | --- | --- | --- | --- | --- | --- |
| Affective Attitude | 48.9 | 10.8 | 57.3 | 9.0 | 49 | -3.05 ** |
| Cognitive Attitude | 78.4 | 13.3 | 84.9 | 8.6 | 49 | -2.10 * |
| Behavioural Attitude | 55.8 | 9.1 | 61.9 | 7.8 | 48 | -2.51 * |
| Perceived Control | 35.7 | 5.5 | 40.4 | 8.3 | 49 | -2.28 * |
| Operating Systems | 68.2 | 11.3 | 76.7 | 11.2 | 49 | -2.64 * |
| Communication | 46.9 | 7.6 | 55.1 | 6.4 | 49 | -4.24 *** |
| WWW Skills | 54.3 | 9.2 | 63.2 | 8.6 | 49 | -3.53 *** |
| Word Processing | 62.5 | 7.4 | 68.5 | 9.7 | 49 | -2.42 * |
| Spreadsheets | 23.8 | 5.1 | 27.4 | 4.0 | 48 | -2.85 ** |
| Database | 15.0 | 20.7 | 6.8 | 7.8 | 48 | -2.67 * |
| Graphics | 19.6 | 7.5 | 23.5 | 6.5 | 47 | -1.99 |
| Multimedia | 21.7 | 5.3 | 25.7 | 5.0 | 47 | -2.68 * |
| Create Web Page | 50.3 | 16.1 | 62.3 | 13.7 | 48 | -2.83 ** |
| Programming | 22.2 | 12.8 | 35.3 | 19.8 | 48 | -2.65 * |
| University Use | 95.1 | 20.1 | 103.0 | 18.8 | 48 | -1.43 |
| Field Use | 71.7 | 29.9 | 81.0 | 24.8 | 45 | -1.18 |

*     p < .05
**    p < .01
***   p < .001

**Culture Differences**
  The only pre-program difference that proved to be significant was cognitive attitudes. Students who has English as a second language (*M* = 84.4 *SD* = 11.1) had significantly higher cognitive attitudes than students who had English as a first language (*M* = 77.8 *SD* = 9.2; *p* <.05). The post program t-test showed no significant differences, with the exception of programming ability. Students who had English as a second language (*M* = 37.1 *SD* = 17.9) had significantly higher ability than students with English as their first language (*M* = 25.7 *SD* = 17.1; *p* <.05).

**Educational Implications**

  First, it appears that the laptop program helped reduce differences between male and females students with respect to computer ability, and to a lesser extent computer attitude. This is a significant finding suggesting that a one-year laptop program can help to level the "computer" playing field with respect to gender.

  Second, the laptop program actually accentuated differences between dial-up (low SES) and high speed (higher SES) users. Both computer attitude and ability improved more for students with high speed connections. The message here is that that "accessibility" had a strong impact on success in a laptop program.

  Finally, culture, as measured by English being the first language, did not have a significant impact on computer attitudes, ability, or use.

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