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ABSTRACT

The interactions between computer use and access by adolescents and their computer-related opinions and values are presented in the framework of a "manifold model" of computer interactions. This model emphasizes the complexity and multidimensional nature of the system of variables in which such interaction is embedded. For this study, the association between gender and various usage and attitude variables was predicted by the model and tested with data from a representative survey of urban grade 11 students involving over 3,000 students from major urban areas in all 10 Canadian provinces. Analyses of the data reveal consistent gender differences in access to and usage of computers in each of three usage categories--recreational, home non-recreational, and school--as well as in attitudinal variables associated with computer use in each of the usage categories. The theoretical importance of the study is found in the support the study gives to the multidimensional manifold model as a descriptor of the complex system surrounding adolescents' computer-related activities and opinions. The results indicate that it is inappropriate to make statements about what influences male and female adolescents to use or reject computers without considering the context of the usage. The text is supplemented by five tables and eight figures. (7 references) (Author/EW)

A Multidimensional Study of Adolescent Gender Differences in Computer Use and Impact

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Abstract

The interactions between computer use and access and computer-related opinions and values are presented in the framework of a "manifold model" of computer interaction which emphasizes the complexity and multidimensionality of the system of variables in which such interaction is embedded. In particular the association between gender and various usage and attitude variables was predicted by the model and tested with data from a representative survey of urban Canadian Grade 11 students involving over 3000 students from major urban areas in all ten Canadian provinces. The data reveal consistent gender differences in access to and usage of computers in each of three usage categories--recreational, home nonrecreational, and school--as well as in attitudinal variables associated with computer use in each of the usage categories. Some implications of these data as baseline parameters and of the manifold model as a theoretical framework for subsequent gender difference studies in adolescent-computer are discussed.

A Multidimensional Study of Adolescent Gender Differences in Computer Use and Impact

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Gender differences are of interest in many areas of education, particularly with respect to achievement, attitudinal, and access-type variables in mathematics, science, and now, technology. Recent studies have consistently documented gender differences in computer use and in attitudes toward computers (Hattie & Fitzgerald, 1987; Lockheed, Thorpe, Brooks-Gunn, Casserly, & McAloon, 1985); however, many studies have considered computer use and attitude as unidimensionable variables. The theoretical framework for the present study is one which describes computer access in terms of a "manifold model"--a dynamic multidimensional model whose state characteristics are sensitive to contextual variables.

In mathematics, the state of a dynamic system at any point in time is called a manifold. In analyzing the nature of access that adolescent youth have to computers, the concept of a manifold model can serve as a framework for a multidimensional study of computer use that includes the interaction of variables representing salient demographic, attitudinal, and experiential variables. In particular, the manifold model developed for this investigation consists of node clusters relating to general and

personal attitudes toward computers, use and user stereotypes, computer self-perception, social issues and values, and access variables. This model is shown in Figure 1. Its derivation and characteristics are described in detail elsewhere (Collis, Kieren, & Kass, 1988; Kass, Collis, & Kieren, 1988; Kass, Kieren, Collis, & Therrien, 1987).

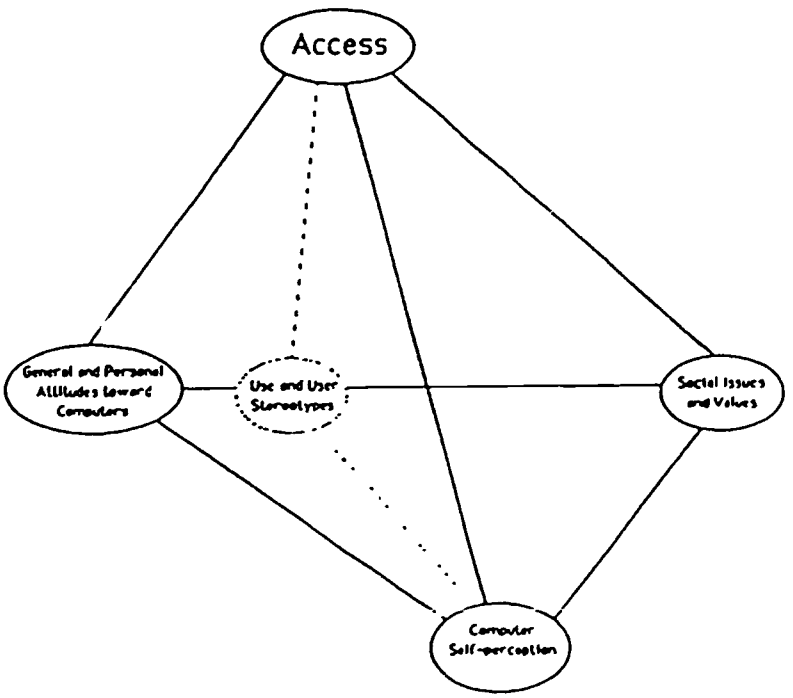

Figure 1. The general manifold model to predict adolescent access to computer use.

The model not only is multidimensional in itself, but also is sensitive to salient contextual variables. In particular, the contextual variables which are hypothesized to strongly influence the interaction of the model variables include gender and type of

computer use--recreational, nonrecreational home use, and school use. The manifold model formed the conceptual framework for the two overall focuses of this study:

- To interpret the results of a 1987 cross-Canada survey on gender differences in the access and use of computers by Canadian Grade 11 students in three different contexts--recreational use, nonrecreational home use, and school use; and with respect to the attitudes, values, and concerns that Canadian adolescents hold with respect to computers.

- To illustrate the multidimensional characteristics of these gender differences and to demonstrate how gender differences in access, attitudes, and value variables vary with the type and context of computer use.

In particular, this study used the manifold model to generate and test a series of specific models to predict differences in computer access relative to use type and gender. The manifold model also framed the investigation of gender differences in held stereotypes about computer use, in personal and general concerns about computer-related issues, and in affective variables associated with computer use.

Method

Subjects and Procedure

The instrument used for data collection in this study, The

Computers and Canadian Youth Questionnaire IV, was developed and validated in a series of three large-scale pilot studies (Kass & Kieren, 1985, 1986). The final questionnaire consisted of 120 items and was administered in 120 Grade 11 social studies classes in as many different secondary schools representing every major urban centre in each province of Canada. The percentage of students responding to the survey in each region of Canada was approximately the same as the percentage of adolescents in those regions according to the 1981 Canada Census. There were approximately equal numbers of males (n = 1380) and females (n = 1428). The data were collected between November, 1986 and April, 1987.

The results were analyzed using a variety of multivariate techniques, including MANOVA, factor analysis, and path analysis, as well as various nonparametric tests for categorical data. Models were developed to predict gender differences in access to computers for recreational use, nonrecreational home use, and school use. The fit of these models to the data was tested using path analysis. Factor analysis was used to generate interpretable composite variables representing students' held stereotypes about computer use and users, and students' concerns about social issues relating to computers. MANOVA was used to test the relationships between gender/usage groups (high- and low-frequency male and

female users) at home and at school and factor score sets relating to stereotypic thinking about computer use and users, and to values and concerns about computers. When significant multivariate effects were found, univariate analyses of planned comparisons were conducted.

Results

Among the many results of this study are the following:

1. Computers are truly a ubiquitous phenomenon for Canadian youth but strong gender differences in access and usage to computers exist. Fifty percent of the males and 35% of the females have access to a computer at home and nearly all report that there are ten or more computers in their schools. Gender differences in the likelihood of using an available home computer are significant, with 18% of the males with access to a home computer describing themselves persistent users (more than twice a week) compared to 4% of the females with access to a home computer. Conversely, among the students with access to a home computer, 16% of the females compared to only 11% of the males indicated they never use it or use it no more than once or twice a year.

Figure 2 summarizes home access to computers and student usage level given home access.

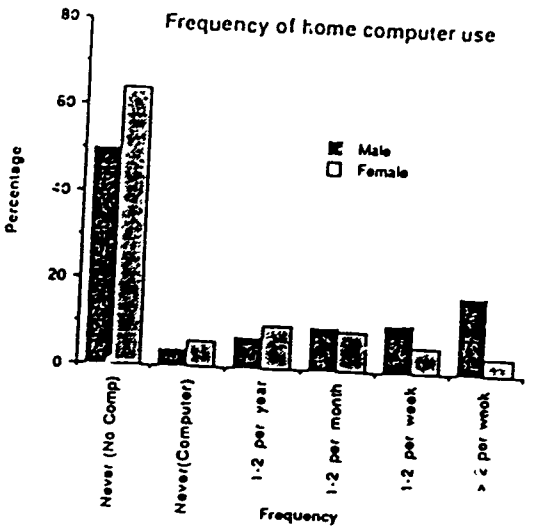

Figure 2. Frequency of home computer access and use, Grade 11 Canadian students.

For students having access to a home computer, there was nc relationship for either males or females between frequency of home usage and parents' educational level, students' grades, or students' postsecondary educational plans.

2. Gender differences in frequency of usage were strong and significant for all three categories of computer use--recreational, nonrecreactional home use (for students having access to a home computer), and school use--with males always more frequent users than females. For example, among students with home computers, 38% of the males compared to only 20% of the females were frequent word processing users, and for school users of computers, 25% of the males compared to 16% of the females

reported frequent usage of word processing at school. Figure 3 summarizes gender differences in various usage categories and situations.

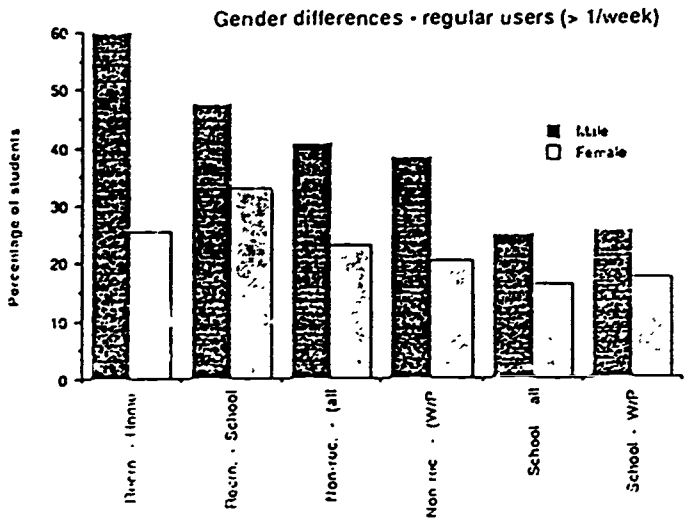

Figure 3. Gender differences in frequencies of regular use, by use categories, subcategories, and locations. (Percentages based on number of same-sex sample having access to a computer for the particular situation. "Regular use" defined as more than once a week.)

For males with access to a home computer, there was a positive relationship between frequency of home use and frequency of school use of computers. For females with access to a home computer, the relationship is more complicated. Table 1 summarizes these relationships.

Table 1

Relationship Between Home and School Use of Computers, by Gender

Gender/Home Usage Group	School Use				
	Never	Some weeks never, some occasionally	Some weeks a lot	Once or twice a week	More than twice a week
Frequent home users					
Females	54.9%[a]	17.3	3.0	9.8	15.0
Males	38.1%	17.4	7.1	7.1	30.2
Home nonusers[b]					
Females	78.2	5.1	1.3	2.6	12.8
Males	76.9	11.5	5.8	3.3	1.9

Note. [a]Percentage refers to gender/usage group.

[b]Based only on students who have a home computer but never use it.

For males, there was also a significant positive relationship between school grades and school computer use, $x^2(1013,4) = 11.06$, $p < .03$ when frequent school users were compared to nonusers. For females, there was no such significant relationship, $x^2(1121,4) = 8.72$, $p > .06$.

3. Males were significantly more self-confident and self-satisfied than were females about themselves as computer users in all types of usage situations.

In order to more specifically compare affective reactions to the three types of computer use--recreational, home/task-oriented, and work at school--students responded to four pairs of bipolar adjectives reflecting affective responses to each of the three categories. Students were asked to designate their positions on five-point continuums spanning the following adjective pairs: calm--nervous, in control--out of control, confident--unsure, using time well--wasting time, with reference to how they feel when using a computer for recreation, at a home task, or at school. Figures 4 and 5 summarize these responses for the pairs "calm-nervous" and "confident-unsure" for the students with access to computers. Table 2 summarizes all the responses.

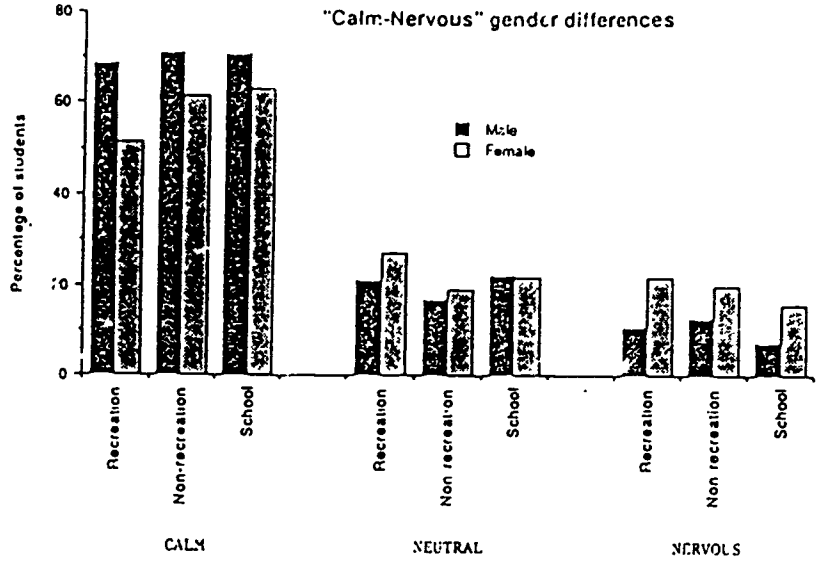

Figure 4. Gender differences in "calm-nervous" self-reports relative to three usage categories. (Percentages based on number of same-sex sample having access to a computer for the particular usage type.)

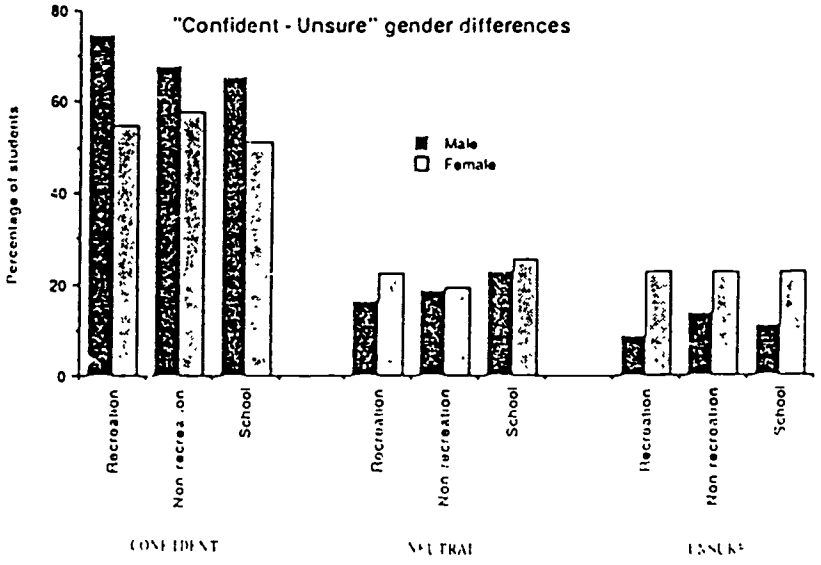

Figure 5. Gender differences in "confident-unsure" self-reports relative to three usage categories. (Percentages based on number of same-sex sample having access to a computer for the particular usage type.)

Table 2

Comparison of Feelings When Using Computers in Different Contexts, Expressed in Percentages of Students Using a Computer in Each of the Contexts

	Very	A little	Neither	A little	Very	Gender Comparison
	Calm			Nervous		
Recreation						
Male	43.4%	25.1	21.0	8.4	2.1	$x^2(1813,4)$ =
Female	28.4	22.9	27.0	16.6	5.1	71.87, $p < .001$
Home Task						
Male	46.7	24.0	16.8	10.1	2.3	$x^2(1338,4)$ =
Female	38.5	22.7	18.9	14.9	5.1	19.34, $p < .001$
School						
Male	46.0	24.6	22.2	5.8	1.3	$x^2(1163,4)$ =
Female	38.3	24.4	21.6	12.7	3.0	23.13, $p < .001$
	In Control			Out of Control		
Recreation						
Male	48.2%	28.8	13.0	6.5	3.5	$x^2(1814,4)$ =
Female	27.6	35.3	20.0	13.0	4.1	89.25, $p < .001$
Home Task						
Male	44.4	26.6	18.9	7.4	2.6	$x^2(1337,4)$ =
Female	31.2	33.6	20.1	10.3	4.7	27.72, $p < .001$
School						
Male	40.8	28.0	21.2	6.9	3.0	$x^2(1160,4)$ =
Female	24.4	34.1	24.2	11.9	5.4	39.04, $p < .001$

(Table continues)

	Very	A little	Neither	A little	Very	Gender Comparison
	Confident			Unsure		
Recreation						
Male	45.4	29.4	16.4	6.5	2.3	$x^2(1809,4)$ =
Female	21.4	33.4	22.5	18.2	4.5	144.81, $p < .001$
Home Task						
Male	39.8	27.9	18.7	10.2	3.3	$x^2(1331,4)$ =
Female	25.4	32.6	19.4	16.7	6.0	38.72, $p < .001$
School						
Male	35.7	30.7	22.7	7.7	3.2	$x^2(1157,4)$ =
Female	22.6	29.0	25.6	16.1	6.7	42.55, $p < .001$
	Using Time Well			Wasting Time		
Recreation						
Male	21.9	22.1	28.4	15.5	12.1	$x^2(1813,4)$ =
Female	17.6	23.4	31.3	15.5	12.3	5.69, $p < .23$
Home Task						
Male	46.5	27.8	15.5	6.3	3.9	$x^2(1341,4)$ =
Female	45.8	25.4	17.2	6.4	5.1	2.30, $p < .69$
School						
Male	36.8	29.6	20.6	6.8	6.2	$x^2(1162,4)$ =
Female	34.0	27.6	26.0	6.6	5.8	4.68, $p < .33$

Note. [a]Percentages refer to sample of gender group having access to a computer for designated activity.

These results show that, within gender, self-perceptions are generally consistent among usage categories, even though frequency of access in the different usage types does show more variation.

4. Three distinct, fully recursive models were hypothesized to predict gender differences in access to and usage of computers in all three usage categories. Each of these models was supported by the data. Generalized regression coefficients resulting from the various tests of the data using path analytic techniques showed the fully recursive models for predicting nonrecreational home use and school use to fit the data particularly well, with generalized R^2s ranging from .874 to .979. Reduced models representing gender differences in access prediction for nonrecreational home use and school use also fit their respective male or female data well, with generalized R^2s ranging from .820 to .939 (Kass, Kieren, Collis, & Therrien, 1987).

As an example of these models, Figure 6 shows the fully recursive model hypothesized to predict nonrecreational home use of computers, for students having access to a home computer.

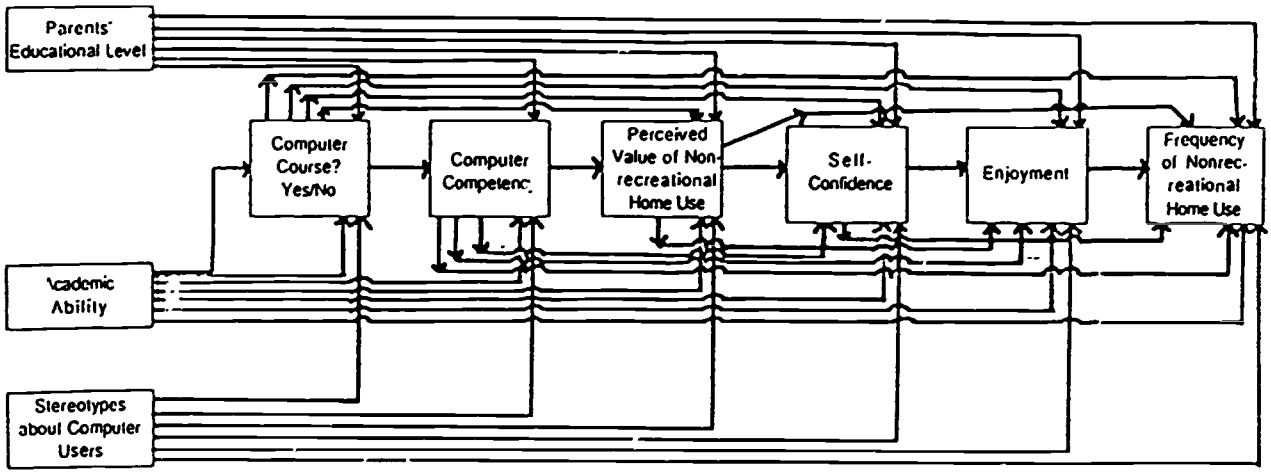

Figure 6. Fully recursive model to predict home nonrecreational use.

This model fits the male and female data well, with the generalized R^2s for both the male and female data equal to .874. Coefficients obtained from the analysis of this model show that for both males and females perception of computer competency is the strongest predictor of nonrecreational home usage of computers, followed by self-confidence and liking for male students and the same two variables in reversed order for female students.

Subsets of the model were hypothesized to predict gender differences in frequency of nonrecreational home use. For males, parents' educational level, perceived utility of the

computer application, and general liking or disliking of computer use were predicted to most strongly predict frequency of home nonrecreational usage. This reduced male model is shown in Figure 7 and also fit the male data well, explaining 82% of the variability in nonrecreational home usage (compared to the 87.4% predicted by the full recursive model).

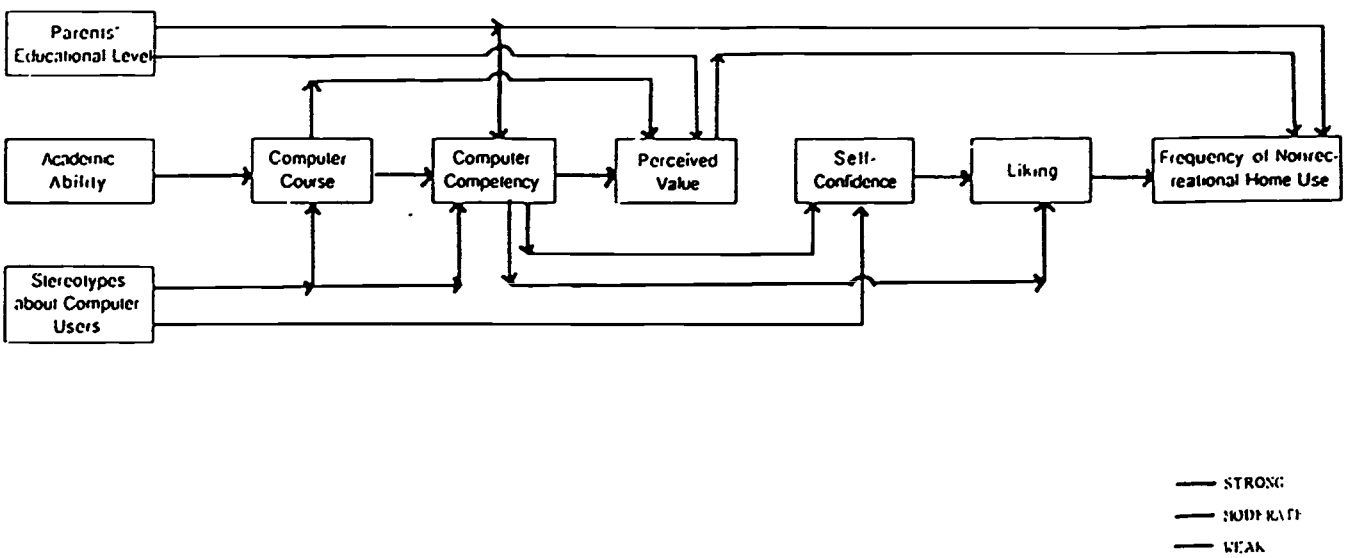

Figure 7. Hypothesized reduced model for prediction of nonrecreational use of home computers for males. Letters on paths represent predictions of relative influence of paths (W = weak, M = moderate, S = strong).

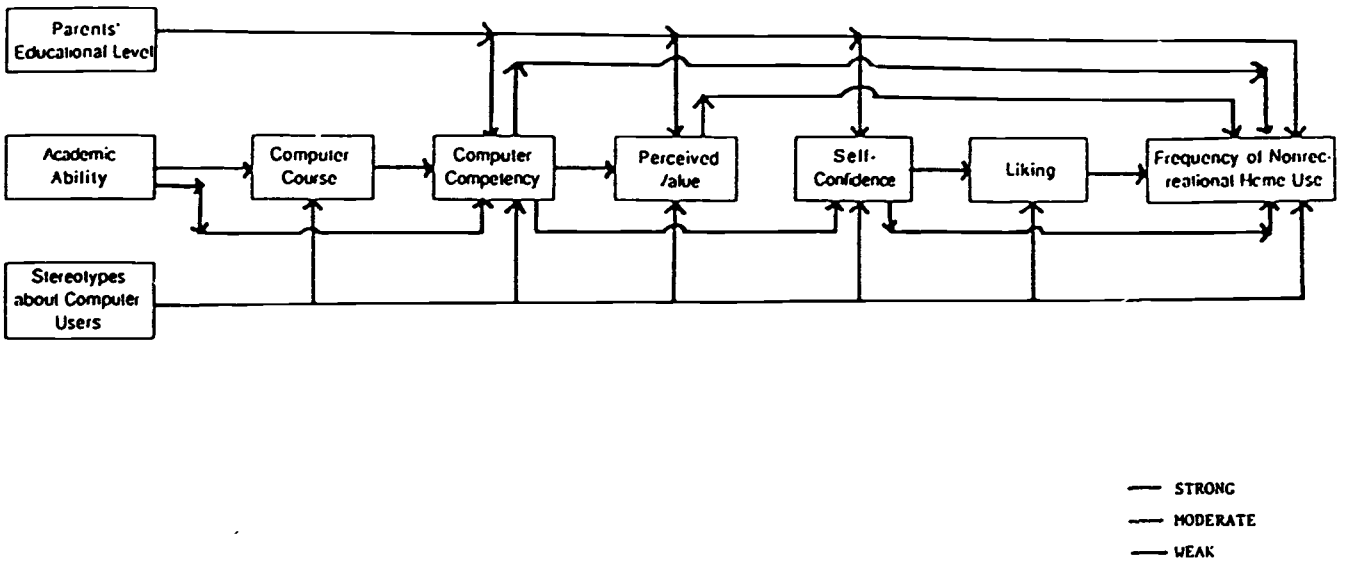

Figure 8. Hypothesized reduced model for prediction of nonrecreational use of home computers for females. Letters on paths represent predictions of relative influence of paths (W = weak, M = moderate, S = strong).

5. Significant multivariate gender effects were found for social and personal concerns relating to the potential of computers in Canadian society and in future life (with males more positive than females in each case).

Students were asked to respond to 24 opinion statements concerning computer issues using five-point Likert-type response categories. The statements are given in Table 3, along with means and standard deviations of the male and female responses to the items.

Table 3

Opinions About Value of Computers and Impact of Computers on Society

Item	Male		Female	
	M[a]	SD	M	SD
1. Computer use can bring out human creativity and self-expression.	2.58	1.11	2.60	1.02
2. Because of communication by computers French-English relations in Canada will improve.	2.01	1.02	2.06	.90
3. Personal choice and freedom in many areas of life are restricted by computers. (N)	1.69	1.06	1.77	.97
4. I will feel comfortable if I ever have to use a computer in my work or career.	2.43	1.21	2.17	1.14
5. Most jobs involving computers are dull and repetitious. (N)	1.76	1.91	1.71	1.08
6. Computers will not be very important to me in my future life. (N)	1.67	1.21	1.50	1.14

(Table continues)

Item	Male		Female	
	M	SD	M	SD
7. Computer art and music is of poorer quality than that produced by humans directly without computers. (N)	1.97	1.33	2.07	1.20
8. Unauthorized copying of computer software should be illegal.	1.90	1.28	2.27	.96
9. Computers will be important for Canadians in their future work and jobs.	2.68	1.12	2.74	1.02
10. Jobs that use computers have a higher status than jobs that don't use computers.	1.75	1.14	1.66	1.08
11. In general, if computers and computer output are used to help make decisions, human judgment will be improved.	1.66	1.14	1.50	1.02
12. Computers have raised the quality of life in my province.	1.92	1.02	1.86	.89

(Table continues)

Item	Male		Female	
	M	SD	M	SD
13. Computers will make the overall economic situation for women worse. (N)	1.45	1.04	1.30	.98
14. In things I do at present computers are not important to me. (N)	2.11	1.26	2.48	1.19
15. Computers have a negative effect on family life. (N)	1.42	1.09	1.34	1.03
16. A national network of computers will strengthen Canadian unit.	2.06	1.05	1.97	.85
17. In the future computers will give people in my province a better chance for a good life.	2.09	1.05	1.97	.91
18. Computers will not be very important to me in my future work or job. (N)	1.62	1.17	1.75	1.09
19. To make life better in my province in the future, more computers are needed.	1.92	1.10	1.76	.94

(Table continues)

Item	Male		Female	
	M	SD	M	SD
20. Computers will make work easier for people in my province.	2.30	1.05	2.27	.93
21. By the time I finish training for a job, computers will probably make a lot of my training out-of-date. (N)	1.97	1.13	1.99	1.06
22. In the future, people will be in control of computers, and not vice versa.	2.33	1.18	2.23	1.04
23. The introduction of computers will mean fewer chances for promotion in the work force. (N)	2.12	1.13	2.32	1.04
24. Computer technology will widen the gap between the wealthy and the poor in Canada. (N)	2.06	1.15	2.11	1.00

Note. [a]Responses ranged from 0 (strongly disagree) to 4 (strongly agree).

Items marked (N) were recoded before analysis so that a higher score corresponds to a more positive response (i.e., a higher level of disagreement with a negatively worded statement).

In order to better interpret patterns of responses within these 24 items, a principal components factor analysis was applied to the correlation matrix relating to these data. Factors with eigenvalues greater than one were extracted and subjected to varimax rotation. Variables with loadings at or near .700 were used for interpretation of the factors. Table 4 shows the factor loadings of variables used for interpretation of the rotated factors.

Table 4

Factor Loadings Used for Interpretation, Values, and Issues Relating to Computers

Variable	Factor					
	1	2	3	4	5	h^2
17. Good life in Province	.750					.582
19. More computers in Province	.704					.516
16. Help Canadian unity	.694					.496
12. Raise quality of life	.662					.485
18. Not important to my work		.716				.576
6. Not important to my life		.693				.606

(Table continues)

Variable	Factor 1	2	3	4	5	h^2
14. Not important to me now		.638				.489
15. Negative on family			.607			.438
13. Worse for women			.540			.381
23. Fewer job chances				.669		.534
24. Widen gap for poor				.616		.410
21. Jobs out of date				.594		.406
8. Computer crime					.779	.654
Eigenvalues:	4.53	2.72	1.35	1.27	1.04	
Percent of Variance: (Total)	18.9	11.4	5.6	5.3	4.3	
Interpretation:	Positive quality of life/work in Canada	Unimportant personally	Negative impact on homes	Negative impact on work/ wealth	Computer crime	

Factor scores were calculated on the first five factors for each student. These scores were used as dependent variables in a multivariate analysis of variance using gender as the independent variable. Table 5 gives the results of that analysis.

Table 5

MANOVA Results: Social/Personal Concerns Factor Scores and Gender

Multivariate F = 24.12(2347,5), p < .001 using Pillais' trace

Univariate Results:

Variable	Means and standard deviations	SS	F	p <
Factor Score 1:				
Improve quality of Canadian life		23.94	24.17	.000
Males	.103 (1.10)			
Females	-.098 (.881)			
Factor Score 2:				
Unimportant to me		30.86	31.25	.000
Males	-.117 (1.00)			
Females	.112 (.985)			
Factor Score 3:				
Negative impact on home		2.90	2.91	.088
Males	.036 (1.03)			
Females	-.034 (.974)			
Factor Score 4:				
Negative impact on work		3.72	3.72	.054
Males	-.041 (1.04)			
Females	.039 (.959)			
Factor Score 5:				
Computer crime is problem		53.55	54.77	.000
Male	-.155 (1.06)			
Female	.147 (.916)			

Overall, the males are significantly more positive than females about the potential benefits of computers for Canadian society. Females are significantly more likely than males to believe computers will have no personal value to themselves and to be concerned about computer crime.

Not only are there overall gender differences in the computer-issue factor scores, but there are also significant differences between nonusers and regular computer users within each gender. For example, females who are regular users of home computers are significantly different than females who are nonusers of home computers on this cluster of computer-issue factor scores ($F(5,188) = 10.12$, $p < .001$, using Pillais' trace) with regular home-using females significantly more positive, $p < .001$, on Factor 1 than nonusing females, and significantly more in disagreement, $p < .001$, with Factor 2 than nonusing females. The same multivariate pattern of results is obtained when regular home-using males are compared with home-nonusing males ($F(5,375) = 7.55$, $p < .001$) and the same significant univariate diferences are found on Factors 1 and 2. Clearly opinions about the values of computers to Canadian society and to one's personal life are positively related to frequency of computer access and, although overall gender differences are present, within-gender differences are also substantial.

Discussion

The educational importance of this study derives from its detailed description of perceptual and demographic influences on students' decisions to be computer users either at home or at school. The data demonstrate that different variables affect access and its consequences for males and females, and these variables alter in meaningfulness depending on home or school venue. The theoretical importance of the study is found in the support the study gives to the multidimensional manifold model as a descriptor of the complex system surrounding adolescents' computer-related activities and opinions. The results indicate that it is inappropriate to make general statements about what influences male and female adolescents to use or reject computers; instead, the context of usage must be considered. Also the results confirm the multivariate nature of influences impinging upon the decision to use or not use computers. The "manifold model" appears to offer explanatory flexibility as a framework for description and prediction of gender differences in adolescents' access to computers and computer-related interactions and is supported as a conceptual organizer for subsequent research in this area.

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Notes

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