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ABSTRACT

Most studies investigating preservice teachers' attitudes towards computers have drawn subjects from required computer classes or from elective courses. This study examines computer attitudes of preservice teachers in reading, mathematics, and science education methods courses which have not traditionally emphasized the role of computers in the classroom. An instrument measuring attitude was developed and administered to preservice teacher education students (N=360) enrolled in noncomputer education methods courses. Results of the study, reported in two stages, indicate that the factor structure of student attitudes toward computers in methods courses is similar to that assessed in computer education courses and represent: (1) general attitudes towards computers; (2) positive feelings for computers; (3) understanding the utility of computers; and (4) negative feelings for computers. Contrary to expectations, however, the attitudes of students in required methods courses were significantly more positive than the attitudes of their counterparts in computer education electives. (LL)

Preservice teachers' computer attitudes in non-computer classes.

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Abstract

Most studies investigating preservice teachers' attitudes to computers have drawn subjects from required computer classes or from elective courses into which students self-select. The purpose of the present study is to investigate the computer attitudes of preservice teacher education students in education methods courses which have not traditionally placed emphasis on the role of computers in the classroom. Results of the study indicate that the factor structure of student attitudes toward computers in methods courses is similar to that assessed in computer education courses with a 4-factor oblique solution that has been interpreted as representing student's 1) general attitudes toward computers, 2) positive feelings for computers, 3) understanding of the utility of computers, and 4) negative feelings for computers. Contrary to the investigators' expectations however, the attitudes of students in required methods courses were significantly <u>more</u> positive than the attitudes of their counterparts in computer education electives.

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Computers are playing important roles in education and training at many levels. This is especially true of higher education where students frequently are required to take computer-oriented courses or demonstrate proficiency in basic computer literacy in order to achieve degree objectives. Students do not always approach computer use with enthusiasm however and numerous recent studies have explored student attitudes toward computers and how they relate to learning. Most studies investigating preservice teachers' attitudes to computers have, however, drawn subjects from required computer classes or from elective courses into which students self-select. The purpose of the present study is to investigate the computer attitudes of preservice teacher education students in reading, mathematics, and science education methods courses which have not traditionally placed emphasis on the role of computers in the classroom. The present investigation will focus on two major research questions:

1) What factors appear to be required in order to account for the computer attitudes of preservice teacher education students?

2) Are there differences in the computer attitudes of different populations of preservice teacher education students?

Our first question concerns the theoretical structure of preservice teachers' computer attitudes. Unfortunately, most studies exploring the dimensionality of computer attitudes have focussed on specific instruments so making generalizations to a population is hazardous at best. In one recent exception to this trend Woodrow (1991) administered four different attitude scales to preservice teachers and factor analyzed responses across all four scales. Her results suggest as few as three or four theoretical factors may

be adequate to account for preservice teachers' computer attitudes. An important limitation of the Woodrow study, however, was its use of a relatively small sample of subjects (n=98) drawn from an elective computer education course, a limitation which leaves some important questions unanswered.

It may be, for example, that students selected from a computer education elective course view computers differently than students in other kinds of courses (e.g. non-elective or non-computer courses). Given the tendency for computer education courses to be add-ons to the core methods curriculum it could reasonably be argued, if differences in factor structure or attitude measures are found, that the truer picture of preservice teachers' attitudes and their underlying factor structure should emerge from their <u>methods courses</u>, which generally play a much larger role in their professional training and which probably more closely correspond to the situational context in which those students will ultimately work (i.e. Most teachers will not teach in a computer lab.) Woodrow, indeed, recognizes the limitations of her study and recommends that a useful follow-up would be to administer the same set of attitude scales to a wider population of subjects that includes students not enrolled in computer elective courses. The purpose of the present study is to provide such a follow-up study.

Development of the attitude measure was similar to the procedures used in the Woodrow (1991) study. Items from four instruments including the Computer Use Questionnaire (Griswold, 1983), the Computer Attitude Scale (Loyd & Loyd, 1985; Gressard & Loyd, 1986), eleven attitude and anxiety items from the Computer Survey (Stevens, 1980, 1982), and the Attitudes Toward Computers scale (Reece & Gable, 1982) were assembled in random order into a single

measure consisting of 71 computer attitude items and 14 items requesting demographic and previous computer experience information. Due to an error in printing one item (#8) from the Confidence subscale of the Computer Attitude Survey was omitted from approximately a fourth of the survey forms used in the study.

The composite attitude instrument was administered to approximately 360 preservice teacher education students from two public universities in Texas and Indiana in the fall of 1992 (n=200) and the spring of 1993 (n=160). Students participating in the survey were enrolled in non-computer education methods courses that have not traditionally emphasized the role of technology in education.

Data Analysis

All data analysis was carried out in SAS (Version 6) under the VAX/VMS operating system. Data were analyzed in two stages. The first stage of data analysis was carried out after data were collected in the fall of 1992. This stage of analysis involved a series of factor analyses to determine the underlying factor structure of the subjects' attitudes. Although Woodrow's analysis provided a useful reference point, the intent was not to simply replicate Woodrow's analysis since there could be no guarantee that the underlying factor structures of the two populations were identical. Data analysis in this stage began with a principal components analysis followed by both orthogonal and oblique rotations that specified numbers of factors as suggested by results of prior analysis. Following the factor analysis of the items in the composite scale, scores for each student on each of the four instruments were also factor analyzed.

Following the second round of data collection in the spring of 1993,

another set of factor analyses were carried out on the entire data set and means and standard deviations for each of the computer attitude scales used in the study were computed so that comparisons could be made to scores reported by Woodrow. The goal of this second stage of anrlysis was to confirm the earlier factors that had emerged using round one data and to test a prediction by Woodrow (1991, p. 177) that the attitudes of subjects not enrolled in elective computer courses would be more negative than those in her study (who were enrolled in an elective computer course).

Results and discussion: Stage 1

Since one of the Computer Confidence (CC) items was omitted on about a third of the surveys used in round one of the data collection, data analysis in stage one was limited to 70 items. A principal components analysis of those 70 items resulted in 15 components accounting for approximately 71% of the survey variance with the first seven factors accounting for approximately 56%. These results were similar to those obtained in the Woodrow study with few or no item loadings that exceeded .40 on factors 8-15.

Following the principal components analysis an orthogonal (Varimax) rotation that specified 7 factors was applied. This analysis accounted for approximately 39% of the total variance. Of this variance Factors 1, 2, and 3 accounted for 10.7%, 10.3%, and 7.6%, respectively for a total of about 29%. Factors 4-7 each contributed less than 4% for a total of about 10%.

Following the orthogonal rotation specifying 7 factors, an oblique (Promax) rotation specifying 7 factors was carried out. Results of this analysis also suggested an underlying structure composed of three factors. Factors 1, 2, and 3 correlated fairly highly with one another although Factor 3 was found to correlate negatively with 1 and 2. None of the remaining

factors correlated with each other or with Factors 1, 2, or 3 above .36 or below -.36.

Our analysis of Stage 1 data (n=200) appeared to suggest that three related factors could account for preservice teachers' attitudes toward computers. Inspection of item loadings on these three factors suggested labels of "Positive feelings for computers", "Utility of computers", and "Negative feelings for computers." These three factors appeared consistent with results reported by Woodrow (1991) who identified factors she labelled "Computer liking", Social and educational impact of computers", and "Computer anxiety."

At this point data analysis turned to the scores obtained by students on each of the instruments included in the composite measure. Although three factors seemed to be emerging from the analysis of the items, it was not clear whether those factors would be most appropriately treated as orthogonal in nature. We reasoned that a factor analysis of the scale and subscale scores would help in making the decision about the kind of rotation (orthogonal or oblique) to employ in the final factor solution. Results of a principal component analysis of the instrument scores revealed a single factor with an eigenvalue exceeding 1.0 that accounted for approximately 80% of the variance with all seven scale and sub-scale scores loading at or above .78. As a result of the findings up to this point, we concluded that an orthogonal three-factor solution was unlikely and decided to apply an oblique rotation.

Results of the oblique three-factor rotation once again supported an underlying solution of three related factors. Only four of the 70 items failed to load at or above .40 (or below -.40) on one of these three factors. Factor 1 dominated the solution accounting for about 22% of the variance.

Factors 2 and 3 accounted for 4.9% and 3.5% respectively. Overall, the three factors accounted for about 31% of the variance. Inspection of the item loadings suggested that Factor 1 tapped positive feelings since most items loading on this factor were either positively worded (e.g. "I enjoy computer work.") or were negatively loaded items suggesting the absence of positive affect (e.g. "I don't enjoy talking with others about computers.") Factor 2 appeared to be dominated by cognitively oriented attitudes concerning the utility of computers (e.g. "Computers can be a useful instructional aid."), with 14 of the 20 cognitively oriented Computer Use Questionnaire items loading on this factor. Finally, Factor 3 appeared to represent a negative feelings factor since 16 of the 17 items loading on this factor were negatively worded, many of them suggesting strongly negative feelings (e.g. "I feel aggressive and hostile toward computers.")

Results and discussion; Stage 2

The second stage of data analysis adhered to the same sequence of procedures as have been described for Stage 1 but employed the complete data set (n=360) rather than the subset (n=200) employed at Stage 1. The principal components analysis at Stage 2 resulted in 16 components accounting for approximately 68% of the survey variance with the first seven factors accounting for approximately 53%. These results were quite similar to those obtained in the Stage 1 analysis. Only two item loadings exceeded .40 on factors 8-15.

Following the principal components analysis an orthogonal (Varimax) rotation that specified 7 factors was applied. This analysis accounted for approximately 53% of the total variance. Of this total, Factors 1, 2, 3, and 4 accounted for 9.3%, 6.7%, 6.5%, and 6.2% respectively for a total of about

29%. Factors 5-7 contributed 4.1%, 2.5%, and 1.7% respectively. Although our analysis at Stage 1 had suggested a 3-factor solution our new analysis appeared to suggest a slightly different solution. Specifically, a shift in the drop in variance across the factors led us to consider a 4-factor solution.

Following the orthogonal 7-factor rotation, an oblique (Promax) rotation specifying 7 factors was carried out. Once again, unlike the analysis at Stage 1, results of the Stage 2 analysis suggested an underlying structure composed of <u>four</u> factors. All four of the factors that emerged at Stage 2 correlated fairly highly with one another although (as before) one factor was found to correlate negatively with the other three. None of the remaining factors correlated with each other or with Factors 1-4 above .38 or below -.38 (see Table 1).

At this point we again turned to the scores obtained by students on each of the instruments included in the composite measure. Our intent was to determine whether the Stage 1 analysis which had suggested an oblique final solution was still appropriate. As before, we factor analyzed the seven scale and subscale scores for each student. Once again, only a single factor emerged from the principal components analysis with an eigenvalue greater than 1. The lone factor accounted for 80% of the variance with all seven measure loading heavily (see Table 2). We concluded that a multiple-factor orthogonal solution was unlikely and decided to apply an oblique rotation at Stage 2 as we had at Stage 1.

Given our uncertainty about the appropriate number of factors to employ in our final solution we carried out both 3- and 4-factor oblique analyses. Results of the 3-factor solution were very similar to the results obtained in

Stage 1. Item loadings suggested that one factor tapped positive feelings. A second factor was dominated by cognitively oriented attitudes concerning the utility of computers. A third factor appeared to represent a negative feelings factor. Overall, the 3-factor solution accounted for about 42% of the total variance.

The 4-factor solution accounted for about 45% of the total variance and appeared to add a general attitudinal factor (Factor 1) that tapped both positively and negatively worded items. Moreover, the three remaining factors appeared very similar to those noted above (i.e. positive feelings, utility, and negative feelings). Cognitively oriented items that emphasized the utility of computers tended to load heavily on Factor 2. Items expressing positive feelings for computers loaded heavily on Factor 3. Items expressing negative feelings for computers loaded heavily on Factor 4, which correlated negatively with the other three factors. As indicated in Table 3, the general factor (Factor 1) correlated most highly with the positive feelings factor (Factor 3), next most highly (although negatively) with the negative feelings factor (Factor 4), and least with the utility factor (Factor 2).

Stage 2 of our data analysis also explored possible differences between scores for our methods students and those reported for students in computer education elective courses (Woodrow, 1991). Since the intent of this analysis was to compare our results with those reported by Woodrow, the data in Table 4 include Woodrow's results as well as results of population t-tests comparing the attitude means of students in our study with those reported by Woodrow (treated as the population). All student responses were recoded so that higher means corresponded with more positive attitudes. In addition, all means and standard deviations were rescaled to a single range of 10-50 so that

comparisons could be more easily made. Rescaling of the means also addressed the issue of the missing item from the Computer Confidence (CC) subscale of the Computer Attitude Survey (CAS). Although the omission of one item represents an obvious limitation, the rescaling of means provides a meaningful basis for comparison, that limitation notwithstanding.

Surprisingly, means of students in our methods courses appear to be significantly higher than those reported by Woodrow for students in an elective computer course, contrary to Woodrow's prediction and our expectation. According to the population t-tests conducted using our data and the means and standard deviations provided by Woodrow (1991, p. 172), although the Canadian students had more positive scores on the Computer Liking subscale of the Computer Attitude Scale, the methods students had significantly more positive scores on every other measure.

Summary and Conclusions

Results of the present research support the hypothesis that three or four related factors account for preservice teachers' attitudes toward computers. Inspection of item loadings on the factors identified suggests labels of "Positive feelings for computers", "Utility of computers", "Negative feelings for computers", and a possible general attitudinal factor. These factors appear consistent with results that have been reported recently in a similar study (Woodrow, 1991) that identified factors labelled "Computer liking", Social and educational impact of computers", and "Computer anxiety."

Contrary to our expectation, students in our non-computer methods courses generally reported more positive computer attitudes that those in an elective computer course. Since the underlying factor structure in both populations appears to be the same these differences probably cannot be

attributed to factorial instability in the composite measure. Having ruled out factor instability as a source of the observed differences, the source (or sources) of the observed population differences remain unspecified. We conclude that there is a continuing need to explore computer attitude variation among teacher education students and suggest that our findings of a common factor structure support meaningful comparisons across populations.

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Table 1.

Inter-factor correlations for the 7-factor oblique solution across all items.

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	FACTOR7
FACTOR1	100 *	-46 *	49 *	38 *	19	21	-7
FACTOR2	-46 *	100 *	-41 *	-42 *	-21	-14	19
FACTOR3	49 *	-41 *	100 *	45 *	29	29	-10
FACTOR4	38 *	-42 *	45 *	100 *	29	35	-14
FACTOR5	19	-21	29	29	100 *	1	8
FACTOR6	21	-14	29	35	1	100 *	-18
FACTOR7	-7	19	-10	-14	8	-18	100 *

NOTE: Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 37 or less than -37 been flagged.

Table 2.

Factor loadings for each scale and sub-scale score on the single factor that emerged from the principal components analysis of the scale and sub-scale scores at Stage 1 and Stage 2.

SCALE or SUBSCALE	Stage 1 factor Loading	Stage 2 factor Loading
Computer Attitude Scale (Total scale)	97	97
Computer Anxiety Subscale	89	89
Computer Confidence Subscale	92	92
Computer Liking Subscale	90	89
Attitudes Toward Computers Scale	90	91
Computer Survey Scale	87	87
Computer Use Questionnaire	78	79

NOTE: Factor loadings have been multiplied by 100 and rounded to the nearest integer.

Table 3.

Inter-factor correlations for the 4-factor oblique solution across all items.

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
FACTOR1	100 *	35	53	-45
FACTOR2	35	100 *	53	-34
FACTOR3	53	53	100 *	-45
FACTOR4	-45	-34	-45	100 *

NOTE: Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.633568 have been flagged by an '*'.

Table 4.

Rescaled mean scores (range=10-50), standard deviations, and results of t-tests to assess significant differences between Woodrow (1991) and data collected in the present study.

INSTRUMENT	Woodrow data (1991) Mean	SD	Stage 2 data Mean	SD	t-pop (2-tailed) t	p	df
Computer Survey	36.6	4.09	37.17	4.14	2.59161	0.0100	347
Computer Use Quest.	34.8	3.7	37.79	4.16	14.7843	0.0000	335
Attitudes Toward C.	37.9	6.4	38.63	6.02	2.11171	0.0354	342
Computer Attitude[1]	35.63	5.9	36.83	6.02	3.66232	0.0003	325
Anxiety scale	35.7	6.0	38.05	6.72	7.33187	0.0000	349
Confidence scale[2]	35.0	6.6	37.11	6.16	5.96921	0.0000	347
Liking scale	36.1	6.3	35.14	6.78	-2.8309	0.0049	342

1. Mean and SD based on 29 (rather than 30) items due to the omission of Computer Confidence (CC) item #8 from survey.
2. Mean and SD based on 9 (rather than 10) items due to omission of CC item #8.