Pre-service Teachers' Teaching with Computers

Some Factors Influencing Pre-service Teachers' Self-efficacy

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Abstract Although computers are widely available in schools and their use is supported by public policy, their uptake by teachers is not universal. There is evidence that, even where teachers have access and essential skills, they lack confidence in their ability to integrate computers in their teaching. Multimedia cases have been developed for the purpose of increasing teachers' self-efficacy beliefs (confidence) for teaching with computers (SETWC). It was important to understand what factors might influence SETWC. This paper reports the results of a study which examined the effect of several variables on SETWC. The most significant influence on SETWC was levels of comfort with using computers

1. INTRODUCTION

In Queensland, Australia, as in other parts of the industrialised world, computers have become widely available in schools. Whether the equipment is located in laboratories or classrooms, the vast majority of teachers have some access to computers for use in support of teaching and learning. Policy makers, school administrators and the community support and encourage the use of computers at all levels of schooling. In Queensland, the government has provided financial support for Schooling 2001, a policy framework which includes as goals the use of computers "in every subject area at every level of education" and the connection of every classroom to the Internet by 2001 (Education Queensland 1998).

Nevertheless, not all teachers have adopted the use of computers as an integral part of their professional practice. Although there are instances of exemplary practice, the overall situation has been described as "patchy" (Galligan, Buchanan and Muller 1999). Recent discussions among pre-service teachers returning from teaching practice have included comments about the limited use being made of computers in some classrooms. However, students observed that even teachers who did not use computers in their teaching expressed belief in the importance of computers for education.

There is unlikely to be a single, simple explanation for the apparent reluctance of some teachers to embrace information and communication technologies (ICT). Teachers appear to share the broad community enthusiasm for ICT in education and see it as a 'good thing'. However, they report a lack of confidence in their ability to use ICT effectively for teaching and often attribute this to inadequate preparation (Albion 1996, Handler 1993).

In a previous paper (Albion 1999) research about the preparation of teachers for working with ICT was reviewed and an argument was developed in support of teacher beliefs as an important issue to be addressed in seeking to extend the use of ICT in teaching. Self-efficacy for teaching with computers (SETWC) was identified as an area of belief which was related to teacher behaviour in the longer term, was measurable using existing scales and was capable of being influenced by teacher educators in the context of pre-service and in-service courses. Multimedia cases designed using a problem-based learning framework have been proposed for this purpose (Albion and Gibson 1998).

As part of the evaluation of the multimedia materials (Gibson and Albion 1999), it was proposed to examine the effects of the materials on pre-service teachers' SETWC as measured before and after working with the materials. Teachers' beliefs and behaviours in respect of computers are unlikely to stand in isolation from their other beliefs (Albion 1999). Hence it was decided to obtain measures of some other variables which might be associated with SETWC in order to control for the effects of those other variables in the study. This paper presents the results obtained for the additional variables and their association with SETWC and discusses the implications of the relationships for future work on increasing pre-service teachers' SETWC.

2. FACTORS EXAMINED

The Microcomputer Utilisation in Teaching Efficacy Beliefs Instrument (MUTEBI) was initially developed and used in the context of science

teaching (Enochs, Riggs and Ellis 1993) but it is not specific to that context. It comprises two sub-scales corresponding to the two components of the self-efficacy construct identified by Bandura (1977), namely efficacy expectations, which was labelled by Enoch et al. as self-efficacy (SE), and outcome expectations, labelled as outcome expectancy (OE).

It seems reasonable to assume that positive attitudes towards computers and strong self-efficacy for computer use would be prior conditions for positive self-efficacy for teaching with computers. Scales for the measurement of attitudes towards computers and self-efficacy for computer use have been developed and used with teacher education students (Kinzie, Delcourt and Powers 1994). The Attitudes towards Computer Technologies (ACT) instrument comprises two scales, one of 8 items measuring Comfort/Anxiety related to computers and the other of 11 items measuring Usefulness of computers. The Self-efficacy for Computer Technologies (SCT) instrument was developed and later modified to assess self-efficacy with different types of computer technologies (Kinzie et al. 1994). Form B of the instrument, as described by Kinzie et al., comprised 46 items measuring perceived self-efficacy for word processing (10 items), electronic mail (9), searching CD-ROM databases (6), use of spreadsheets (7), creation and management of databases (7) and use of statistical packages (7). A more recent study conducted with pre-service teachers (Albion, in press) reported on the development of a slightly modified version of the SCT. The modification consisted of replacing the sub-scale relating to statistical software with sub-scales related to operating systems and the Internet. The scales used in this study were the original ACT and the modified version of the SCT.

Various studies have suggested a relationship between teachers' use of ICTs and approaches to classroom management. Pupil control ideology (Graham, Benson and Henry 1985) is a uni-dimensional construct which locates attitudes towards pupil control along a continuum between custodial and student-centred orientations. The 10 items instrument described by Graham et al. was used in this study.

There have been many studies of the construct variously referred to as teacher efficacy or self-efficacy for teaching. In a study of the construct dimensions of teacher efficacy, Guskey and Passaro (1994) modified the items used in previously published versions of the instrument to remove what they saw as anomalies in the wording of the items. Their instrument included 21 items which resolved into two dimensions. The first, the *internal* sub-scale, appears to represent perceptions of personal influence in teaching and learning. The second, the *external* sub-scale, appears to represent the influence of elements beyond the direct control of the teacher. Because it seemed likely that SETWC might be related to more general self-efficacy for

teaching the Guskey and Passaro (1994) instrument was included in the battery for this study.

A study involving 170 practising teachers and 167 pre-service teachers in the USA found that innovativeness was a significant predictor of computer use for the practising teachers (Marcinkiewicz 1994). Hence innovativeness was of interest in this study and was measured using the 10 items version of the scale (Hurt, Joseph and Cook 1977).

All instruments used in this study were derived from previously published studies. The body of the questionnaire comprised 134 items representing 15 scales and sub-scales as described above. For consistency and ease of use, all scales were presented as a four point Likert items ranging from strongly disagree to strongly agree. Scale scores were computed as the mean of item scores on each scale in order to facilitate comparisons among the scales.

3. RESULTS

The questionnaire was administered during a mass lecture in the first week of semester to students enrolled in a final year subject required for all students in the Bachelor of Education programs. A total of 178 responses was collected.

Most (62%) of the respondents were pre-service Primary teachers enrolled in the four year undergraduate (55%) or two year graduate entry (7%) degrees. A further 26% were enrolled in Early Childhood undergraduate (25%) or graduate entry (1%) degrees and the remainder (12%) were pre-service Secondary teachers.

The majority of the respondents were female (82%). Most (75%) reported their age as less than 25 years, with 35% aged less than 21 years and 40% between 21 and 25 years. A further 10% were aged from 26 to 30 years with the remainder (15%) aged more than 30 years. The high proportion aged less than 25 years suggests that most were traditional students who had entered their university course directly from secondary school.

For most of the respondents (74%), the only computer-related subject studied at university was a compulsory unit usually taken in first year, although some (14%) reported that they had studied five or more computer related subjects. Almost all respondents (92%) reported having access to a computer at their residence during semester; 72% reported Windows and 20% Macintosh systems. In a previous study conducted with the same cohort of students during their first year at university (Albion, in press), analysis of posttest data (N = 110) found that 78% had access to a computer at their

residence during semester; 54% Windows and 16% Macintosh. That study reported that there had been an increase in access (from 58% to 78%) over the first year of university study. Data from the current study suggest that the proportion of students with home access has continued to increase.

Computer use in a typical week was reported as: less than one hour (12%), 1 to 5 hours (46%), 6 to 10 hours (26%) and more than 10 hours (16%). The comparable values from the previous study (Albion, in press) were: less than one hour (21%), 1 to 5 hours (43%), 6 to 10 hours (22%) and more than 10 hours (14%). That study reported a significant increase in hours of computer use during the first semester of study and that increased level appears to have remained stable over three years.

Table 1 lists the Cronbach's alpha reliability coefficients, means and standard deviations calculated for the Likert scale data. The maximum possible score for each scale was 4.0. As described previously (Albion, in press), scores on the sub-scales of the SCT were combined to form a composite measure of self-efficacy for computer use which was used in subsequent analysis.

Table 1. Alpha reliability, mean and SD of scores (N = 178)

Instrument	Sub-scale	Reliability (alpha)	Mean	SD
MUTEBI	Outcome expectancy (OE)	.74	2.66	.40
	Self-efficacy (SE)	.88	3.00	.45
ACT	Comfort/Anxiety	.89	2.98	.65
	Usefulness	.76	3.36	.42
SCT	E-mail	.98	3.31	.83
	Internet	.94	3.02	.88
	Word processing	.94	3.67	.49
	Operating system	.91	3.26	.72
	Spreadsheet	.96	3.22	.85
	Database	.98	2.98	.94
	CD-ROM	.96	2.65	.93
	SCT composite	.98	3.20	.63
PCI		.66	2.09	.37
Teacher Efficacy	External	.74	2.21	.37
	Internal	.75	2.87	.32
Innovativeness		.85	3.11	.43

Because the study sought to investigate any relationships among the variables, especially any possible effect on the SE scale of the MUTEBI, Pearson product moment correlation coefficients were computed for pairs of measures. The results are shown in Table 2.

Table 2. Correlation coefficients for pairs of variables (N = 178)

	Comf.	Usef.	SCT	PCI	OE	SE	Ext.	Int.
Usef.	.50 ***							
SCT	.70 ***	.46 ***						
PCI	-.15 *	-.35 ***	-.07					
OE	.12	-.02	.18 *	.21 **				
SE	.64 ***	.60 ***	.56 ***	-.23 **	.14			
Ext.	-.07	-.33 ***	-.03	.39 ***	.09	-.39 ***		
Int.	.13	.09	.22 **	.00	.43 ***	.26 **	-.13	
Innov.	.22 **	.37 ***	.20 **	-.38 ***	.07	.45 ***	-.52 ***	.16 *

* $p < .05$ ** $p < .01$ *** $p < .001$ (2-tailed)

It is evident from Table 2 that there are several significant correlations. For the purposes of this study, the correlations involving the SE sub-scale of the MUTEBI are of primary interest. SE was significantly correlated with each of the other variables except OE. Moreover, many of those variables were significantly correlated with each other. The potential influences of other variables on SE were important in study of the effects of the multimedia materials since, if SE were to be strongly influenced by relatively stable factors, there might be less potential for the materials to effect changes in SE.

In order to clarify the relative predictive influence of other variables on SE, backward multiple regression was applied. SE was entered as the dependent variable. SCT, both sub-scales of the ACT, PCI, Innovativeness, the two sub-scales of teacher efficacy, age, gender, number of university computer subjects studied and weekly hours of computer use were entered as independent variables and backward regression analysis was applied. Six variables were retained by the analysis in a model which accounted for 61% of the variance ($R^2 = .61$, $F [6, 161] = 42.24$, $p < .00005$).

Table 3 shows the results for the final regression model. Of the six variables remaining in the model, scores on the ACT and SCT sub-scales have been previously found to be positively associated with computer use (Albion, in press). Any gains in those scores as a result of working with the multimedia materials might be expected to contribute to an increase in SE. Although there is no evidence that Teacher Efficacy or Innovativeness would be affected by working with the materials, it is conceivable that exposure to successful exemplars of innovative teaching practice might

impact positively on users' attitudes. Thus, there is no reason to consider that any of these predictors of SE should impact negatively on the effects of the multimedia intervention.

Table 3. Final regression model for SE sub-scale of MUTEBI

		B	SE B	Beta	T	Sig T
ACT	Comf.	.239	.051	.341	4.72	.0000
	Usef.	.238	.069	.219	3.45	.0007
SCT		.112	.051	.156	2.19	.0303
Teacher efficacy	Ext.	-.265	.074	-.211	-3.60	.0004
	Int.	.152	.071	.108	2.13	.0347
Innov.		.148	.062	.142	2.39	.0178
(Constant)		.810	.395		2.05	.0420

4. DISCUSSION

Of the six variables in the final regression model, the most significant effect was for the comfort/anxiety sub-scale of the ACT. It would be surprising if being comfortable about using computers were not associated with, or probably a precondition for, being more confident about using them for teaching. There is a clear implication here for teacher education programs that seek to prepare teachers for teaching with ICT. Previous research (Albion, in press) found that experience with computers was the principal influence on the level of comfort with computers among pre-service teachers at the commencement of their studies. Teacher education courses should be structured so as to encourage pre-service teachers to make frequent use of computers for meaningful tasks.

The second strongest predictor of SE in the regression model was the external sub-scale of the teacher efficacy scale. The internal sub-scale of the teacher efficacy scale was also in the final regression model, although it was the weakest predictor of SE remaining in the final model. Considering both the external and internal factors of teacher efficacy, the implication is that the more confident pre-service teachers are about their capacity to teach, the more likely they are to be confident about teaching with computers. One implication of this finding is that teacher education programs that include activities designed to increase pre-service teachers' self-efficacy beliefs for teaching should also result in increased self-efficacy for teaching with computers.

The usefulness sub-scale of the ACT was the third strongest predictor in the regression model. In principle, it might be possible to believe in the educational usefulness of computers and still lack confidence for using computers in the classroom. However, in practice, such belief is likely to

either result from experience with computers or to encourage such experience. In either case, an increase in confidence for teaching with computers might be a logical consequence. Teacher education programs that encourage frequent and varied use of ICT to accomplish tasks that pre-service teachers perceive as relevant and important are likely to encourage beliefs in the usefulness of ICT and may indirectly increase pre-service teachers' self-efficacy for teaching with ICT.

Self-competence for computer use and Innovativeness have been found to predict computer use for teaching (Marcinkiewicz 1994). The final regression model obtained in this study included Innovativeness and self-efficacy for computer technologies (SCT) as, respectively, the fifth and sixth strongest predictors of SE. Innovativeness is associated with a positive attitude towards change and it is understandable that higher scores on the Innovativeness scale might be associated with willingness to adopt new approaches to teaching involving ICT as measured by SE. The association of higher scores on SCT with SE is explicable in terms of teachers with higher levels of self-efficacy for using computers in other settings being more prepared to use them in class. In a period of rapid social change such as the present time, openness to change is an important quality, which should be encouraged in teacher preparation programs. Where they succeed, there may be positive implications for self-efficacy for teaching with ICT. In previous research (Albion, *in press*), the only consistent predictor found for higher scores on SCT was greater computer use. Teacher education courses seeking to prepare teachers to teach with ICTs should adopt practices which encourage consistent use of ICT for relevant tasks.

Higher scores on the PCI scale represent a more custodial orientation. Hence the negative correlation between PCI and SE implies that pre-service teachers with less custodial orientations towards classroom management are more likely to have higher SE. This is consistent with studies that have found use of ICT in teaching to be associated with more student-centred approaches to management. PCI was very significantly correlated ($p < .001$) with usefulness, Innovativeness and the external factor of teacher efficacy, each of which was more strongly correlated with SE than was PCI. Hence, it was eliminated from the regression analysis model and the other variables were retained.

There are implications in these relationships for the potential effectiveness of an intervention such as multimedia materials that seek to increase users' self-efficacy for teaching with computers. Were SE to be significantly dependent upon one or more factors that would not be affected by the intervention, then the effectiveness of the multimedia, for at least some users, might be reduced. Among the significant predictors of SE identified above, attitudes towards computer technologies (comfort/anxiety

and usefulness) and self-efficacy for computer technologies might be expected to be positively affected by working with the multimedia materials. These relationships increase the likelihood that working with appropriate multimedia materials (Gibson and Albion 1999) will have the desired effect upon pre-service teachers' self-efficacy for teaching with computers and their subsequent inclination to integrate ICT into their teaching.

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BIOGRAPHY

Peter Albion was a teacher of mathematics, science and computing in Queensland secondary schools for seventeen years before joining the University of Southern Queensland in 1991. He is currently Senior Lecturer in Educational Computing. His research interests include the development of teachers' self-efficacy integration of ICT into teaching and the application of problem-based learning to the design of multimedia and online education.