It is the paper published as:

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Title: Pre-service Primary Teachers prior engagement with ICTS in their Secondary Science Studies

Year: 2010

Editor: Committee

Conference Name: INTED 2010: 4th Proceedings

Conference Title: International Association of Technology, Education and Development (INTED)

Conference Location: Spain

Publisher: INTED2010 Proceedings CD

Date: 8-10 March 2010

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URLs: http://library.iated.org/view/BOYLAN2010PRE ; http://researchoutput.csu.edu.au/R/-?func=dbin-jump-full&object_id=25343&local_base=GEN01-CSU01

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PRE-SERVICE PRIMARY TEACHERS' PRIOR ENGAGEMENT WITH ICTS IN THEIR SECONDARY SCIENCE STUDIES

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(25 Jan 2010 Version)

Abstract

In all areas of the curriculum in New South Wales schools, the inclusion of Information and Communication Technologies (ICTs) to support and enhance learning is mandated. The current research examined the reported level of usage and the variety of ICT applications used by first year primary teacher education students when they studied science in their senior high school years (Years 11 and 12). The research question was: To what degree have primary teacher education students used ICTs as part of their senior secondary science studies? In particular, this research focused on the degree to which these pre-service students engaged with both science studies in the senior years and the range of ICTs used as part of those science studies. Longitudinal data were collected for four sequential intake cohorts, 2006 to 2009 inclusively (n= 319). Data were generated through the administration of a questionnaire developed by the authors during the first semester of their studies at a rurally based university, Charles Sturt University located in Wagga Wagga New South Wales, Australia. Data analyses were conducted using SPSS Version 16.

Major findings revealed that a) approximately 80% of students were females, a result similar to most NSW universities, and b) between 38% and 56% of each intake cohort had not studied a science subject in Years 11 and 12. For those students who had studied a science subject, Biology was the most frequently selected subject. Students were asked to report on what forms of ICTs they had used within their science subjects. Between 17% and 22% of each intake cohort of students reported that they had not used an ICT in their science studies. For those students who reported using an ICT in their science studies, the most frequent ICT used was the internet for researching topics for their science class (66% to 78%). This was followed by the use of word processing for report writing purposes 63% to 76%) and power point application for presentation of information made in class (37% to 57%). One unexpected finding was the very low proportion within each cohort who had used a data logger to capture and transform first hand data collected from practical investigations (2% to 34%). The need to develop focused training sessions for these primary students to enhance their facility and expertise with using ICTs as part of their on campus primary science education classes, as well as during their professional teaching experiences emerged as a priority issue. For primary teacher education students, it is the investigative nature of doing science that is central to developing their pedagogical knowledge of how scientists work and use ICTs as part working scientifically.

Keywords: Pre-service primary teachers, science education, information and communication technologies

INTRODUCTION

As science curriculum documents are revised and updated, one recurring feature within this process has been the growing emphasis on including Information and Communication Technologies (ICTs) as part of the teaching and learning process. In New South Wales, the Board of Studies through its Science 7-12 Curriculum Consultative Committee asserted the importance for science students to use ICTs as part of their science learning experiences. In particular in the Year 11/ 12 (Stage 6) science courses, students are required specifically to undertake both first hand and second hand investigations that incorporate the

use of data recording devices such as data loggers, data analysing and presenting techniques using word processing, spreadsheet and database programs and searching the world wide web or internet to access, extract and evaluate information and determine its importance and the implications derived from these secondary sources as part of their routine studies in senior secondary science.

This paper explores data collected from incoming teacher education students over the years of 2006 to 2009 and considers what it means for the development of pre-service teachers' technological and pedagogical knowledge within teacher education programs for their teaching of primary science and technology.

Significance of the study

The use of ICT in everyday life continues to expand and its use in primary science education can enhance the way learners explore their world. The integration of information and communication technology into science classrooms is increasingly important for engaging and motivating today's students [1]. The use of ICT is one of six dominant characteristics of effective science teaching '*to enhance [the] learning of science with opportunities to interpret and construct multimodal representations' [2].* Many science educators believe that a key means of achieving scientific literacy goals is through ICT integration and the engagement of students in authentic scientific inquiry.

> *Integrating ICT into existing subjects is the model used in primary classrooms. The main argument here is that integration means that more authentic learning will take place. For example, scientists and mathematical modellers use ICT to gather and process data and so the use of ICT by the students in similar ways can be justified, and perhaps argued as an essential inclusion in the curriculum* Lloyd [3].

Data loggers, for example, give students the opportunity to experience the inquiry style of learning science. Gipps [4] agrees that '*Doing science*' using ICT tools helps to promote an understanding of science as a way of inquiry and not just an accumulation of facts and theories.

New teachers are expected to integrate ICT into their science teaching once in schools. Teacher education programs must support pre-service teachers' learning to use technology so as to enable them to teach with technology. In addition, the challenge for teacher education programs is that pre-service teachers must not only come to be users of ICT tools, but also be skilled in the designing of quality learning and teaching experiences for the usage of these tools by primary students in Science and Technology.

Lloyd [3] warns however that integration is reliant on the expertise and interest of teachers. "*Where teachers lack experience, or where the inclusion of ICT is an afterthought to unit planning, then the use of ICT by students can be superficial*". In addition, although experiences in the use of some ICT tools may well have been gained in other secondary education subjects or from wider settings, Laffey and Espinosa [5] warn us that we should not extrapolate mastery of skills in the use of ICT tools in one context with mastery for using these tools in other contexts. Pre-service teachers must complete their B. Education (Primary) studies adequately prepared to enter the profession as technology-using teachers with the understandings and skills for using and teaching ICTs in their early career practice as primary teachers of Science and Technology.

This study provides an insight that could inform future developments of primary teacher education programs.

CONTEXT

At Charles Sturt University (CSU) the Bachelor of Education (Primary) is a 4 year pre-service teacher education program that focuses on years K-6 (age range 5 - 12 years) with specific studies in the six key learning areas including Science and Technology. Entry requirements to Bachelor of Education (Primary) are determined by the student's aggregated performance as measured at the end of Year 12 based on either a) the Higher School Certificate (HSC) examinations for New South Wales students or b) the

Victorian Certificate of education (VCE) for Victorian students. In both state education systems the study of science in Years 11 and 12 is NOT compulsory.

METHODOLOGY

The sample of students who participated in this study were first year primary teacher education students enrolled at Charles Sturt University, Wagga Wagga campus. Longitudinal data collected from the 2006, 2007, 2008 and 2009 intake cohorts is reported in this paper. In total, 319 responded to the questionnaire. The questionnaire, designed by the authors, was administered to each intake cohort and included questions that sought student responses to items about biographical information, prior science studies and the ways in which ICTs were used within their senior secondary science studies. The data were analysed using SPSS version 16.

The research question was: *To what degree have primary teacher education students used ICTs as part of their senior secondary science studies?*

RESULTS

The biographical data collected from the survey sought information on gender, age and the basis for entry to university. In Table 1, each cohort's information is reported.

**Table 1. Student biographical information**

Year	Mean age (Yrs)	Age range	Gender		
			Male (N, %)	Female (N, %)	Omit (N, %)
2006	20.71	17-49	13 19.7%	53 80.3%	0 0%
2007	23.41	18-48	13 17.6%	59 79.7%	1 1.4%
2008	20.73	17-46	8 10.1%	71 89.9%	0 0%
2009	21.03	17-39	24 23.8%	76 75.2%	1 1.0%

A second part of the survey asked students about whether they had studied a science course during their Year 11 and 12 studies and, if so, what was the course(s) studied. Their responses to these science study questions are reported below in Fig. 1.
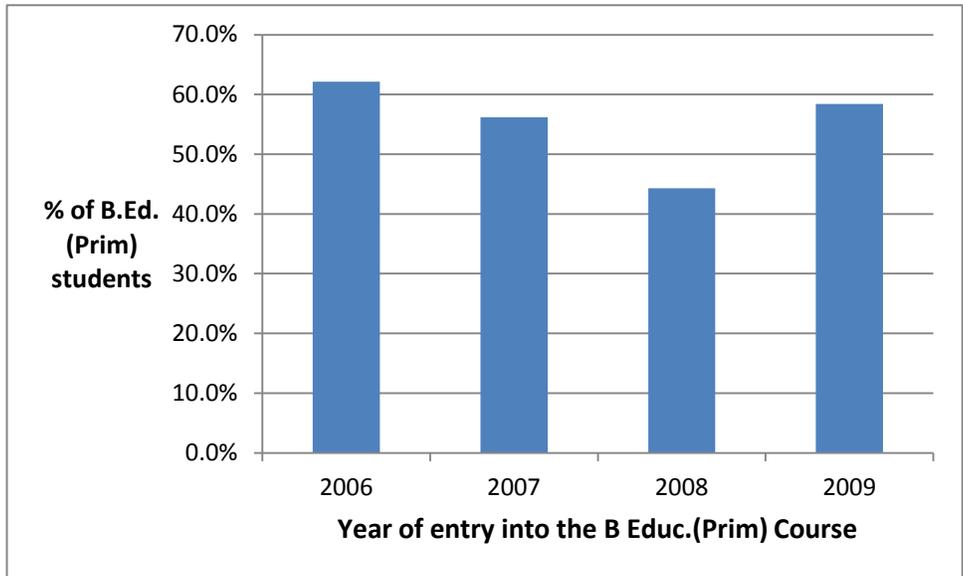
Figure 1. Percentage of Bachelor of Education (Prim) students who had studied science at the HSC / VCE level

Over the 4 year period 2006-2009, the mean proportion of students studying science in the Bachelor of education (Primary) course who had studied science to the end of Year 12 (i.e. the HSC/VCE level) is 55.3%, i.e. about 1 in 2 students has studied a senior secondary science course. In Fig. 2, the details of which HSC / VCE science course these students studied is listed. The percentage calculations reported in Fig. 2 represent the percentage of students who studied *at least* one science course as a proportion of the total Bachelor of Education (Primary) cohort for that year.
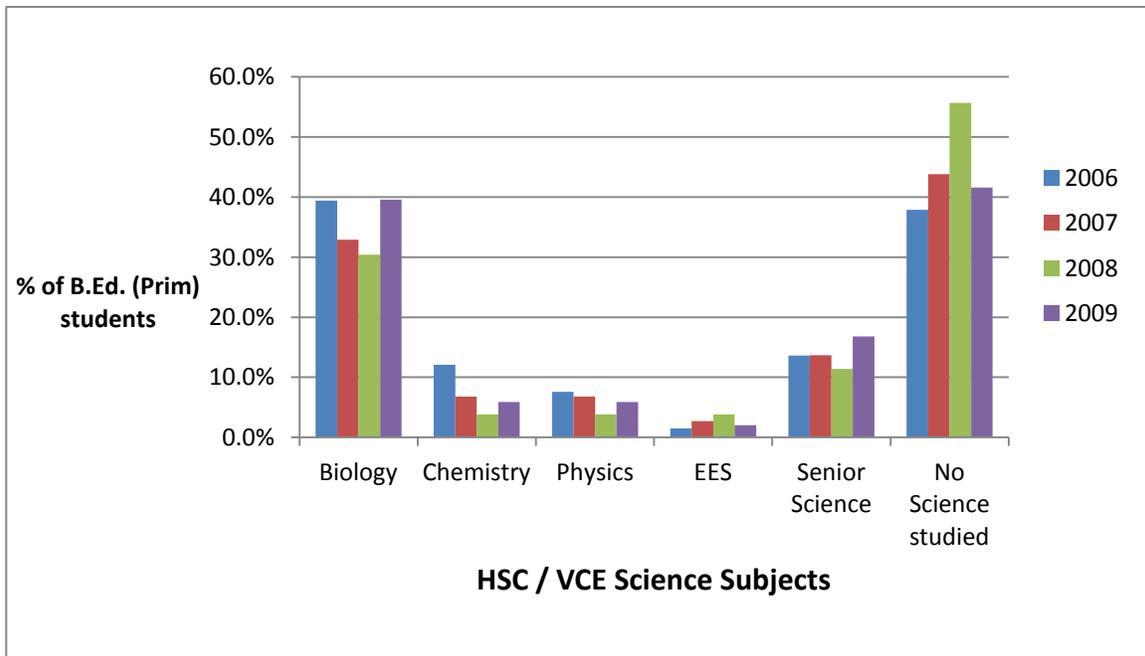
Figure 2. HSC/VCE Science subjects studied by students entering the Bachelor of Education (Prim) Course
Note: In Fig .2, EES refers to Earth and Environmental Science.

From Fig. 2, three clear patterns can be clearly identified: i) most students who study a senior secondary science course select Biology; ii) the second most frequently studied senior secondary science course is

Senior Science; and iii) on average 44.7% (almost 1 in 2 students) did NOT study any science in Years 11 and 12. Additionally, Fig.2 indicates that very few students had studied Chemistry, or Earth and Environmental Science, or Physics in Years 11 and 12.

Engagement with ICTs in science studies

The students' reported engagement of ICTs in senior science studies was calculated by selecting the smaller proportion of the cohort who had affirmed that they had studied a science in Years 11 and 12. This decision to exclude all students who had NOT studied a senior science subject must be acknowledged and does not preclude possible engagement with ICTs in non-science based subjects in Years 11 and 12.

The study then sought information from the students about i) whether they used ICTs as part of the science studies (Table 2), ii) which particular subjects used ICTs (Table 3), iii) what forms of ICTs did they engage with while completing their Year 11/12 science studies (Fig. 3), and iv) what was the form most frequently used by these students (Fig. 4).

Students who did not study a science in Years 11 and 12 were not included in the calculations described in Table 2. The significant outcome from Table 2 is the high proportion of students who stated that they did use an ICT within their two years of senior secondary science education.

Table 2. Used ICTs in Yrs 11/12 Science

Intake Year	Used ICTs in Science					
	Yes		No		Omit	
	N	%	N	%	N	%
2006	32	(78.0%)	9	(22.0%)	0	(0%)
2007	32	(78.0%)	9	(22.0%)	0	(0%)
2008	28	(80.0%)	6	(17.1%)	1	(2.9%)
2009	47	(79.7%)	12	(20.3%)	0	(0%)

The other encouraging aspect of the data reported in table 2 is the slow decrease form 2006 to 2009 in the proportion of students who did not use an ICT.

These students were then asked to identify which particular science subject employed ICTs as part of the teaching and learning process. This is reported in table 3. Results are as expected and directly correlate with the higher proportions of students who studied Biology and Senior Science.

Table 3. ICTs used in specific science subjects

Science subjects	Intake Year			
	2006	2007	2008	2009
Biology	19 (46.3)	14 (34.1%)	18 (51.4%)	24 (40.7%)
Chemistry	7 (17.1%)	2 (4.9%)	3 (8.6%)	3 (5.1%)
Physics	4 (9.8%)	1 (2.4%)	2 (5.7%)	5 (8.5%)
Earth and environmental Science	0 (0%)	0 (0%)	1 (2.9%)	1 (1.7%)
Senior Science	7 (17.1%)	8 (19.5%)	6 (17.1%)	12 (20.3%)
Other Science	2 (4.9%)	3 (7.3%)	2 (5.7%)	4 (6.8%)

N.B. The numbers reported in Table 3 for each intake year are greater than the numbers of students in each year cohort as it is permissible for students to study one, two or three science subjects in years 11 and 12.

The next question invited the students to identify what ICT applications they used as part of their science studies. Of those students who had completed a science course of study in Years 11 and 12 (on average 55.3%), between 17% and 22% of each intake cohort reported that they had *not* used an ICT. Other students were able to identify multiple ICT applications. As can be seen in Figure 3, of those students who had studied science in years 11 and 12 and reported using an ICT in their science studies, the most reported ICT used was the internet for researching topics for their science class (66% to 78%). This was followed by the use of word processing for report writing purposes (63% to 76%) and power point application for presentation of information made in class (37% to 57%). One unexpected finding was the very low proportion within each cohort who had used a data logger to capture and transform first hand data collected from practical investigations (2% to 34%).
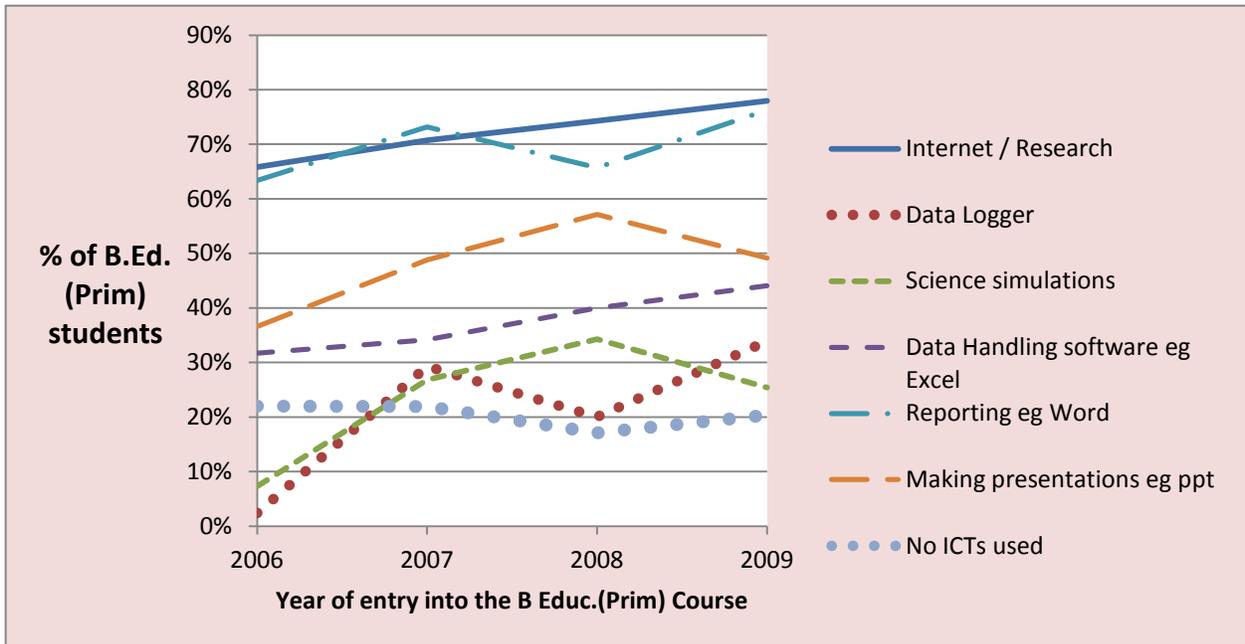
Figure 3. Engagement with ICTs in Science

When asked to indicate the most frequently used ICT used in their year 11 and 12 science studies it was again reported by the students that data handling software, data loggers and science simulation software were the least frequently used ICT applications (Figure 4).
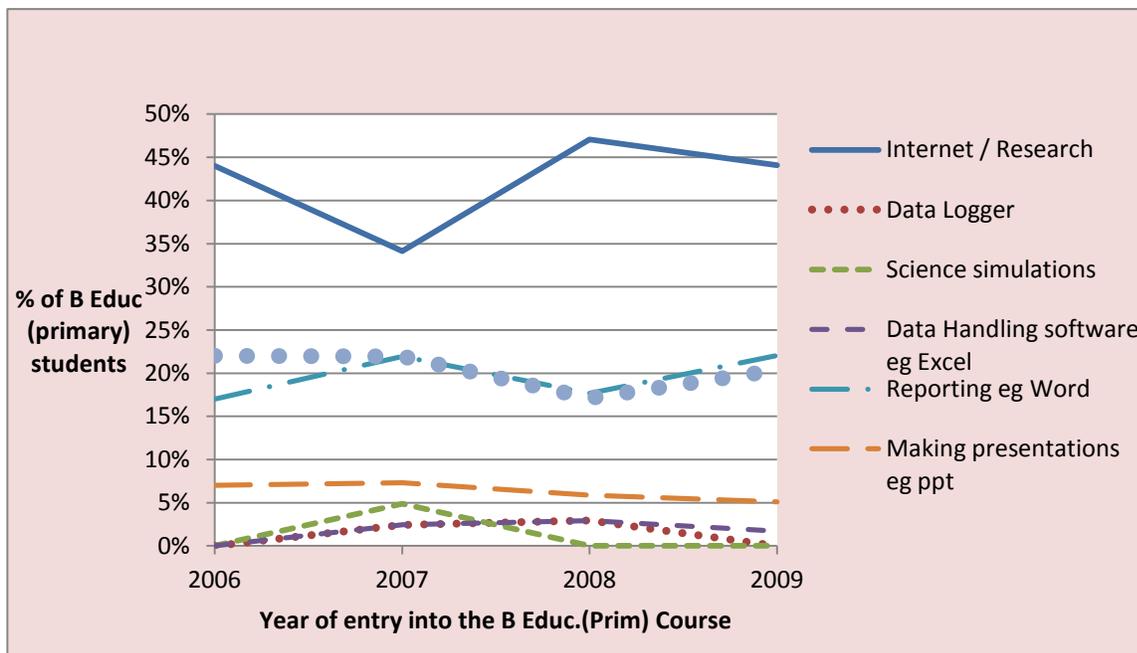
Figure 4. Most frequently used form of ICT First Stated response

DISCUSSION AND CONCLUSION

Approximately 80% of CSU's primary pre-service teachers are females and many are entering the teacher education course with little science background and a narrow range of experiences of ICT applications in science education. More commonly, their senior science studies were in Biology with less than 10% of the incoming cohort having studied chemistry, physics or earth and environmental sciences. With a lack of appropriate background in science and technology, many students may doubt their capacity to teach science effectively.

Amongst those primary pre-service teachers who had completed a science course of study in Years 11 and 12 (on average 55.3%), this study found an increasing level of engagement with ICTs in senior science studies across the period 2006-2009. However a high proportion of students reported only using ICT as a reference source and the use of ICTs to communicate information (word processing, PowerPoint presentations). Noticeably lower was the proportion of students who used ICTs as scientific investigative tools (Data handling software, Data loggers). The narrow nature of student learning utilising ICTs is not entirely surprising. However a possible implication of this may be that pre-service teachers entering teacher education courses will have a simplistic view of scientific inquiry unaware of the multiplicity of approaches and ICT tools that scientists employ in their work. If primary teachers are to achieve curriculum goals in Science and Technology through facilitating authentic scientific inquiry, they will need to develop insights into aspects of science practice including the multiplicity of approaches, methods and ICT tools that scientists employ in their work [6,7,8, 9].

Most teacher education programs have the instructional goal of developing pre-service teachers' understandings and skills in ICT. The challenge for teacher educators is to extend pre-service teachers' understandings of the various ICT applications and their relevance to science inquiry teaching.

> *Using word processors, sending email, doing web-based searching or preparing PowerPoint slides as a PST or as a prospective teacher are fairly rudimentary accomplishments when compared to a vision of teachers helping students use technology for representing, analysing and communicating about their world*. [5]

Experimental investigation is central to the pursuit of science and the learning of science. Primary science education combines the scientific processes with scientific knowledge as children gather and analyze evidence, construct and test explanations and think critically about evidence and explanation to develop

their understandings in science. Data logging, data handling, modelling and simulation software can help primary students to engage and provide new, authentic, educational activities that support an inquiry based approach. These are as valuable to science teaching and learning as the ICT multimedia authoring tools primary students can use to communicate scientific concepts and arguments.

ICT has a huge potential for supporting learning in science but is often underutilised in the science classroom as evident by the 17% to 22% of each intake cohort who reported that they had not used an ICT in their senior science studies. If learning in higher education is the result of the 'constructivist activity of the student' [10] then identifying incoming teacher education student's varying conceptions of and previous experiences in the multiple practical application of ICTs to science education is important. The enormous divergence between the ICT competency base of entry pre-service teachers poses a considerable challenge to teacher educators responsible for the development of primary teacher education programs which support pre-service teachers' learning to use technology and develop understandings of the role of technology in supporting students learning in Science and Technology. Teacher education programs must provide pathways or programs that will support students to develop their technological and pedagogical knowledge to be effective users of the multiple applications of ICTs in their science teaching.

An understanding of and skills in the use of data recording devices, data analysing and presenting techniques for primary Science and Technology classroom practice are best learnt through first-hand experience. At CSU it has meant rethinking what needs to be provided in the primary education science teaching method subject. These subjects promote science as active inquiry and the pre-service teachers are required to demonstrate their scientific investigative skills and competence with a wide array of ICT applications. Opportunities are provided for the pre-service teachers to undertake their own practical scientific investigations or work with scientists in real-life inquiries.

The fast-changing nature of technology creates additional challenges for teacher educators who need to stay abreast of new technologies and their creative use and simultaneously educate pre-service teachers on how to integrate technology effectively into their teaching practice. Currently the teacher educators are being challenged to explicitly demonstrate, model and train pre-service teachers in the use of interactive whiteboards in science education in ways that move beyond transmissive modes of teaching.

In concluding, the research indicates the importance of engaging pre-service teachers, during their teacher education program, in the experiences of learning and using a wide range of ICT applications that are valuable to science and science education. It cannot be assumed that they have had prior experiences of multiple ICT applications in their own science studies prior to commencing the B. Education (primary) course. The need to develop focused training sessions for these primary students to enhance their facility and expertise with using ICTs as part of their on campus primary science education classes, as well as during their professional teaching experiences emerges as a priority issue. For primary teacher education students, it is the investigative nature of doing science that is central to developing their technological and pedagogical knowledge of science teaching and the use of ICTs as tools in working scientifically.

This study promotes integration of ICT with best pedagogical practice teacher education courses so that new teachers engage their primary students in authentic scientific inquiry and display competencies in using ICTs in primary Science and Technology

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