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# Digital Opportunities Within the Aboriginal Teacher Education Program: A Study of Preservice Teachers' Attitudes and Proficiency in Technology Integration

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*This article explores changes that occurred in preservice teachers' thinking about the use of educational technology in a post-secondary, Aboriginal, elementary teacher education program. The research explores relationships associated with changes in preservice teachers' attitudes and perceived proficiency with technology integration. Quantitative results indicate significant increases in several attitude constructs as well as overall computer proficiency over the course of the project. Supplemental qualitative analysis reveals participants' perception of technology integration as a contributing factor in this positive change. The findings from this study represent a research effort to better prepare teachers to meet the educational needs of Aboriginal students in a 21st century context.*

*Cet article explore l'évolution dans les idées des stagiaires quant à l'emploi des technologies éducatives dans un programme postsecondaire de formation pour enseignants autochtones à l'élémentaire. La recherche porte sur des rapports associés aux changements dans les attitudes des stagiaires et leur perception de leur compétence relative à l'intégration technologique. Les résultats quantitatifs révèlent des augmentations significatives tant dans les attitudes que la compétence technologique globale au cours du projet. Une analyse qualitative supplémentaire indique que la perception des participants quant à l'intégration technologique constitue un facteur contributif dans ce changement positif. Les résultats de cette étude représentent un effort de recherche visant une meilleure préparation des enseignants de sorte à répondre aux besoins pédagogiques des étudiants autochtones au 21e siècle.*

This article explores changes that occurred in preservice teachers' thinking about the use of educational technology in a post-secondary, Aboriginal, elementary teacher education program. It reports on findings from a two-year study of a technology integration project for a cohort of 20 students with a focus on skills that prospective teachers should develop prior to certification. In the context of this study, technology integration can be defined as teachers utilizing content and technological and pedagogical expertise effectively for the benefit of students' learning (Pierson, 2001). The findings from this study represent part of a larger research effort which explored the links between technology and pedagogy to better prepare teachers to meet the educational needs of Aboriginal students in a 21st century context.

 

## Background

As Canada's economy becomes increasingly knowledge driven, there is significant risk that under-skilled Aboriginal peoples will be left behind and marginalized as the rate of technology integration in the economy rises (Greenall & Loizides, 2001). Aboriginal communities face a "digital divide" that involves less access to, use of, and training in information technologies and Internet resources on reserves (Downing, 2002). Geographic isolation, lack of public access sites on reserves, small numbers of homes with Internet connections, and a lack of computer skills and training programs have been cited as barriers which prevent some Aboriginal peoples from creating sustainable futures and fully participating in the knowledge economy (Downing, 2002).

Recently, the Government of Canada financed a national priority to address local and regional infrastructure needs through programs sponsored by Industry Canada (e.g., Community Access Program, First Nations SchoolNet, and Broadband for Rural and Northern Development) to develop a $225 million rural broadband strategy beginning in 2009-2010. In addition $127 million was allocated to the First Nations Infrastructure Fund, which promotes access to nearby regional broadband networks and telecommunications expansion projects (Theckedath & Thomas, 2011). While federal endorsements begin to address the gap in service levels between rural and urban Canada, technologies requiring training and maintenance beyond that which the community of focus can supply may exacerbate the divide (Grossman, 2008). Technological skill development becomes especially vital for Aboriginal Canadians living in communities that are remote, lack large educational institutions, and for whom distance learning using computers fits with community and cultural standards (Downing, 2002).

Over the past two decades, transfer-of-authority arrangements have given Aboriginal peoples more participation and control over how education is delivered in their communities (Cherubini, 2008). However, efforts to reclaim their systems of education are stymied by a growing Aboriginal population with proportionally higher children and youth than the rest of the nation. In 2006, the percentage of Aboriginals under the age of 15 was 29.7 percent compared to 17.4 percent for Canada's total population (Statistics Canada, 2006). Additionally, high dropout rates on reserves contribute to the low proportion of the registered Indian population with at least a high-school education (Statistics Canada, 2006). The data suggest that Aboriginal youth face significant challenges in developing equivalent levels of competency necessary to avoid the creation of a technology and information elite (Grossman, 2008). It has been recognized for decades that having Aboriginal teachers in the classroom is the first line of change in the education of Aboriginal children and youth. Studies have shown that Aboriginal teachers facilitate the achievement of these students through positive role modeling, lower staff turnover and sensitivity to the cultural and learning needs of their students (Royal Commission on Aboriginal Peoples, 1996).

The use of technology applications can restructure the way that Aboriginal education is delivered, and how individuals are empowered to participate in society, especially Aboriginal youth (Crossing Boundaries National Council, 2006). On reserves, high dropout rates contribute to the low proportion of the registered Indian population with at least a high-school education. According to the 2006 census, 34% of Aboriginal people aged between 25 and 64 had not completed high school compared to 15% of non-Aboriginal Canadians (Statistics Canada, 2006). Unlike previous generations, urban youth today have grown up immersed in technology and have internalized it. From the point of entry into school, students across Canada are routinely expected to utilize the World Wide Web (WWW) for information, skills, and knowledge. In most

Aboriginal communities, the level of home computer penetration is extremely low (Aboriginal Communities Connectivity Data and Statistics, 2004). Using technology in the classroom can help build student interest in attending school. Distance learning courses also encourage students to stay in school by providing them with flexible options for course delivery. Aboriginal youth can increasingly be able to remain in situ to finish high school and continue post-secondary studies without having to travel to urban centres (Greenall & Loizides, 2001).

## Research Context

With 634 First Nations, 53 Inuit, and 50 Métis reserve communities and Aboriginal settlements throughout Canada, the need to impart technological skills that build learner capabilities while also fostering pride in and strengthening Aboriginal community beliefs and traditions is exigent (Canadian Council on Learning, 2009). Given that technology skills are fundamental to participation in today's economy, the need to teach all students to discern and fully benefit from technologies available forms a part of provincially-mandated curricula in the 21 st century (e.g., Alberta Learning, 2004; Jenson, Taylor, & Fisher, 2010). However, the unprecedented increase in the proportion of Aboriginal children in Canada has created a shortage of Aboriginal elementary teachers, especially in remote communities, who possess the necessary technology integration skills to support teaching and learning.

In 2002, the Faculty of Education at the University of Alberta established the first Alberta site of the Aboriginal Teacher Education Program (ATEP) at Blue Quills First Nations College, and Northern Lakes College. Currently there are over 92 students enrolled in the ATEP across northern Alberta. ATEP is the culmination of ongoing collaborations with Elders, community members, partner colleges, school districts, and the students themselves, to meet the goal of increasing the capacity of preservice teacher education students to understand and work within an indigenous worldview in their classrooms. Fundamental to success of the ATEP is geographical accessibility which allows students to access Education degree programs within their own communities (see http://www.atep.ualberta.ca).

In an effort to remove accessibility barriers and explore digital opportunities available to Aboriginal educators in remote communities, the University of Alberta launched a pilot project with Blue Quills First Nations College in September 2007. For two years, a cohort of 20 ATEP teacher candidates were supplied with individual laptops, educational software, and wireless Internet access cards (EVDO) for daily use in class, at home, and as part of a student teaching practicum experience. The use of equipment and infrastructure transformed the program at Blue Quills First Nations College from a traditional face-to-face classroom site into a blended learning environment, combining both computer-based instructional components with classroom instruction (Peacock, Norton, & Carbonaro, 2008). Once barriers in communicating across distance were addressed, further progression of the ATEP project was possible.

## Research Rationale

The purpose of the present study was to explore the relationships among technology integration education of teacher candidates (i.e., exposure to technology programming over time), and any associated changes in student attitudes toward computers and perceived proficiency with technology.

While numerous contributions to the educational technology literature on the development of preservice and inservice teachers' experiences with technology have been generated through large granting institutions such as the United States Department of Education initiatives such as *Preparing Tomorrow's Teachers to Use Technology (PT3)*, (United States Department of Education, 2004), comparably less Canadian research has disseminated to the field. Therefore, conducting group-specific research involving Canadian Aboriginal preservice teachers and technology is warranted.

As well, greater implications of this research in the context of Aboriginal education are significant. Negative attitudes toward computers or lack of proficiency might affect academic motivation and performance and are of concern if they are found concentrated among certain categories of individuals with particular background characteristics (Omar, 1992). And, as the development of computer literacy requires both proficiency and a positive attitudinal stance (Dyson, 2002), the scales used in this study may be important assessment tools for measuring change as well as predicting future behavior towards computers when used in similar cultural contexts (Kay, 1993).

## Literature Review

Best practices for improving Aboriginal education have recommended (a) the use of interactive learning (Ryan, 1992); (b) a cohesive community-oriented environment that focuses on harmony, co-operation, and group work (Smith & Shade, as cited in Rasmussen, Baydala, & Sherman, 2004); (c) the use of co-operative learning (Pewewardy, 2002); and (d) enabling learner control (Byrnes, 1993). The value in offering student-centered learning opportunities has some educators calling for the use of interactive multimedia and technology to effectively teach Aboriginal students (Rasmussen et al., 2004). Researchers and teachers working in the area of Indigenous school education in Australia through the 1980s and 1990s found that computers fit with these perceived learning styles (O'Donoghue, 1992; Steen, 1997). For example, Fryer's (1987) work with computer-assisted learning listed several points of congruence: (a) the software involved in the study allowed students to work co-operatively in groups, (b) lessons became more activity based and there was more one-to-one interaction and less teacher-to-whole class talk, and (c) students took greater charge of their own learning. The use of technology in the classroom can act as a catalyst for educational reform to support new methods and strategies for teaching that are more compatible with the holistic vision of Aboriginal education.

If preservice teachers are proficient in integrating technology into their teaching, but do not believe that technology has educational value, they will likely not teach with it despite having the skills (Ropp, 1999). Although teachers' attitudes have not historically been considered in the introduction of computers into the classroom, researchers contend that successful implementations need to address teachers' attitudes toward computers (Hunter & deLeeuw, as cited in Violato, Mariniz, & Hunter, 1989). According to Hignite and Echternacht (1992), it is critical that teachers possess both positive attitudes and adequate computer literacy skills to successfully incorporate technology into the classroom. When using strategies such as more exposure to technology integration in preservice courses, future teachers' attitudes toward the usefulness of computers in education are positively affected (Brown & Warschauer, 2006).

The successful integration of technology into schools depends not only on teachers' attitudes, but also on how schools accept and use computers. In an ethnographic study of the utilization of digital resources at two different Native American Tribal schools, Guice and McCoy (2001) conducted extensive interviews with administrators and teachers to uncover issues underlying the reasons for Tribal choices relating to computer use. Findings indicated that the issue, which most affected technology adoption, was whether or not the Tribe's attitude toward education was positive. Their case study highlights the different historical relationship that Aboriginal peoples have with systems of education. The legacy of residential schools may lead to a perception of education as a means to acculturate children. Prior negative school experiences can lead to the belief that formal education is not worthwhile; attitudes which can be passed on to subsequent generations (see The History of Canada Online at http://canadachannel.ca/HCO/index.php/5._Education#The_Legacy_of_Aboriginal_Education). However, not all authorities take a similar stance. In point, Ermineskin Schools in Alberta, under the mandate of the Miyo Wahkohtowin Community Education Authority, have identified the integration of technology in education as a priority. The community recognizes that integrating technology and education complements student learning and enhances the effectiveness of teachers. They have embraced computers as a culturally relevant teaching tool to disseminate the Plains Cree language and culture throughout the schools. The authority has also partnered with the Alberta Distance Learning Centre (ADLC) to implement a Cyber School for high school students with courses delivered through the Internet (Jawad, 2001/2002). Consequently, Ermineskin schools have been recognized by Apple Canada as a technology success story for achieving a high standard in using technology in education.

Clearly, integrating computers into Aboriginal classroom practice is a complex interplay that requires changes to the whole school's practice and culture, to the way curriculum is taught, and in teachers' attitudes (Krysa, 1998). To this end, it may be that teachers who believe in the benefits of technology in their teaching practice persevere through challenges that face classroom educators. In a survey of 344 Canadian public school teachers, Wotherspoon (2006) found many of the teachers surveyed tend to hold in common with Aboriginal communities and educational authorities a general commitment, instilled with specific institutional and pedagogical actions, to make school a place better informed by community interests (Wotherspoon, 2006).

## Methodology

### Participants

From September 2007 to May 2009, 20 preservice elementary teachers enrolled in the collaborative ATEP program participated in the project. Students were admitted to the teacher education program having completed the first two years of university requirements. A total of 16 participants consented to analysis of their data for the current study. The demographic portion of the Teachers' Attitudes Toward Computers (TAC) questionnaire was administered at the start of the program to collect entrance information on the participants as shown in Table 1.

Prior to starting the program, participants attended one week of professional development seminars to become acquainted with laptop technology, and attended a culture camp hosted by Blue Quills First Nations College. As a prerequisite for admission to the ATEP program, all participants completed training in basic computer applications at the college/university level of instruction. As well, all participants had residential Internet access via EVDO technology (with the exception of one student), and all were provided with a personal laptop for use at home,

Table 1

*Participant Demographic Distribution (n=16)*

| | |
|---|---|
| Age Range | 2 (18-25 years)<br>3 (26-30)<br>6 (31-35)<br>3 (36-40)<br>1 (41-45)<br>1 (46+) |
| Gender | 4 males<br>12 females |
| Self-identification Status | 4 Metis<br>6 First Nations<br>3 non-Aboriginal<br>3 unidentified |
| Residential Location | Geographically dispersed throughout northern Alberta and the Town of St. Paul, Alberta |

school, and during classroom practicum experiences for the project duration. Lastly, all participants reported no prior professional teaching experience.

## Instruments / Data Sources

A mixed-methods approach was used to gather study data. This approach was selected because it provided a more comprehensive understanding of the project. The general quantitative information was followed up by a more detailed investigation at the individual level.

Quantitative data was collected using two surveys: the Technology Proficiency Self-Assessment (TPSA), and the Teachers' Attitudes Toward Computers (TAC). These instruments solicit self-reported data on preservice teacher attitudes and use of computers. Qualitative data was also collected in the form of structured questions designed to encourage a full, meaningful answer using the participants' own knowledge and feelings about the infusion of technology into their teacher education experience.

## Quantitative Data

The TPSA is a measure of computer competencies designed specifically to survey the domains of teaching and learning with computers. Teacher candidates are asked to rate their confidence in performing the tasks identified on a 5-Point Likert Scale. The TPSA consists of 20 items, five each from the following domains of proficiency: (1) e-mail, (2) World Wide Web, (3) integrated applications (e.g., presentation software), and (4) integrating technology into teaching. The scale is a combination of simple and adaptive pedagogical uses of technology, such as, "I feel confident that I could . . . use an Internet search engine to find Web pages related to my subject matter interests." Reliability estimates for the subscales range from Cronbach's $\alpha = 0.73$ (e-mail), to $\alpha = 0.87$ (integrated applications; Christensen & Knezek, 2001). Content validity for the TPSA is considered high in that the items were constructed based on skills recommended by the International Society for Technology in Education ([ISTE]; Ropp, 1999). The TPSA instrument has been used in cross-cultural contexts, with discriminant validity demonstrated in a comparison study of Mexican and American preservice teachers (Morales, Knezek, & Christensen, 2008).

Researchers, studying the effects of technology integration education on the attitudes of teachers, developed the TAC questionnaire. Confirmatory factor analysis was used to verify construct validity of the instrument (Christensen & Knezek, 1996). The version used in this study (TAC v. 3.2a) loads on 7 different factors for measuring teachers' attitudes toward computers:

1. Computer Enjoyment/Enthusiasm (15 items).
2. Computer Anxiety (15 items).
3. Computer Avoidance/Acceptance (13 items).
4. E-mail for Classroom Learning (11 items).
5. Negative Impact of Computers on Society (11 items).
6. Computer Productivity in the Classroom (15 items).
7. Semantic Perception of Computers (10 items; Knezek, Christensen, Miyashita, & Ropp, 2000). Published reliabilities for these subscales appear very good and range from .85 to .98 ($n = 621$), (Christensen & Knezek, 2009). The TAC instrument also reportedly functions well as an indicator for research in technology integration (Hancock, Knezek, & Christensen, 2007).

## Qualitative Data – Technology Integration

Four open-ended survey questions were constructed to identify links between the technology integration component of the program and project outcomes related to computer attitudes and proficiencies. These questions were given at the completion of the program:

Q1: Is it important to integrate technology into your future classroom – why or why not?

Q2: What do you feel were the benefits of the ATEP technology initiative? What were the drawbacks of the ATEP technology initiative?

Q3: Given the choice, would you have preferred a traditional classroom experience, or a technology-infused one?

Q4: How has your personal comfort with computers changed as a result of this project?

The specific design of the technology-integration component of the project compares to earlier efforts by Beyerbach, Walsh, and Vannatta (2001), and Nicaise and Barnes (1996), in the use of technologies such as e-mail, multimedia presentation software, and Internet exploration to support a constructivist approach to teaching and learning. The current study also leveraged more recently available instructional support/delivery systems such as (a) asynchronous course management systems (e.g., WebCT), (b) synchronous peer-to-peer virtual classroom technology (e.g., Elluminate), and (c) video conferencing for student and instructor use. Some examples of instructional activities are as follows:

Examples from Year One activities:

1. Introduction to the use of laptop computers in the classroom.
2. Doing a photo scavenger hunt.
3. Using the EVDO Internet wireless access cards; backing up your computer.
4. Installing Windows Vista and understanding your operating system.
5. Web apps for classroom management; Web apps for special needs students; introduction to WebCT; how to burn a DVD.
6. Introduction to SmartBoards; using Inspiration software for concept mapping.
7. Using Excel for assessment.
8. Using Windows MovieMaker for digital storytelling.
9. Effective searching with Google; creating animated PowerPoint books.

Examples from Year Two activities:

1. Doing research online and using online research apps; Web apps for Physical Education.
2. Using Ning; Google Maps and other mapping applications for Social Studies.
3. Web 2.0 applications for Social Studies.
4. Using Read and Write Gold for teaching reading; District Office Online and online job applications.
5. Smart Notebook software; Boardmaker Plus!; Creating oral reflections/podcasts online.
6. Blogging with Blogger; Building web sites with Google Sites.

Standards which guided development of infusion activities included the International Society for Technology in Education (ISTE) Standards, and the Alberta Education Information and Communication Technology Program of Studies (http://www.education.gov.ab.ca/ict/pofs.asp). As well, similar to strategies discussed in Beyerbach et. al. (2001), professional development activities were designed which identified specific learning objectives for teacher candidates as well as faculty/teacher educators, which offered hands on learning experiences and applications to support teaching and learning through the project. Programmed technology integration activities are shown in Table 2.

Table 2

*Conceptual Development of Technology Integration and Associated Activities by Program Term*

| | |
|---|---|
| **YEAR 1 - Term 1 Introductory Professional Term** | |
| 13 Weeks Total: 4 weeks in class; 5th week in field experience observation & participation; 4 weeks in class; 4 weeks full-time field experience placement | |
| EDEL 321: School Physical Education. Curriculum & Instruction | Activities:<br>90% Face-to-Face Instruction |
| EDEL 302: Elementary School Art Curriculum & Instruction | Activities:<br>80% Face-to-Face Instruction<br>20% On-Line Eportfolio |
| EDPS 310: Managing the Learning Environment | Activities:<br>75% Face-to-Face Instruction |
| EDPY 301: Inclusive Education: Adapting Instruction for Students with Special Needs | Activities:<br>75% On-Line Special Education Software tools |
| EDFX 325: Introductory Field Experience | Activities: School-based practicum |
| **YEAR 1 - Term 2 Education Core II** | |
| 13 Weeks in Class | |
| EDPY 454: Behavioural Management of Severely Disruptive Children | Activities:<br>50% On-Line |
| EDPY 303: Educational Assessment | Activities:<br>90% On-Line Elluminate |
| LIS 405: Canadian Children's Literature for Young People in Schools & Libraries | Activities:<br>100% On-Line eClass (WebCT) |
| EDEL 316: Communication Through Mathematics | Activities:<br>75% Face-to-Face Instruction<br>25% On-Line Gizmos learning objects |
| EDEL 305: Language Arts in the Elementary School | Activities:<br>75% Face-to-Face Instruction<br>25% On-Line Digital Storytelling |
| **YEAR 2 - Term 3 Education Core II** | |
| 13 Weeks in Class | |
| EDEL 335 : Elementary Social Studies Curriculum & Instruction | Activities:<br>75% Face-to-Face Instruction<br>25% On-Line *Inspiration,*Digital storytelling |
| EDEL 330: Elementary School Science Curriculum & Instruction | Activities:<br>75% Face-to-Face Instruction<br>25% On-Line Inspiration; Gizmos |
| EDEL 325: Elementary School Music Curriculum & Instruction | Activities:<br>75% Face-to-Face Instruction<br>25% On-Line Webquest |
| EDPY 456: Consultation Collaboration in Special Education | |
| EDPY 452: Assessment- Instruction of Exceptional Learners | |

*Table 2 continued on next page*

*Table 2 continued from previous page*

| YEAR 2 - Term 4 Advanced Professional Term | |
|---|---|
| 1st four weeks of compressed coursework<br>Final 9 weeks full-time special education field experience | |
| EDPS 410: Ethics & Law in Teaching | Activities:<br>80% On-Line Instruction |
| NS4xx: History of Indigenous Education | Activities:<br>50% Face-to-Face Instruction |
| EDFX 426: Special education field experience | Activities: School-based practicum |

## Procedure

A pretest/posttest group design was used for the quantitative data to explore the impact of technology integration on preservice teachers' attitudes and computer use. The TAC and TPSA surveys were jointly administered during class time by the project administrator using a paper format at Time 1 (September, 2007), and via an on-line format (e.g., www.surveymonkey.com) at Time 2 (April, 2009). Both surveys were scored in accordance with the manual *Instruments for Assessing Educator Progress in Technology Integration* (Knezek et al., 2000). To this end, participant responses to negatively worded items were reversed prior to analysis. All 5-point Likert items were coded as 1 = *Strongly Disagree* through to 5 = *Strongly Agree*, with higher values reflecting more positive ratings. Semantic differential items (TAC Factor 7) were converted from 7 points to 5 points for comparative purposes in reporting means and standard deviations for the quantitative data set.

Open-ended survey questions were administered on conclusion of the project alongside final TAC and TPSA survey questions using the same on-line format. The selection of questions was minimized to avoid participant response fatigue as a result of multiple survey administration (Porter, Whitcomb, & Weitzer, 2004). Qualitative analyses included identifying common themes and assigning associated codes for each of the technology-related questions. Content was evaluated on a thematic basis, with dichotomous responses reported in percentages, and typical examples highlighted which represent key units of content in the analyses (Hsieh & Shannon, 2011).

# Results

## Quantitative Analysis

In consideration of the small sample size, non-parametric analyses were undertaken, accepting that the outcomes may lack power (McCluskey & Lalkhen, 2011).

Means and standard deviations of the observed variables for the sample are presented in Table 3. Compared to pretest scores, the post test mean scores for each scale and associated subfactors were higher on conclusion of the project. These results indicate mean increases in both computer attitudes and proficiencies for preservice teachers over time.

Table 3

*Summary Statistics of Observed Variables: Mean Scores of Teachers Attitudes Toward Computer (TAC) Scale and Technology Proficiency Self-Assessment (TPSA) Scale*

| | | Pretest | | Posttest | |
|---|---|---|---|---|---|
| | **Variable** | ***M*** | ***SD*** | ***M*** | ***SD*** |
| Teachers' Attitudes Toward Computers (TAC) | Factor 1 - Enjoyment | 3.5 | .38 | 4.2 | .41 |
| | Factor 2 – Anxiety* | 3.5 | .39 | 3.6 | .47 |
| | Factor 3 – Acceptance | 3.9 | .39 | 4.1 | .33 |
| | Factor 4 – Classroom E-mail | 3.5 | .62 | 4.0 | .73 |
| | Factor 5 – Impact on Society | 3.2 | .43 | 3.6 | .47 |
| | Factor 6 – Productivity | 4.4 | .43 | 4.5 | .46 |
| | Factor 7 – Perception of Computers | 3.3 | .86 | 4.0 | .75 |
| Technology Proficiency Self Assessment (TPSA) | 1 – E-mail Skills | 4.3 | .67 | 4.9 | .23 |
| | 2 – WWW (Internet) Skills | 3.8 | .71 | 5.0 | .00 |
| | 3 – Integrated Application Skills | 3.6 | .69 | 4.7 | .41 |
| | 4 – Teaching with Technology Skills | 3.8 | .77 | 4.6 | .42 |

*Note.* * A high score represents a low level of anxiety.

To determine if the TAC and TPSA scales used for this study population consistently reflect the constructs they are intended to measure in comparison to previously reported North American values, internal reliability estimates were calculated as shown in Table 4. Prior TAC studies have reported reliability estimates ranging from Chronbach's α = .85 for Factor 5 - Negative Impact on Society (Christensen & Knezek, 2009), to α = 0.98 for Factor 1 – Enjoyment and Factor 2 – Anxiety. These estimates fall in the range of "very good," according to DeVellis' (1991) guidelines. The data set used in this study yielded values which ranged from Chronbach's α = .51 for Factor 5 – Negative Impact on Society, to α = .94 for Factor 4 - E-mail. Results indicate that most of the original attitudinal subscales tested well in the current study. However, there is notable exception in that both comparisons revealed Factor 5 as the lowest reliability

Table 4

*Comparison of Current Study and Previously Published Reliability Estimates for TAC Questionnaire and TPSA Survey*

| **Scale/Factor** | | **Study Results** | **Published** |
|---|---|---|---|
| TAC 1 | Enjoyment | .81 | .98 |
| TAC 2 | Anxiety | .75 | .98 |
| TAC 3 | Acceptance | .76 | .90 |
| TAC 4 | E-mail | .94 | .95 |
| * TAC 5 | Negative Impact on Society | .51* | .85 |
| TAC 6 | Classroom Productivity | .90 | .96 |
| TAC 7 | Perception of Computers | .88 | .94 |
| TPSA 1 | E-mail Skills | .67 | .73 |
| TPSA 2 | WWW Skills | .83 | .76 |
| TPSA 3 | Integrated Application Skills | .74 | .88 |
| TPSA 4 | Teaching with Technology skills | .84 | .87 |

*Note.* * Factor falls below minimally acceptable standards of reliability (DeVellis, 1991).

estimate, with the value in the current study falling below minimally acceptable values of $\alpha = < .65$ (DeVellis, 1991). All other study estimates fall within the range of "minimally acceptable" to "very good."

To establish whether a positive correlation exists between attitudes towards computers (TAC) and proficiency with computers (TPSA) Spearman's rho was used to measure the strength of relationship between participants' overall TAC and TPSA scores at Time 1 (pretest) and again at Time 2 (posttest). This study showed no significant correlation between computer experience and attitudes toward computers at Time 1, $r_s = .31$, $p$ (one-tailed) $< .05$. However, there was a significant, positive relationship between attitudes and proficiency ratings for preservice teachers at Time 2, $r_s = .65$, $p$ (one-tailed) $< .05$. The latter indicates an increased interdependence between computer proficiency and attitude constructs at the conclusion of the study.

In order to determine the influence of technology integration on participants' TAC and TPSA measures, the Wilcoxon Signed Ranks Test was used to determine if differences between Time 1 and Time 2 results were significant, $p$ (one-tailed) $\leq .05$. This test is a non-parametric alternative to a paired $t$ test, makes no assumptions about the distribution of data, and works well for small sets of data. As shown in Table 5, four out of seven TAC Factors showed significant differences in ratings between Time 1 and Time 2. These results indicate that preservice teachers' attitudes towards computers in the areas of: Factor 1 (Enthusiasm), Factor 4 (E-mail for Classroom Use), Factor 5 (Impact on Society), and Factor 7 (Perceptions of Computers)

Table 5

*Wilcoxon Signed Ranks Test Differences Between TAC and TPSA Data at Time 1 and Time 2*

| **Scale/ Factor Differences Δ (Time 2 - Time 1)** | | | | **Sum of Rank** | ***Z*** | **Exact *P* (one-tailed)** |
|---|---|---|---|---|---|---|
| Δ | * | TAC 1 | Enthusiasm | (-) 5.50<br>(+) 39.50 | -2.018 | .023* |
| Δ | | TAC 2 | Anxiety | (-) 11.50<br>(+) 24.50 | -.922 | .270 |
| Δ | | TAC 3 | Acceptance | (-) 20.00<br>(+) 20.00 | -.297 | .410 |
| Δ | * | TAC 4 | Classroom E-mail | (+) 45.00 | -2.675 | .002* |
| Δ | * | TAC 5 | Negative Impact on Society | (-) 8.00<br>(+) 37.00 | -1.735 | .049* |
| Δ | | TAC 6 | Classroom Productivity | (-) 15.00<br>(+) 30.00 | -.889 | .205 |
| Δ | * | TAC 7 | Semantic Perception Computers | (-) 15.00<br>(+) 30.00 | -2.668 | .002* |
| Δ | * | TPSA 1 | E-mail Skills | (+) 36.00 | -2.539 | .004* |
| Δ | * | TPSA 2 | WWW Skills | (+) 45.00 | -2.670 | .002* |
| Δ | * | TPSA 3 | Integrated Application Skills | (+) 45.00 | -2.668 | .031* |
| Δ | * | TPSA 4 | Teaching with Technology Skills | (-) 1.00<br>(+) 20.00 | -1.997 | .002* |

*Note.* *Exact Sig. $p$ (one-tailed) <.05

significantly increased over the course of their participation in the program. It is noted that results for Factor 5 should be interpreted with caution as reliability estimates for this factor fall below minimally acceptable standards. For the TPSA data, all four TPSA Factors showed significant differences across time in the areas of: Factor 1 (E-mail Skills), Factor 2 (WWW Skills), Factor 3 (Application Skills) and Factor 4 (Teaching with Technology Skills). The TPSA results indicate that students made significant improvements in their confidence to perform technology-related tasks by the end of the program.

To explore any differential gains from Time 1 to Time 2 for attitudes by level of proficiency, that is low versus high proficiency, the data was analyzed by classifying participants into two groups based on their proficiency scores at Time 1. The cases were ranked from lowest to highest on the TPSA and divided into two groups. The Wilcoxon Signed Ranks Test was then used to determine which level of proficiency showed greater gains in attitudinal factors at Time 2, $p$ (one-tailed) <.05. The results displayed in Table 6 indicate that participants grouped by Low Proficiency show a significant change in attitudes on TAC Factor 4 (Classroom E-mail), Factor 5 (Negative Impact on Society), and Factor 7 (Perception of Computers). Again, results for Factor 5 should be interpreted with caution due to low study reliability. For the High Proficiency group, there were no significant changes in attitudes on conclusion of the program. The significant effect for the Low Proficiency group on Factors 4, 5, and 7 indicates that participants who were initially less competent made more positive improvements in these attitudes towards computers at Time 2 than their colleagues who were initially more competent.

Table 6

*Wilcoxon Signed Ranks Test Difference in TAC Factors from Time 1 to Time 2 by High/Low Proficiency Comparison*

| **TAC Factor Differences Δ (Time 2 - Time 1)** | | | | **Low Proficiency** | **High Proficiency** |
|---|---|---|---|---|---|
| **Δ** | | TAC 1 | Enthusiasm | $Z$ = -1.753<br>$p$ = .063 | $Z$ = -1.095<br>$p$ = .188 |
| **Δ** | | TAC 2 | Anxiety | $Z$ = -1.511<br>$p$ = .125 | $Z$ = -.535<br>$p$ = .375 |
| **Δ** | | TAC 3 | Acceptance | $Z$ = -.944<br>$p$ = .219 | $Z$ = -.736<br>$p$ = .313 |
| **Δ** | * | TAC 4 | Classroom E-mail | $Z$ = -2.023<br>$p$ = .031* | $Z$ = -1.841<br>$p$ = .063 |
| **Δ** | * | TAC 5 | Negative Impact on Society | $Z$ = 2.060<br>$p$ = .031* | $Z$ = -.184<br>$p$ = .500 |
| **Δ** | | TAC 6 | Classroom Productivity | $Z$ = -1.214<br>$p$ = .156 | $Z$ = .000<br>$p$ = .563 |
| **Δ** | * | TAC 7 | Semantic Perception Computers | $Z$ = 2.023<br>$p$ = .031* | $Z$ = .000<br>$p$ = .563 |

*Note.* *Exact Sig. $p$ (one-tailed) <.05

## Qualitative Analysis

To systematically link Teachers' Attitudes Towards Computers and Technology Proficiency Self-Assessment survey findings to technology integration efforts, content analysis of four, open-ended survey questions was undertaken to assess the rationale behind why participants' attitudes and proficiencies may have increased as a result of their participation in the study.

All participants (100%) indicated they would use technology as a method of instruction in future classrooms. From this result, three content areas emerged, the most frequent being that technology has become a fixture in children's lives today, a reality likely to intensify in the future. Participants also spoke to the multimodal nature of technology and its accessibility for various learning styles, and ultimately highlighted the role that technology can play in generating student interest in classroom activities:

> "Technology is a huge part of children's lives. They need to be able to use it. Technology can address different learning styles and enhance most lessons." "Absolutely important. This is what students know today and we have to continue that." "It is the future and children need to know it."

> "When trying to reinforce a dry subject adding technology peaks students' interests and keeps them motivated. Also, allowing students to create their own projects on their own laptops motivated their creativity." "Technology used in the program was helpful in designing [interactive] activities for math."

> "Technology is the way of the world and the trends are such that there is no immediate change for less technology in the foreseeable near future, and, in fact, it will probably increase, giving cause for society to continue to promote and advocate for technological outcomes and more use in the classroom." "It maintains students' interests and gives us opportunities to access information that is creative and inspiring."

With regard to whether participants' felt they experienced positive benefits as a result of the research project, key themes emerged regarding the importance of having a laptop for hands-on experiences; how technology enhanced both attitudes and appreciation for the various uses of computers, and how technology can be used to build efficiencies when completing assignments and preparing classroom lessons:

> "The benefits are that technology has created awareness for those who may have overlooked the importance of technology [a situation] which would have continued if this program did not offer laptops." "I feel that these initiatives have given me benefits that other students from other programs may not have."

> "I gained an immense amount of technology knowledge. I was able to share many new things with the school I was placed in. I also had the opportunity to work on lesson plans at home. I was able to practice different strategies at home, using my Smartboard software. I felt confident to try new software that I was unfamiliar with, such as Senteo." "There were benefits to learning up-to-date programs, how to use them, and having access to resources and technology all of the time."

> "Having laptop technology made getting assignments done much easier when accessing resources off the Internet."

Participants did experience drawbacks associated with technology integration in their program, expressed through frustration with uneven levels of technology knowledge within the cohort, and concerns about the additional time required to learn new technologies:

> "Technology, though desired by those who are not as literate, needed more support as the load often went onto those cohorts who did have the knowledge to support them." "Some students work at different levels and that sometimes causes setbacks."

> "It does take more time to do things instead of talking about it. If I was not familiar with something than it took me time to figure it out and make it work for me." "There was less instructional time for [other types of] learning when [I] spent [time] learning about computers."

When given a choice, eleven participants indicated they would repeat a blended-learning opportunity, rather than re-experience a traditional face-to-face classroom. For the remaining participants, five indicated they would prefer even more technology in their learning experience.

> "I enjoy both learning with technology and face-to-face instruction." "I loved the on-line courses and the connection with the instructors."

> "I would rather have had more technology incorporated." "At the beginning, I was hesitant about a technology enhanced one [program], but that would be my preference now."

Lastly, 10 of the participants indicated that their personal comfort with computers changed as a result of the project, with three indicating a great increase, and three indicating no change:

> "My comfort with computers has changed tremendously. I had a home computer before this project but learned a whole lot more than I would by just playing at home." "I feel much more comfortable and confident with computers and technology." "Amazing difference, I feel confident and capable to use technology without assistance. I am also not afraid to ask for help or try new programs or projects on my own."

> "I knew a lot before, but I learned some new resources."

> "I have not experienced much change in this regard, but I certainly feel that not only do I know how to teach through the use of technology, but now also have the ability to teach how to use the computer . . ."

## Discussion

The purpose of the present study was to explore relationships among a technology-infused ATEP program and any associated changes in preservice teachers' attitudes and perceived proficiency with computers. Despite low statistical power, quantitative results showed significant increases in several attitude constructs as well as overall computer proficiency over the course of the project, with supplemental qualitative analysis revealing participants' perception of technology integration as a contributing factor in this positive change.

Further evidence implicating the importance of technology in aligning attitudes and proficiencies is found in the correlational analysis that showed a significant, increasing interdependence between overall attitudes and proficiencies by conclusion of the study. As students participated in teaching and learning with technology, at some point during their two-year experience a shift occurred and the relationship between attitudes and efficacy increased. What cannot be determined is how much time is necessary in order to effect the corresponding change. Findings from the literature review suggest that more time using technology leads to better computer attitudes, with corroborating studies indicating that to feel comfortable using computers takes approximately 1,000 hours of training or more (Liu, Macmillan, & Timmons, as cited in Lambert, Gong, & Cuper, 2008). While the correlation reported in this study does support the premise that a time factor is needed to influence attitudes and proficiencies, beyond the establishment of how much time, knowledge of quantity is insufficient without also acknowledging participants' quality of experience. These questions could be addressed in the future through experimental manipulation of the technology integration variable to draw conclusive evidence for the time and quality elements, as the significant correlation found could be the result of other unknown intervening or mediating variables that emerged over time. As well, a more intentional qualitative approach could shed light on such questions, along with rigor in the use of pilot testing during question development to ensure validity of the constructs used.

Pre-post analysis indicated that participants' self-ratings of computer efficacy significantly increased over the course of the program, with several attitudinal factors also increasing, namely: (a) enthusiasm towards the use of computers, (b) interest in using e-mail for classroom use, (c) positive perceptions/regard for computers, and (d) the affirmative impact that computers can play in society. Thus, it would appear that exposure to technology-integration programming fosters an increase in some attitudes as well as computer proficiencies among preservice teachers. It is problematic to isolate which construct changes first—attitudes or skill. Several formal models have been created to address this issue, the most applicable being a causal analysis conducted by Levine and Donitsa-Schmidt (1998). Using structural equation modeling, they confirmed a model that, in part, finds that computer experience has a positive effect on computer confidence and attitudes towards computers. This suggests that perceptions of efficacy are a necessary foundation to developing positive attitudes. Findings from the current study support such a conclusion, as participants with lower levels of proficiency had greater increases in attitudes by the end of the program. Those participants who already possessed higher skill levels did not demonstrate significant changes. Hence, we can hypothesize that once a certain perceived level of skill is reached, there is a diminishing impact on attitudes. Although attitudes increased only for the low proficiency participants, we found that all participants experienced significant improvements in self-perceptions of proficiency. Ultimately determining which construct, attitudes or proficiency, is more predictive of successful classroom technology integration would prove informative in future studies. Lastly, a word of caution is expressed in the interpretation of pre and post survey measures as a potential method bias was introduced in the use of different administration procedures.

While quantitative analysis revealed solid internal consistencies for the questionnaires used in this study, an exception was found for Factor 5 on the TAC survey. Although a more reliable measure of attitudes regarding the impact of technology on society would have proved an important study contribution, in looking at items on the subscale, they cover quite diverse themes of social negativity, which might explain the relative lack of consistency for this factor. Regardless, the existence of high internal consistency on the remaining subscales does not imply that the scales are actually valid. Should the TAC be used in future for cross-cultural purposes, this subscale should be rethought and an appropriate factor analysis performed to adapt the entire instrument for potential incompatibility of item content, provided a sufficient *n* can be reached. A further limitation of this study is that it did not employ measures of cultural identification or acculturation. Thus, the extent to which the participants are representative of all Aboriginal teacher educators working within Aboriginal communities remains undetermined.

**Educational Implications**

Technology integration education appears to strongly influence teachers' self-perceptions of their developing skills with computers. Findings from this study support the argument that funding ongoing technology integration for preservice teacher programs is a key component towards technology making a difference in the education of Aboriginal students (Christensen, 2002).

Our findings established that feelings of efficacy support the subsequent development of positive attitudes toward the use of computers in the classroom. For teachers this can translate into effective pedagogical uses of technology in the classroom. For students, an understanding of this learning process can enable teachers to acknowledge and avoid neglecting the emotional aspects of computer use that are part of the student experience. To this end, teachers can implement the periodic administration of questionnaires such as the TAC or TPSA in order to help evaluate student progress and explore the source of difficulties when developing and monitoring classroom interventions in technology education. Completing questionnaires and answering questions will also encourage students to reflect on their learning experience which is an important step in empowering student learning and providing constructive teaching feedback (Levine & Donitsa-Schmidt, 1998).

## Limitations

By design, the limits of this exploratory study are numerous, but those for future consideration are mentioned herewith.

1. Wherever possible, Canadian and Aboriginal research has been drawn upon to develop a culturally relevant review. However, the phase of technology adoption for this particular community lags significantly behind that of the dominant culture, leaving applicable research to be unavoidably drawn from conventional studies (circa 1990) conducted during the early uptake of technology in education.
2. It is acknowledged that most current systems of research practice are rooted in Western-European culture and that those values and those of culturally different participants, such as Asians, Aboriginals, and African-Americans, frequently come into conflict in the research process (Lee, as cited in Marshall & Batten, 2003). Undeniably, this study focused on deficits and problems which could lead to further stigmatization of the community discussed; however, conscious effort was given to avoid the bias of research as the methodological driver at the expense of community well-being. For future investigations, it is recommended that time be spent and relationships developed to ensure participants and researchers work together to shape the conception and definition of the issues (Marshall & Batten, 2003).

3. We acknowledge that the generalizability of the study results is compromised by the size of the sample. However, this research highlights the quantitative limitations associated with studying minority populations with high student attrition rates. As well, long standing geographic isolation and limited public access have prevented Aboriginal peoples from fully participating in the knowledge economy. Thus, the already restricted population range is confounded by issues associated with the digital divide which preclude the potential for larger sample sizes. As barriers to access are removed, and Aboriginal Teacher Education programs continue to develop across rural Alberta and the rest of Canada, we can be encouraged that future research efforts will possess greater statistical power.
4. A limitation of this study is that it did not employ measures of cultural identification or acculturation. Thus, the extent to which the participants are representative of all Aboriginal teacher educators working within Aboriginal communities remains undetermined. For the interested reader, the survey instruments (TPSA and TAC) can be reviewed in detail at: http://iittl.unt.edu/instruments.html

## Conclusion

In the context of Aboriginal Teacher Education we need to be respectful and mindful that Aboriginal "ways of knowing" are just beginning to be understood by teachers who are integrating technology into their pedagogy. As such, more recent efforts by researchers such as Mishra and Koehler (2006) who have built specific tools (i.e., Technological Pedagogical Content Knowledge [TPCK]) to address the “wicked goal” of teaching with technology are just beginning to appear on the horizon of Aboriginal teacher education. While such tools have enormous pedagogical potential, their cultural applicability and potential for adaptation would need to be carefully considered prior to pursuing their use in cross-cultural research.

Additionally, the rapid growth and impact of social media tools like Facebook, Twitter, and Youtube in educational environments needs to be understood from an Aboriginal perspective. Such tools are often seen as threats to the cultural context of Aboriginal communities. Aboriginal academic colleagues (E. Steinhauer, personal communication, June 28, 2012) are concerned that such tools may further erode the often-fragile educational environments in rural communities given the uncensored nature of these social media tools. Future research needs to focus on how these social tools can be used effectively in an educational context to preserve, promote, and strengthen Aboriginal culture.

This study is important as it acknowledges Aboriginal teacher candidates as a resource towards emancipation of small communities from what has been referred to as the fourth world of social exclusion, made up of people in areas where technology does not reach, and people who are unable to access it (Castells, 1999). Overcoming challenges related to access, school completion rates, Aboriginal control, and cultural relevance relies in large part on the political will of Canadian governing bodies to remedy the historical imbalances caused by colonization (Richardson & Blanchet-Cohen, 2000). Distance education can offer Aboriginal learners the opportunity to stand astride their own and the mainstream culture. As a result, they can avoid both the problems of being a minority culture within a mainstream institution and the consequences of lack of access to educational resources (Gruber & Coldevin, 1995).

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