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Impact of New Information Technologies on Teachers and Students

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Abstract: This paper summarises findings from several commissioned studies, doctoral dissertations, and federally-funded technology in education projects coordinated by the authors in conjunction with international colleagues over the past five years. It features evidence regarding the impact of information technologies on teacher training and student achievement, and spotlights trans-national trend analysis through common instrumentation as the technique believed to be the most promising research avenue for the future.

1.   INTRODUCTION

Quantitative assessments conducted since 1995 in several school systems in the USA and other parts of the world have yielded consistent and encouraging results regarding the influence of new information technologies on teacher and student attitudes, skills, and the use of technology tools. This paper summarises findings from several commissioned studies, doctoral dissertations, and federally-funded technology in education projects coordinated by the authors in conjunction with international colleagues over the past five years. It concludes with discussion of the evidence gathered to date regarding the impact of new information technologies on student achievement, and spotlights trans-national trend analysis as the technique believed to be the most promising research avenue for the future.

2.   FUNDED INSTRUMENTATION RESEARCH

During 1995-97 the authors were awarded research support from a University of North Texas endowed fund to construct instruments for assessing teachers' attitudes toward new information technologies. The result was the Teachers' Attitudes Toward Computers (TAC) questionnaire (Christensen and Knezek 1996) and the Teachers Attitudes Toward Information Technology (TAT) Questionnaire (Knezek and Christensen 1998). This development effort, which involved selecting and revalidating items from 15 separate computer attitude instruments, received recognition in its early stages in the form of a Best Quantitative Studies Award by the Society of Information Technology in Teacher Education (1997). During the ensuing years one or both of these instruments has been translated into Arabic, Chinese, Dutch, Japanese, Korean, Portuguese, Spanish, and Thai.

TAC and TAT development work was founded in earlier work funded by the Fulbright Foundation of Washington D.C., the Japan Society for the Promotion of Science, and the Texas Center for Educational Technology, concerning the measurement of student attitudes toward information technology at the elementary and secondary education level. Two instruments, the Young Children's Computer Inventory (YCCI) and the Computer Attitude Questionnaire (CAQ) were developed during the first half of the 1990s as part of this initiative. Findings regarding the impact of computer use by young children in Mexico, Japan, and the USA were reported at the Fifth World Conference on Computers in Education, in Birmingham, England (Knezek, Miyashita, and Sakamoto 1995). These were later merged with complementary findings from the Information Technology in Education and Children Project (ITEC) and the International Association for the Assessment of Educational Achievement Computers in Education Project (IEA-CompEd) in a book entitled *Children and Computers in School* (Collis, Knezek, Lai, Miyashita, Pelgrum, Plomp, and Sakamoto 1996). An instruments book featuring the YCCI, CAQ, TAC and TAT was released during the year 2000 (Knezek, Christensen, Miyashita and Ropp 2000b) and a book of multi-national findings based on this set of instruments was published in the year 2000 as well (Morales, Knezek, Christensen and Avila 2000).

3.   MAJOR FINDINGS ACROSS CULTURES

Several major cross-cultural findings related to information technology and education emerged from studies completed during the 1990s:

1. Early initial exposure to computers in school increases computer enjoyment by approximately 2/3 of a standard deviation. (Collis et al. 1996).
2. No gender differences were found in attitudes toward computers at the first grade level in Mexico, Japan, or the USA (Collis et al. 1996).
3. The only area where consistent gender differences were found at the first grade level was empathy (a caring concern for the thoughts and feelings of others) (Collis, et al. 1996). Females were found to have higher empathy than males for Japan, Mexico, and the USA. Empathy findings were also later replicated for older children in the USA and Mexico (Knezek and Christensen 2000, Morales et al. 2000).
4. Girls in the fourth through sixth year of school in selected populations may enjoy computers more than boys (Alamhaboub 2000, Knezek and Christensen 2000).
5. By approximately the seventh year in school and continuing throughout secondary education, boys appear to enjoy computers more than girls (Collis et al. 1996, Knezek and Christensen 2000).
6. Psychological impacts of appropriate technology integration appear to emerge within a relatively short time frame in students at the primary school level. For example, positive impacts on the perceived enjoyment and importance of computers appear to occur within the first three months of exposure to computers in school (Collis et al. 1996), and may possibly occur within the first six weeks of school (Knezek and Christensen 2000).
7. Measurable impacts related to achievement may take much longer to emerge. For example, evidence has been found of measurable positive impact ($p < .03$) of high- versus low-integrating teachers on student vocabulary, reading, and writing scores as measured by the Iowa Test of Basic Skills at the end of the fifth grade school year in the USA (Knezek and Christensen 2000), and measurable positive influence ($p < .01$) on motivation and study habits was found to emerge in Japanese primary school children in grades 1-3 after four years of school computer use (Collis, et al., 1996). In addition, significant associations have been found ($r = .34$, $p < .05$) in a study involving 100 Texas school districts, predicting average school district standardised achievement test score based on level of technology expenditures (Knezek, Christensen, Hancock and Shoho 2000a).
8. Teacher competence and confidence with Information and Communication Technology (ICT) is the principal determinant of effective classroom use by students (Collis et al. 1996).

9. Successful technology integration in a classroom environment appears to require will, skill, and access to technology tools on the part of the teacher (Knezek et al. 2000a).
10. Teacher advances in technology integration appears to proceed through a set of well defined stages, where the highest stages require changes in attitude more so than skills (Knezek and Christensen 2000).
11. Self-appraisal of level of technology integration can be effective in prescribing training for an educational professional (Knezek and Christensen 2000).

4.   FOCUSED DOCTORAL RESEARCH

Several doctoral dissertations have provided detailed analysis of selected topics in the area of ICT in education over the past five years. Some of those in which the authors have been directly involved include:
1. Christensen, R. (1997) Effect of technology integration education on the attitudes of teachers and their students. This doctoral dissertation featured three time-sequenced administrations of the TAC and YCCI in a large public elementary school in northern Texas, in order to assess the impact of needs-based technology integration education. The treatment of intensive summer start-up activities followed by monthly visitations by the lead trainer was found to be effective in enhancing the attitudes and skills of teachers. A unique feature of this dissertation was that it demonstrated that the impact of effective teacher training could be measured in terms of changes in attitudes on the part of the teachers and their students.
 2. Gilmore, E. (1998) Impact of Training on the Information Technology Attitudes of University Faculty. This dissertation employed the Faculty Attitudes Toward Information Technology questionnaire (Knezek et al. 2000b) which was produced by extracting selected scales from the TAC. Major findings based on surveys completed by 218 university faculty were that a university whose faculty participated in a semester-long ICT professional development initiative showed positive, broad-based gains in their attitudes toward information technology, while peers in comparable university without the training program did not.
 3. Hopson, M. H. (1998) Effects of a Technology Enriched Learning Environment on Student Development of Higher Order Thinking Skills. This dissertation employed the CAQ and Ross Test of Higher Cognitive Processes to assess the impact of technology enriched learning on 166 fifth and sixth grade students in a public middle school in Texas. The study demonstrated that a Technology Enhanced Learning Environment

significantly and positively impacted the development of the higher order thinking skill of 'Evaluation' for fifth grade students. The study also determined that exposure to technology is associated with positive student attitudes in the areas of computer importance, motivation, and self-reported creative tendencies.

4. Alamhaboub, S. F. (2000) Attitudes Toward Computer Use and Gender Differences among Kuwaiti Sixth Grade Students. The CAQ was used in this dissertation to survey 562 students from 10 public schools in Kuwait. Kuwaiti girls were found to be more positive than boys in their attitudes toward computers as well as in empathy. The study also verified that students who had computers at home had more positive attitudes toward computers than those who had access to computers only in school. In addition, the study found a significant correlation between Attitudes Toward Computers and Motivation, Study habits, Creative Tendencies, and achievement in the field of informatics.

5. Moonen, B. (2001) Teacher Learning in INservice Networks on Internet Use in Secondary Education. This dissertation focused on the integration of the Internet into foreign language teaching, and included TAC measurements gathered from all teacher network participants at four time periods. A key finding was that ongoing inservice training is effective in reducing anxiety and increasing productivity in trainees. A major conclusion was that support in the form of coaching activities is important to solidify effective instructional utilisation. This work also pointed out that groups of trainees with different initial ICT skill levels may require different lengths of intensive support before their attitudes change, and that attitudes change in phases, by type. Specifically anxiety reduction took place relatively quickly during the initial year of the project while a reduction in avoidance and a positive change in the perception of usefulness of ICT for professional productivity did not occur until after the project had been in place for two years.

5.   FINDINGS FROM FEDERALLY-FUNDED PROJECTS

Since 1999, the authors have participated in two large projects funded by the U.S. national government related to technology, teaching and learning. One is a five-year, $9.2 million U.S. Department of Education Technology Innovation Challenge Fund grant for which they are serving as external evaluators. The other is a four-year, $940,000 U.S. Department of Education Preparing Tomorrow's Teachers to Use Technology (PT3) grant for which

they are Principal Investigator and Internal Evaluator, respectively. First year findings from each of these projects have produced many interesting results.

6.   FINDINGS REGARDING TEACHERS

Teachers' proficiency with technology. Findings from data analysis gathered from more than 500 teachers in a Texas school district using a technology proficiency questionnaire (Ropp 1999) indicate that the professional development activities carried out with these teachers during the 1999-2000 school year were highly effective in advancing the skills of teachers. The impact was strong in all four areas selected as relevant to teaching with technology: E-mail skills, WWW skills, classroom use of Integrated Applications, and incorporating methods of Teaching with Technology.

Stages of Adoption of technology. In the study cited in the previous paragraph, teachers also completed the one-item Stages of Adoption (Christensen 1997) survey. Findings from the survey indicate that these teachers advanced as a group throughout the 1999-2000 school year approximately one stage of adoption on a six-stage scale, moving from: *Stage 4: Familiarity and confidence* (I am gaining a sense of confidence in using the computer for specific tasks. I am starting to feel comfortable using the computer.) and moving toward: *Stage 5: Adaptation to other contexts* (I think about the computer as a tool to help me and am no longer concerned about it as technology. I can use it in many applications and as an instructional aid.) Teacher profiles for attitudes at various stages of adoption of technology clearly delineate different levels of enthusiasm and anxiety with respect to integrating technology into the classroom.

Needs and beliefs. Teachers in the 1999-2000 Texas study reported a sizable gain in expertise in several of the skill areas identified as important to the project goals and objectives. Teachers' general beliefs and needs fell into four major categories, and remained reasonably stable from the beginning to the end of the school year. Specific item level needs that changed to a great extent from the fall to the spring were: 1) a lesser need for training in how to use the computer and 2) a greater need to be trained in teaching techniques and strategies to integrate technology into the curriculum.

7.   FINDINGS REGARDING STUDENTS

Computers vs. television. YCCI data gathered from 1737 K-6 students during the fall of 1999 and spring of 2000 from the eight elementary schools

in Texas indicate that high technology-integrating teachers at the first grade level rapidly influence the preference of their students toward using computers over the more passive medium of watching television.

High vs. low integration classrooms. Across grades 1-3, looking at the classroom environment from a pre-post perspective, we find that among teachers who were low integrators of technology, student Attitudes Toward Computers (p<.001), Attitude Toward School (p<.05), Computer Importance (p<.01) and Computer Enjoyment (p<.02) declined significantly from the first to the last six-weeks of school. The students of the teachers who had been previously identified by their principals as high integrators of technology also had a significant decline in Attitudes Toward School (p<.02) but yet increased significantly for Computer Enjoyment (p<.02).

Lack of home computer access. The general impact of technology integrating teachers over several months, across grades 1-6, appears to have been the greatest in the area of Attitudes Toward Computers on students without computers at home. This is evidenced by significant (p < .01) declines in student attitudes toward computers, from fall to spring, among those students without home access to computers who also had low integrating teachers in school.

Changes across grade levels. Student dispositions as a whole tended to decline from the younger grade levels to older grades (grade 1 to grade 6). This is similar to trends found in past studies (Knezek et al. 1995, Christensen 1997). Although all measured attitudes declined, the three indices related to computers declined less across grade levels than other learning-related dispositions.

Gender differences. With respect to student dispositions by gender, girls in north Texas were significantly higher than boys in Empathy, Computer Enjoyment, Attitude Toward School, Motivation to Study, and Study Habits as of fall 1999. During spring 2000, the girls remained significantly higher than boys in Attitudes Toward School and Empathy, while boys became significantly higher on the Motivation subscale.

Skills and attitudes among secondary students. Based on CAQ information gathered from 1507 grade 7-12 Texas students during 1999-2000, secondary school students appear to have positive attitudes toward information technology and most learning-related dispositions. Their information technology skills showed healthy growth during the 1999-2000 school year, to a point where they approached the level of their teachers (Knezek and Christensen 2000). Their relatively low (and declining with increasing age) ratings on attitudes toward school are consistent with studies conducted at the elementary school level and findings from earlier studies using the same scales (Christensen 1997, Knezek et al. 1995). This data, even with its senior year positive spike, may be more of an indictment of our

modern system of education in general, rather than of the policies and/or teaching methods found in these district schools.

8.   ADVANTAGES OF INTERNATIONAL COLLABORATION

Great benefits have been found to accrue from international collaboration in the study of ICT in education. The most obvious is the rich exchange of ideas and the opportunity for consensus identification of research topics believed to be important worldwide. Less obvious but equally important is the ability to use common instruments to identify trends that hold true in several nations and cultures (and some that do not). For example, international collaboration between Mexico and the USA has allowed researchers to conclude that even though the level of access to information technology is very different in these two nations, teachers' beliefs about the usefulness of ICT for improving teaching and learning are very similar in Mexico and the USA.

International collaboration can also be useful for proving that trends thought to be universal may not necessarily hold true for every nation or culture in the world. For example, after several years of studies confirming that females are generally measurably higher in empathy than males, even if no other gender differences are found on a battery of instruments, preliminary results have emerged from Colombia indicating that the opposite may be true in that nation. Further research is needed to determine if these findings can be replicated, and, if they are replicated, why the trend in this nation is different from what appears to be the norm in most of the world. Only though international comparisons was special attention called to this finding in Colombia. These and other comparisons can benefit researchers from any nation who are attempting to answer similar questions about the impact of technology on teaching and learning.

9.   SUMMARY AND REFLECTIONS

Over the past ten years, trans-national research based on universally agreed upon ICT instruments has yielded a number of enlightening findings regarding students and teachers. The only consistent gender difference observed in students at the first grade level is in the area of empathy, where females are already more empathetic than males. This difference between males and females seems to persist throughout elementary and secondary

education. Past research has revealed that ICT attitudes are not generally differentiated based on gender until around grade four. Historically, males' attitudes toward ICT have become more positive than females as they progress through their schooling. However, there is emerging evidence at the 4th through 6th grade level that females may be evolving toward a greater enjoyment of computers than their male counterparts in this age range.

Teachers' attitudes toward ICT are clearly multi-faceted (with at least seven underlying dimensions) and tend to become more positive due to ongoing, needs-based training across attitudinal types. Anxiety tends to be reduced rather quickly with meaningful exposure to ICT. On the other hand, enthusiasm/acceptance of ICT and belief in the utility of ICT for professional productivity is slower to evolve. It appears that other types of attitudes take longer to change, in the time frame of years rather than months.

Teachers' beliefs regarding the usefulness of ICT in education appear to be surprisingly consistent as of the year 2000 across several nations and cultures. This is true in spite of widely varying levels of connectivity and access to other ICT resources. Conversely, teachers' perceived needs are strongly dependent on level of access to ICT resources and current stage of adoption of technology in education. As teachers progress from lower level, simple applications toward full integration of technology in the classroom in support of higher cognitive functions, attitudes progress in predictable patterns along with changes in their needs. The highest stage of integration involves a change in perception of teaching with technology rather than additional training or resources. While many of these findings have been replicated in multiple studies and in multi-national contexts, research in almost every area is far from conclusive and is still ongoing.

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BIOGRAPHY

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