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ABSTRACT

The Will, Skill, Tool (WST) model of technology integration (G. Knezek, R. Christensen, R. Hancock, and A. Shoho, 2000) postulates that enhancing an educator's will, skill, and access to technology tools leads to higher stages of classroom technology integration, which in turn leads to greater student achievement. In this paper, regression analyses and structural equation modeling techniques are presented representing a wide variety of data sets from Texas public schools in order to test combinations of observed variables that optimize the WST model fit statistics. Data sets were: (1) survey responses of 39 teachers in a metropolitan area; (2) data from 100 public school districts about funding and student achievement; (3) data about integration of technology from 12 teachers and their 170 first- and second-grade students; (4) technology integration data from the same 12 teachers; and (5) data from 1,267 K-12 teachers about classroom technology integration. The analyzed of these data sets support the use of the WST model. Implications for educational evaluation and policy are discussed. (Contains 19 references.) (SLD)

Testing a Will, Skill, Tool Model of Technology Integration

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Testing a Will, Skill, Tool Model of Technology Integration[1]

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Abstract

The Will, Skill, Tool (WST) model of technology integration (Knezek, Christensen, Hancock & Shoho, 2000) postulates that enhancing an educator's will, skill, and access to technology tools leads to higher stages of classroom technology integration, which in turn leads to greater student achievement. In this paper, regression analyses and structural equation modeling techniques are presented representing a wide variety of data sets from Texas public schools in order to test combinations of observed variables that optimize the WST model fit statistics. Implications for educational evaluation and policy are discussed.

Key words: technology integration model, student achievement, attitudes toward technology, technology competency

Conceptual Rationale

The school learning environment.

Learning in school has been recognized as a complex issue for many decades. For example, in 1975, Klausmeier and Goodwin identified 37 variables in nine major categories that affect the school learning environment. Among these were items such as instructional goals and objectives, student intellectual ability, teacher interest and knowledge of subject matter, home-school-community relations, physical space and equipment characteristics, and availability of print and audiovisual instructional materials (Klausmeier & Goodwin, 1975, p. 13).

In 1999, the U.S. Department of Education established a $75 million funding initiative aimed at producing 2,000,000 new technology-using educators capable of integrating information technologies into daily classroom practice (Preparing Tomorrow's Teachers to Use Technology Program, 1999). Calls for gauging the impact of this infusion of technology into the nation's classroom also accompanied the funding, and, in 1999, the Milken Exchange on Education Technology identified seven major categories of variables intended to "... help policymakers answer the question, 'What is the return on the public's investment in K-12 learning technology?'"(Coughlin & Lemke, 1999, p.38). Many of these are similar to the categories of

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variables affecting the school learning environment that were identified by Klausmeier and Goodwin twenty-four years earlier.

The search for positive impact.

Much recent research in educational technology has focused on impact. Researchers have been generally successful in demonstrating the positive impact of technology infusion with appropriate teacher training on teacher attitudes toward information technology, student attitudes toward information technology, and other learning-related student dispositions such as motivation (Woodrow, 1992; Collis, et al., 1996; Christensen, 1997). Instruments have been developed by several researchers to aid in this process (Christensen & Knezek, 1998; Knezek & Christensen, 1998; Ropp, 1999; Christensen & Knezek, 1999; Knezek & Christensen, 2000). Researchers have been less successful in identifying positive impacts of technology infusion on student achievement, although some studies have met with success. For example, a review of 130 studies by Bailo and Sivin-Kachla (1995) concluded that using technology to support instruction improves student outcomes in language arts, math, social studies, and science. An evaluation of the West Virginia Basic Skills/Computer Education program concluded that "... the effective use of learning technology has led directly to significant gains in math, reading and language arts skills in West Virginia" (Mann, Shakeshaft, Becker & Kottkamp, 1999). More commonly, however, findings have been mixed.

Method

The approach advocated in this paper is multivariate in nature, based on the development and testing of a formalized model for integrating technology into the classroom. The Will, Skill, Tool model of Technology Integration targets the influence of the teacher on the classroom portion of the school, and further restricts the area of interest in the classroom to technology integration. The model also incorporates the influence of technology integration on student achievement.

Figure 1 contains several indicators of teacher attributes in the areas of will, skill, and tool. Two indicators of classroom integration, and three indicators of student achievement are listed as well. These indicators are conceptually associated with constructs using conventions that have become common in structured equation modeling (Schumacker, 1996).

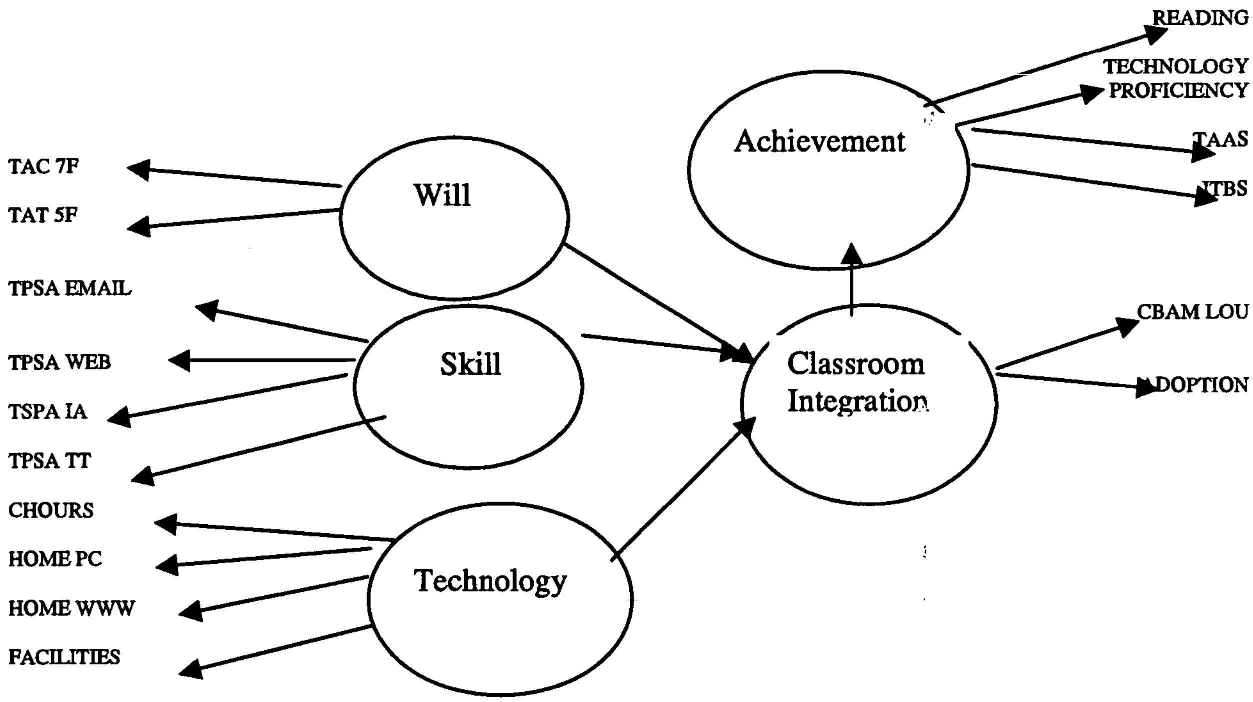

Figure 1. Will, Skill, Tool Model of the Impact of technology integration on achievement.

Study 1: 1999 Teacher Data

The 1999 preliminary test of the model used survey responses gathered during the fall of 1999 from teachers in a public high school in the Dallas Ft. Worth Metroplex area of northern Texas. Thirty-nine teachers completed the following battery of instruments:

- The Teachers' Attitudes Toward Computers Questionnaire (TAC 5.1) (Christensen & Knezek, 1998) measures seven indices regarding teachers' attitudes.

- Teachers' Attitudes Toward Information Technology Questionnaire (TAT) (Knezek & Christensen, 1998) is a semantic differential instrument that measures attitudes toward new information technologies .

- The Technology Proficiency Self-Assessment (TPSA) (Ropp, 1999) measures technology skills in four areas identified by the International Society of Technology in Education as key for their National Educational Technology Standards (NETS).

Two self-reported outcome measures were also included in the battery of instruments. One was the Level of Use Questionnaire (CBAM_LOU) based on the Concerns-Based Adoption

Model/Level of Use scale for diffusion of innovation (Hall, Loucks, Rutherford, & Newlove, 1975), and the other was the Stages of Adoption of technology in education scale (STAGES) developed by Christensen (1997), based on the earlier work of Russell (1995).

Three demographic variables indicating level of access to technology tools were included in the set of 1999 data available to researchers, as well. These were teachers' current hours per week using information technology in the classroom (CHOURS), whether or not teachers had access to a computer at home (HOME_PC or HOMECOM), and whether or not teachers had access to the World Wide Web at home (HOMEWWW).

Results of 1999 Teacher Data Analysis

Ideally structured equation modeling (Schumacker, 1996; Joreskog, & Sorbom, 1998) would have been employed to determine how well the model fit the data, but its use was not attempted for the 1999 data set due to the small data set and large number of degrees of freedom in the model (R.E. Schumacker, personal communication, December 7, 1999). Therefore, regression analysis was chosen to explore how well will, skill, and technology tools could place an individual in the proper stage of adoption.

Impact of Will, Skill, and Tools on Technology Integration

Impact of Will. A regression analysis verified that approximately 40% of the variance in stage of adoption is attributable to "will" measures for these teachers. The R-squared for stage of adoption predicted from the TAT attitude scales (EmailT, WWWT, MMT, ProdT, ProdCl) was .39 (Knezek, Christensen, Hancock & Shoho, 2000).

Impact of Will and Skill Combined. For the 1999 set of thirty-seven secondary teachers, adding skill measures to the equation increased the predictability of stages of adoption of technology from roughly 40% to 70%. The R-squared for Stages predicted from TAT attitude measures and TPSA skill measures is .69 (Knezek, Christensen, Hancock & Shoho, 2000).

Combined Impact of Will, Skill and Access to Technology Tools. Adding measures of access to technology tools for teachers increased the predictability of stages of adoption from 70% to 84% for this set of data. The R-squared for TAT attitudes, TPSA skills, and the three tool variables of current hours per week using technology in the classroom (CHOURS), access to a computer at home (HOMECOM) and access to the WWW at home (HOMEWWW), was .84.

Study 2: 1999 Funding and Student Achievement Data

A second data set was compiled to further test the model introduced in 1999. This analysis explored the relationship between available variables representing both ends of the technology infusion-to-student-achievement continuum. The Texas Assessment of Academic Skills (TAAS) test pass rate, and district wide average SAT score, were used as dependent variables. District-wide hardware expenditures, and district-wide expenditures on software and technology supplies, are the two independent variables used to indicate extent of support for information technology facilities. The data were gathered by randomly selecting 100 of approximately 1046 public school districts in the state and recording their scores from the Texas Academic Excellence Indicator System (AEIS).

SAT Scores. Hardware and software expenditures together accounted for approximately 12% of the variance in SAT scores across the sample of school districts (R squared = .115) (Knezek, Christensen, Hancock & Shoho, 2000). This relationship is significant at the .05 level (f = 3.25, 2 x 50 df, p = .0472).

TAAS Pass rate. Hardware and software expenditures together account for approximately 11% of the variance in TAAS pass rates across school districts (R squared = .11). This relationship is also significant at the .05 level (f = 3.70 , 2 x 58 df, p = .0307).

Limitations of 1999 Analyses

Only thirty-nine teachers from one school are represented in the data for the portion of the model dealing with stage of adoption predicted as a function of will, skill, and access to technology tools. A much larger sample was needed to test all components of this portion of the model in a structured equation modeling paradigm. In addition, just one indicator of technology integration (stages) had been utilized, but in structured equation modeling, multiple indicators for each construct are preferred. Similarly, only 100 school districts were included in the current analysis of the relationship of technology investment to two measures of student achievement. The research team concluded that a comprehensive test of the portion of the model dealing with the impact of classroom technology integration on student achievement probably required lowering the unit of analysis to the classroom level. These modifications in research design were incorporated in studies 3 and 4 described in the following sections.

Study 3: 2000-2001 Technology and Reading Achievement Data

Data were gathered from twelve first- and second-grade teachers from a suburban north Texas public school district and their 170 students during the fall of 2000 and again during the spring of 2001. Teachers provided Stages of Adoption and CBAM Level of Use ratings. Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1998) were administered to students as pretest and post test measures, using the subtests Word Identification, Word Attack, and Passage Comprehension. Stages of Adoption and CBAM Level of Use were used as indicators of the latent variable "classroom integration" while pre-post reading difference scores were used as indicators of "student achievement". As shown in Figure 2, the resulting path coefficient from integration to achievement, in an SEM model with acceptable fit statistics, was .35.

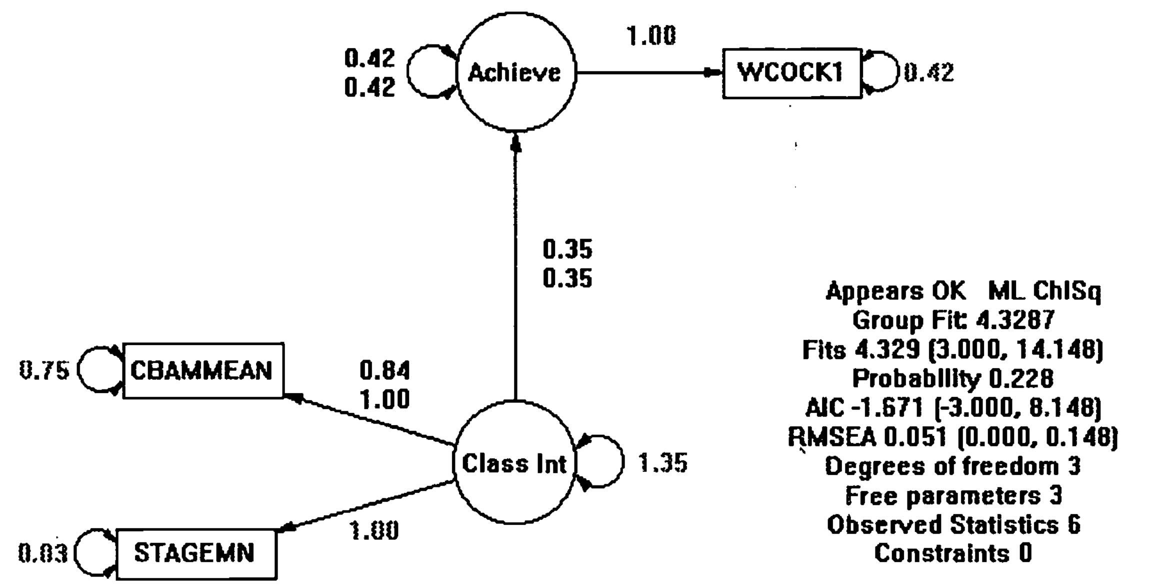

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Figure 2. Structural equation model for Woodcock Reading Mastery Tests score gains as a function of level of classroom technology integration.

Study 4: 2000-2001 Technology Integration Data from Teachers

Will (attitude) and Skill (technology proficiency) and Tool (access to technology tools) data from the twelve teachers described in Study 3 were submitted to an SEM analysis to determine if classroom integration could be well predicted by will, skill, and tool indicators. As shown in Figure 3, Skill appeared to be a strong predictor of classroom integration for these teachers, while Will was a weaker but acceptable predictor. Incorporation of the Tool latent variable did not result in an acceptable fit statistic for this group of teachers.

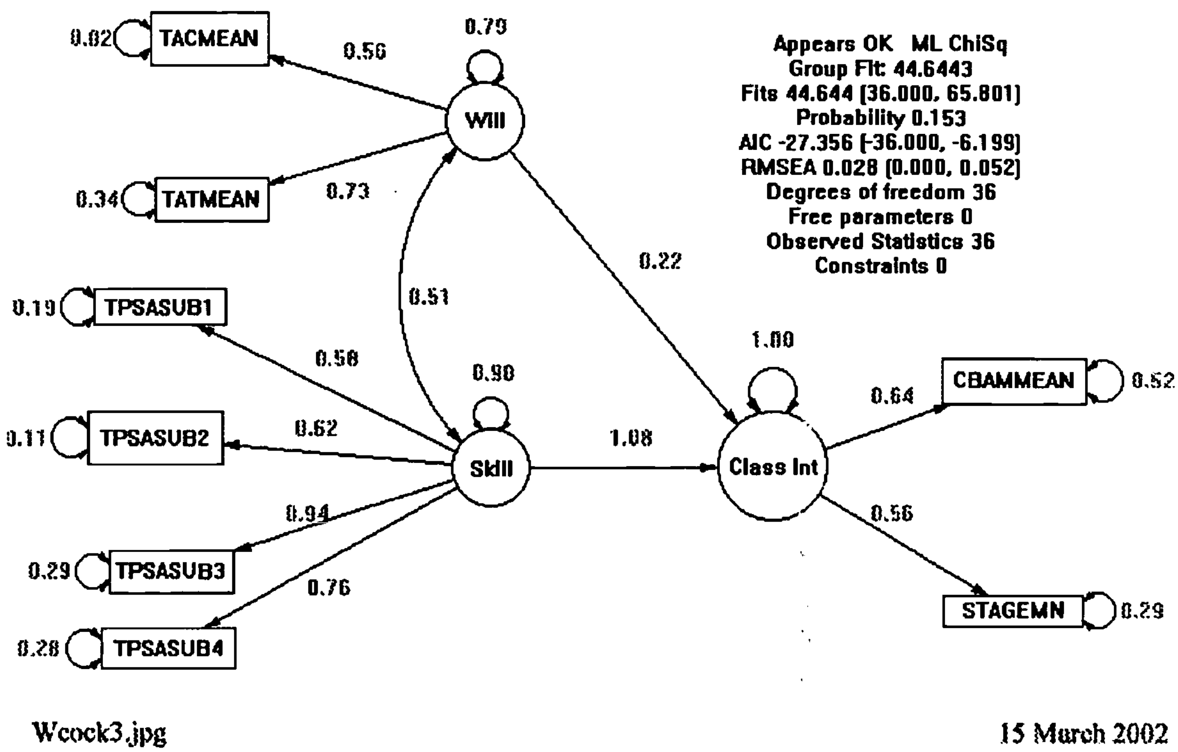

Figure 3. Structural equation model for classroom technology integration as a function of teacher will and skill.

Study 5: 2002 Will, Skill, Tool and Technology Integration Data from Teachers

Data were gathered from 1267 K-12 teachers representing all 37 schools in a suburban public school district of Texas during April of 2002. Preliminary analysis of this data indicates that Will, Skill and Tool latent variables form an acceptable collection of predictors of classroom technology integration (as measured by Stages of Adoption and CBAM Level of Use). Additional research is underway to gather a comprehensive set of data that will enable testing both the teacher (technology integration) side of the model and the student (learner outcome) side of the model from teacher and student data gathered within a set of schools in the same timeframe.

Summary/Conclusions

While the effectiveness of the teaching and learning process has long been recognized as a complicated issue, technology adds another dimension to the assessment of elements that are contributing factors to a student's quality of education. A new model for integrating technology into the classroom is presented along with analysis showing that technology investment can contribute to student achievement. The model includes three key elements for successful integration of technology: Will (attitude) of the teacher, Skill (technology competency), and Technology Tools (access to technology tools). The model also postulates that technology integration in the classroom contributes to higher student achievement. Preliminary analysis of this model has yielded promising results.

The current emphasis on accountability for technology expenditures in the USA has spawned a quest for evidence of positive impact on student achievement, especially at the K-12 level. Since the primary environment in which learners and teachers interact with information technology is evolving to be the classroom, a formalized model of technology integration facilitates systematic testing of theorized relationships. One important aspect to be tested is the predictability of classroom technology integration based on teacher measures of will, skill, and access to technology tools. Another important aspect is the predictability of student achievement based on level of technology integration. Findings to date indicate this two-step model is worthy of further exploration.

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