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THE WILL, SKILL, TOOL MODEL OF TECHNOLOGY INTEGRATION: ADDING PEDAGOGY AS A NEW MODEL CONSTRUCT

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ABSTRACT

An expansion of the Will, Skill, Tool Model of Technology Integration to include teacher's pedagogical style is proposed by the authors as a means of advancing the predictive power for level of classroom technology integration to beyond 90%. Suggested advantages to this expansion include more precise identification of areas to be targeted for teacher professional development, and the prospect for aligning teaching-with-technology style with student learning styles, in order to better serve educational system goals such as student engagement, learning and achievement. Initial findings are that pedagogical preference or style with old and new technologies accounts for approximately 30% of level of classroom technology integration. The authors contend this is worthy of retaining as a fundamental model improvement.

KEYWORDS

Technology integration, predictors, will, skill, pedagogy, access to technology tools.

1. INTRODUCTION

Since 2005 the authors have surmised that the Will, Skill, Tool Model of Technology Integration (WST) unveiled at the turn of the century (Knezek, Christensen, Hancock, & Shoho, 2000) and shown in Figure 1, might be improved by having pedagogical practice (teaching style) "become a full partner in the model" (Hancock, Knezek, & Christensen, 2007, p. 91). A higher order factor analysis (Dunn-Rankin, Knezek, Wallace & Zhang, 2004) completed in 2014 indicated that one of the original model's measurement scales, Teaching with Technology (TWT), and a newly developed measurement scale, Emerging TWT, clustered together in a higher order domain tentatively labeled Pedagogy (Christensen & Knezek, 2014). This prompted the authors to conduct a preliminary test of the integrity of Pedagogy as a separate model construct. This paper details the procedures employed and reports on the initial outcomes of testing the Will, Skill, Tool, Pedagogy Model of Technology Integration (WSTP).

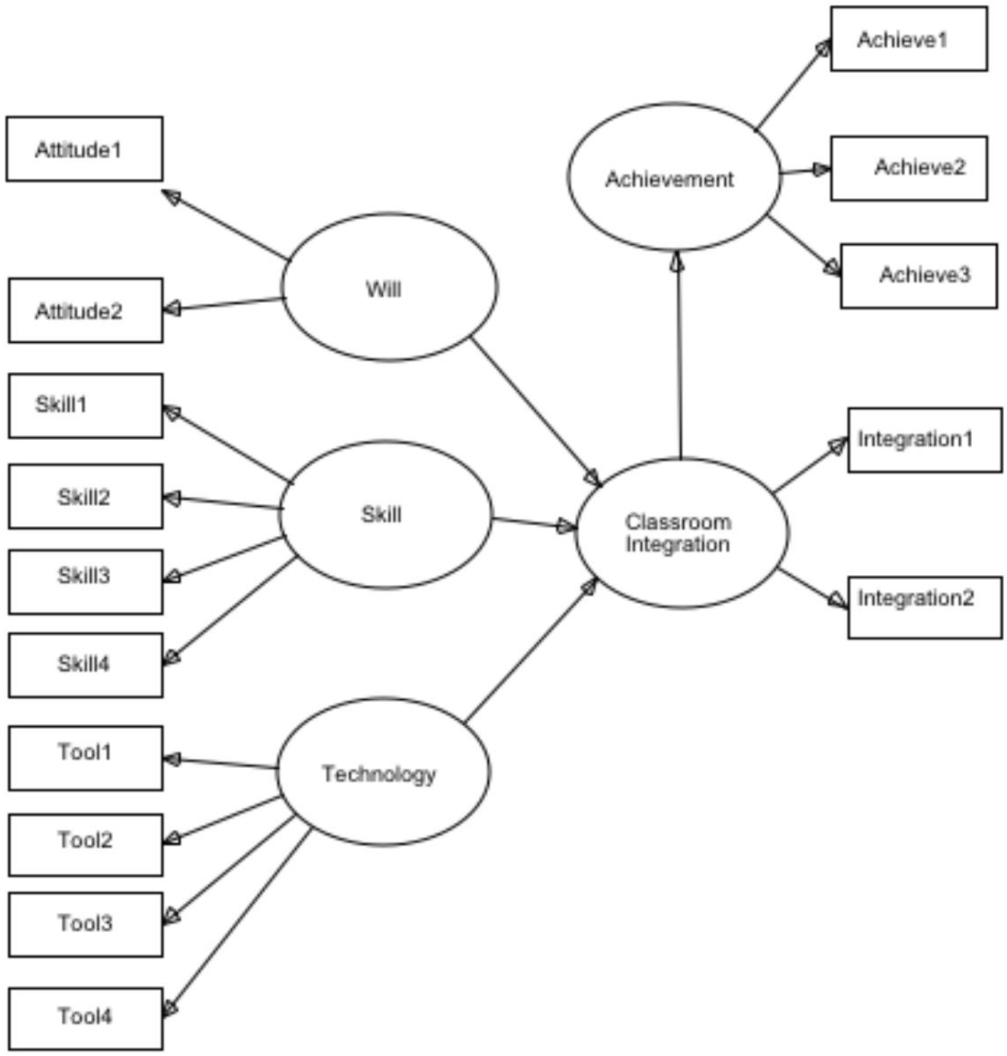

Figure 1. Will, Skill, Tool Model of the impact of technology integration on academic achievement.

2. DEVELOPMENT OF THE WST MODEL

2.1 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.). A complete listing of the variables and categorizations developed by Klausmeier and Goodwin are provided in Table 1.

Table 1.Variables affecting the school learning environment

I. Objectives
  1. Outcomes incorporated
  2. How formulated
  3. How used

II. Subject matter
  1. Kind; e.g., language arts, music
  2. How organized
  3. How sequenced

III. Instructional materials
  1. Kind: printed, audiovisual
  2. Quality
  3. Availability

IV. Characteristics of the learner
  1. Level of achievement and intellectual abilities
  2. Physical maturity and related psychomotor abilities
  3. Affective characteristics: interests, motives, attitudes, values, emotional expressions
  4. Health
  5. Self-concept
  6. Perception of situation
  7. Age
  8. Sex

V. Characteristics of the teacher
  1. Knowledge of subject matter, development, learning, and teaching skills
  2. Psychomotor abilities and physical attributes
  3. Affective characteristics; interests, motives, attitudes, values, emotional expression
  4. Health
  5. Self-concept
  6. Perception of situation
  7. Age
  8. Sex

VI. Classroom interactions
  1. Student-student
  2. Student-teacher
  3. Teacher-teacher
  4. Teacher-Administrator

VII. Organization for instruction
  1. Elementary level: self-contained classroom, team arrangements, departmentalized
  2. Secondary level: departmentalized in separate subjects - self-contained, team arrangements; broad fields - self contained, team arrangements

VIII. Physical characteristics
  1. Space
  2. Supplies
  3. Equipment, etc.

IX. Home-school-community relations
  1. Teachers of particular children – Parents of children
  2. Total school - Total neighborhood
  3. Total school district - Total community

Note. Adapted from Klausmeir & Goodwin, 1975, p 13.

2.2 Consolidation of Attributes

Knezek and Christensen (Knezek, Christensen, Hancock, & Shoho, 2000) created a simplified environmental model for student learning in the WST model. In this model the 37 attributes identified by Klausmeir & Goodwin (1975) were consolidated into three categories focused on learning in a classroom environment aided by the integration of technology. The three-construct WST model is shown in left-hand portion of

Figure 1. The authors also developed a second stage of the WST model focused on predicting the impact of classroom technology integration on achievement. This was in response to the U.S. Department of Education's 1999 calls for gauging the impact of the infusion of technology into the nation's classrooms (Preparing Tomorrow's Teachers to Use Technology Program, 1999). Also 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.3.8). Since the initial model was introduced, other researchers such as DeMars (2001) have identified the need to build effective models to deal with the multiple variables. This second stage of the WST model, which focuses on the impact of classroom technology integration on student achievement, is shown in the right-hand portion of Figure 1.

3. APPLICATIONS OF THE WST MODEL

Knezek, Christensen, and Fluke (2003) found using 1999 – 2001 data that 70% to 84% of teachers level of technology integration could be predicted based on measures of Will, Skill, and Tool, while 8-12% of first and second grade technology intensive reading achievement was attributable to level of classroom technology integration. Morales, Knezek, Christensen, and Avila (2005) examined 10 teacher school district samples spanning 2001 - 2005 and found Will, Skill, and Tool accounted for 64 - 83% of the variance in technology integration proficiency for practicing teachers. Morales (2006) conducted a transnational study of the model using refined measures for seven samples of teachers from Mexico and the USA and concluded 90% to 96 % of classroom technology integration could be attributed to Will, Skill, and Tool measures for these teachers. The total variance explained by the model was more than 90% for all samples, with the trend being that Skill was the strongest predictor of technology integration in the USA, whereas Tool was the strongest predictor in Mexico (Morales & Knezek, 2007). Petko (2012) used the WST model with self-selected measures to determine the impact of constructivist teaching style on the use of digital media in classrooms. Five factors accounted for a total of 60% of the variance in the intensity of use of Information and Communication Technologies. Among these factors were teacher confidence in their competence, access to technology, teacher belief in the power of technology to improve learning and frequency of constructivist forms of teaching and learning (Petko, 2012).

4. UPDATED MODEL SPECIFICATION

The findings by Petco (2012), as described in the previous section, served as an added impetus for the authors of the current work to examine the possible benefits of isolating pedagogical style as a separate construct in an extension of the basic WST model. According to the original model shown in Figure 1, the constructs Will, Skill, and Tool independently influence the Integration of technology in the classroom. Will is conceptually defined as a positive attitude toward the use of technology in instruction; Skill as the self perceived confidence and readiness to use technology; Tool is related to the accessibility and use of technology; and Integration as a self perceived level of technology adoption for educational purposes. Each one of the constructs was operationally defined by several measures:

Will was defined by two measures: Subscales from the TAC and TAT.
Skill was defined by four measures: Email, World Wide Web, Integrated Applications, and Teaching with Technology (TWT) from the TPSA.
Tool was defined by Home access and Classroom access to technology.
Integration was defined by three measures: Stages of adoption, CBAM, and ACOT, as detailed later.

The additional construct of Pedagogy is being added to enhance the model. Watkins and Mortimore (1999, p.17) offered a definition of pedagogy as 'any conscious activity by one person designed to enhance learning in another'. For the purposes of expanding the WST Model, Pedagogy includes teaching style (constructivist, behaviorist, etc.) and in the case of technology integration, the level of confidence teachers feel in their use of technologies to enhance learning for their students.

5. CURRENT CONSTRUCT INDICATORS

5.1 Measures of Will

The Teachers' Attitudes Toward Computers 5.1 Questionnaire (TAC) (Christensen & Knezek, 1998) measures seven indices regarding teachers' attitudes. These scales are: F1 - Enthusiasm/Enjoyment, F2 - Anxiety, F3 - Avoidance/Acceptance, F4 - Email for Classroom Learning, F5 - Negative Impact on Society, F6 - Productivity, and F7 - Semantic perception of computers. The reliabilities for these subscales typically range from .87 to .95 with K-12 teacher data.

The Teachers' Attitudes Toward Information Technology Questionnaire (TAT) (Knezek & Christensen, 1998) is a semantic differential instrument that measures attitudes toward new information technologies including email (variable coded as EMAILT), the World Wide Web (WWWT), multimedia (MMT), technology for teacher productivity (PRODT) and technology for classroom learning (PRODCL). Reliabilities for these scales typically range from .91 to .98 for K-12 teachers.

5.2 Measures of Skill

The Technology Proficiency Self-Assessment (TPSA) (Ropp, 1999) measures technology skills in the following areas: E-mail (TPSA_EMT or TPSA_EMAIL), Integrated Applications (TPSA_IA or TPSA_IAT), use of the World Wide Web (TPSA_WEB) and Emerging Tools. Reliabilities typically range from .81 to .87.

5.3 Measures of Tool

Measures of access to technology Tools include the number of computers available to the teacher in the classroom as well as teacher home access to a computer and teacher home access to the Internet.

5.4 Measures of Pedagogy

The updated version of the Technology Proficiency Self-Assessment (TPSA), TPSA C21, includes two measures of pedagogy, Teaching with Technology (TWT) from the original instrument and, Teaching with Emerging Technologies (Emerging TWT) such as smartphones and social media, from the updated TPSA. Reliabilities typically range from .87 to .93 (Christensen & Knezek, 2014).

6. OUTCOME MEASURES

Three self-reported outcome measures were also included in the battery of instruments administered to teachers. 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), while another was the Stage of Adoption of Technology in Education scale (Stages) developed by Christensen (1997), based on the earlier work of Russell (1995). The third instrument was based on work of Dwyer, Ringstaff, and Sandholtz (1990) for the Apple Classrooms of Tomorrow (ACOT) Project, and is called the ACOT Teacher Stages instrument. Each of these is a single-item instrument that cannot be easily checked for internal consistency reliability. However, test-retest reliabilities for several groups of K-12 teachers have shown reliabilities to typically be higher than .8. Research by Hancock, Knezek and Christensen (2007) demonstrated that the three indices used together as a Technology Integration scale produced Cronbach's Alpha = .84. For many research studies using these measures, the authors produce a unidimensional factor score based on extracting the "true" score for each teacher across the three measures, and use this as the technology integration (outcome) measure.

7. RESULTS

Summary results of the 2011-2014 series of analyses are displayed in Table 2. As shown in Table 2, Teaching with Technology (Pedagogy, aka Technological Pedagogical Knowledge) alone can explain 33 percent of classroom technology integration. Not shown in Table 2 is that the old TWT portion of Pedagogy is currently a much stronger indicator of technology integration (beta = .446) than the Emerging TWT (beta = .147) based on smartphones and other newer technologies. However, both are significant contributors ($p < .05$). It is anticipated that the Emerging TWT will become more important in the future.

Other analysis details not shown in Table 2 demonstrated that among the Technology Proficiency Self-Assessment (Skill) measures, Email skills contributed very little to the regression prediction (beta = -.017, p = .793), once the TWT indicators were included (TWT beta = .446, $p < .0005$; Emerging TWT beta = .137, p = .046), and the contribution of WWW skills was also small (beta = .101; p = .216). Interestingly, Integrated Applications (Microsoft Office Tools) turned out to be the strongest predictor (beta = .363, $p < .0005$) on the entire TPSA instrument, but Emerging Tech Skills (beta = .123, p = .049) was also a significant contributor to classroom technology integration.

The Tool measures summarized in Table 2 collectively contributed at least nine percent of level of classroom technology integration for this group of educators. Among these, Student Classroom Use (beta = .145, p = .015) and Home Hours of Use by the teacher (beta = .159, p = .003) were the strongest contributors.

Implications of the initial exploratory analyses were that the Will, Skill, Tool Model of Technology Integration might benefit from placing a fourth predictive construct for the technology integration model, called Pedagogy, into the model. As shown in the first RSQ column of Table 2, the components of Skill, Tool, and Pedagogy were able to account for 28 percent, nine percent, and 30 percent respectively, of the percentage of the construct *Technology Integration* for the 2014 data set in this study. In addition, as shown in the last column of Table 2, a parallel school district data set from 2011 that also included measures of Will (Teachers Attitudes Toward Computers, TAC) (Christensen & Knezek, 2009) in the professional development assessment battery of instruments administered to 1648 teachers, produced comparable regression coefficients to the 2014 study for the three components identified in the data set. Further analysis of the 2011 data set indicated that 29 percent of Technology Integration could be attributed to the scales comprising Will. The expanded WST Model (WSTP) is shown in Figure 2.

Over interpretation regarding the strength of each of these predictors is cautioned because some portion of the variance predicted by one scale set (for example, Skill) would likely also be able to be predicted by another scale set (for example, Pedagogy), and in fact the sum of the RSQs for the four model components in the second column of Table 2 is more than 100 percent. Nevertheless, these exploratory findings provide hope that a formal structural equation modeling (SEM) approach to testing the WSTP model might confirm the predictive power of a four-component model of technology integration to be beyond the previously reported 90 percent (Morales, 2006; Morales & Knezek, 2007; Knezek & Christensen, 2008), and approaching 100 percent. The authors plan to test this conjecture when the volume of teacher data acquired covering all four components of the model, and using the new TPSA, surpasses n = 1500.

Table 2. Prediction ability of Will, Skill, Tool, and Pedagogy indicators

Model Component	Indicator	RSQ Current data set (2014) (n = 466)	RSQ – Prior data set (2011) (n= 1648)
Will	TAC Subscales 2 (Tech Comfort), 6 (Utility), 8 (Absorption) were sig.		.29
Skill	TPSA 1 (Email), 2 (WWW), 3 (IntApp) (Email was NS)	.28	.29
Tool	Home use, student use, access	.09	.15
Pedagogy	TPSA Teaching with Tech	.33	.30

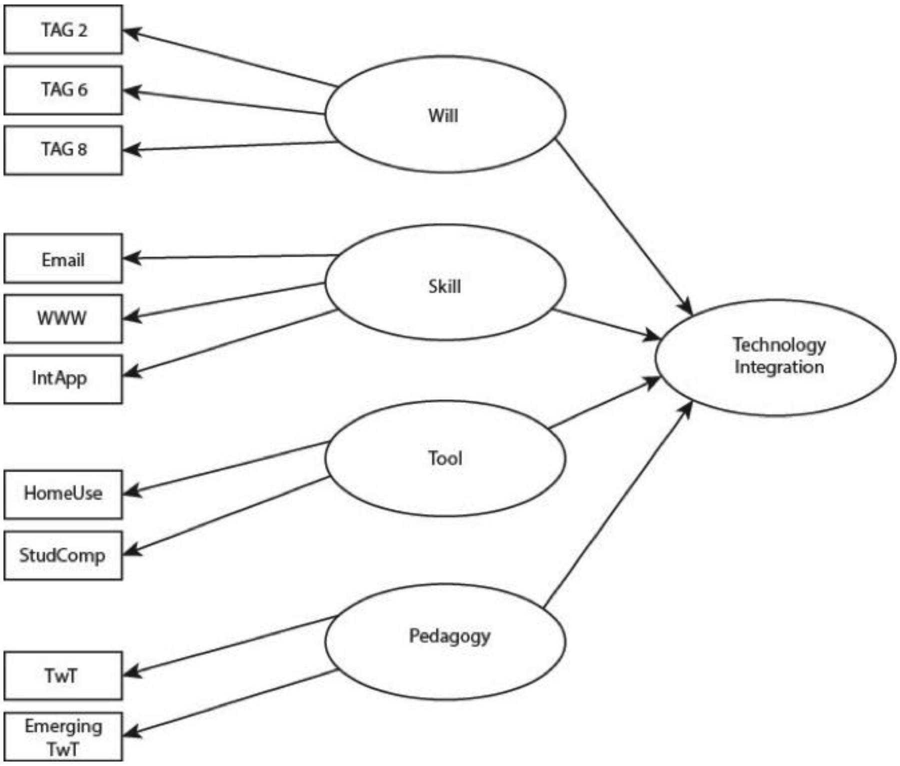

Figure 2. Expanded will, skill, tool model of technology integration, including pedagogy.

8. DISCUSSION

Previous studies (eg. Morales, 2006) found that the strength of the regression-style coefficients for the major model components varied depending upon the local context in which the teachers providing the data resided. For example, for the Morales (2006) study, level of technology-using Skill development was found to be the strongest predicator of technology integration for teachers in the U.S., while for teachers in Mexico, extent of access to technology Tools was the most important predictor. The implication is that the domain in which the local environment has the greatest variability becomes the strongest predictor. The authors of the current paper have found from other studies (Christensen & Knezek, 1999) that for teachers who are near the highest level of technology integration, it is the Will to push forward that becomes the greatest predictor. By following these analogies, we can infer that among the 2014 and 2011 data sets featured in this paper, pedagogical style (Pedagogy) is likely to have the greatest variability among the teachers surveyed, since it accounted for 33% (2014 data) and 30% (2011 data) respectively, of teacher's level of technology integration (see Table 2). The leadership of school districts might wish to provide alternative professional development activities for teachers from different pedagogical schools of thought, in order to better support this diversity.

9. CONCLUSION

Initial testing of the expanded Will, Skill, Tool Model of Technology Integration indicates that Pedagogy as a predictive construct has empirical support from recently-gathered data and promises to bring new perspectives to the realm of initiatives for technology-intensive teacher professional development. In addition to enhancing the ability of the WST model to predict beyond 90% of a teacher's level of technology integration in his or her classroom, it is likely that elucidating the importance of pedagogical style of the teacher will bring more focus on aligning teaching with the preferred learning styles of students. This could enable educational practitioners to push beyond the 8-12% per year of positive impact on student achievement previously identified as attributable to level of classroom technology integration.

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