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Abstract

While research in the field of education suggests teachers are using technology more frequently, a tool for gauging this use was needed to provide educators with feedback regarding best practices. This study focused on the development and pilot of an Instrument for measuring levels of integration within constructivist learning environments as noted by the indicators in the Technology Integration Matrix (TIM) model. Analyses conducted in the study showed the questionnaire to be a highly valid and reliable instrument in terms of measuring the model. Recommendations were made for its use in Pre-K - 12 settings as well as in teacher education.

Gauging Technology Use in Pre-K – 12 Classrooms

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Abstract

While research in the field of education suggests teachers are using technology more frequently, a tool for gauging this use was needed to provide educators with feedback regarding best practices. This study focused on the development and pilot of an instrument for measuring levels of integration within constructivist learning environments as noted by the indicators in the Technology Integration Matrix (TIM) model. Analyses conducted in the study showed the questionnaire to be a highly valid and reliable instrument in terms of measuring the model. Recommendations were made for its use in Pre-K - 12 settings as well as in teacher education.

Introduction

For approximately two decades, society has witnessed the permeation of the Internet in America's public schools. During this time period, the number of classrooms with access to the Internet has drastically increased. A report by the National Center for Education Statistics (NCES) indicated that in 1994 a mere 3% of classrooms were connected to the Internet, while in 2005 this figure soared to 94% (Wells & Lewis, 2006). In conjunction with increased Internet access, greater availability of computer equipment, and advances in technology, students of the 21st Century enter schools with a high degree of tech savvy and need for unique kinds of learning experiences (Brumfield, 2006).

Consequently, such technological shifts have increased the demands on educators in terms of integrating technology into classroom practices. In the results of a survey conducted by Quality Educational Data (QED), teachers reported classroom technology usage was on the rise. Veteran educators, at least ten years in the field, reported seeing a dramatic change in the way technology was incorporated into daily instruction (as cited in Brumfield, 2006). However, in his book, *Oversold and Underused*, Larry Cuban (2001) argued that only a minority of the nation's teachers actually adopt and integrate technology into daily instruction. Furthermore, in a Podcast interview (Hargadan, 2006), Cuban estimated that only 10% of the nation's teachers truly incorporate technology into their instruction from once a week to daily. In light of these figures, the development of a valid and reliable instrument designed to gauge classroom technology practices was warranted.

The focus of this study was on the development and pilot of the Technology Integration Matrix Questionnaire (TIMQ) for measuring the frequency of technology use in Pre-K–12 settings. Four research questions guided the study concentrating on content validity, reliability of integration level constructs, reliability of constructivist constructs, and parallel forms reliability.

The Technology Integration Matrix Model

In an effort to classify the kinds of technology-related learning activities that can occur in classrooms, researchers from the Florida Center for Instructional Technology (FCIT) at the University of South Florida created a model known as the Technology Integration Matrix (TIM). Comprised of 25 unique indicators, the TIM describes learning activities in terms of five characteristics in the constructivist learning environment along a continuum of integration levels (FCIT, 2007). Though tools have been created to gauge classroom practices involving technology, no device for measuring the specific indicators in the Matrix existed (Personal communication, Roy Winkelman, January 3, 2009).

The TIM model was based on two pivotal works: one describing the learning environment in terms of attributes of meaningful learning and the other regarding distinct levels of integration along a continuum. In their work, *Learning to solve problems with technology: A constructivist perspective,* Jonassen, Howland, Moore, and Marra (2003) identify five attributes of meaningful learning which promote engaged learning through technologically enhanced means: *Active*, *Constructive*, *Intentional*, *Authentic*, and *Cooperative*. Constructivist theory differs from behaviorism, which uses conditioning strategies to teach students, in that it places the emphasis on students' prior knowledge to make meaning of new information.

While various perspectives exist regarding the progression and implementation of integrating technology in classrooms, the prevailing view is one where integration occurs along a continuum with various stages or levels of synthesis being attained over time and in diverse settings. Integration refers to the process of synthesizing technology with lessons and instructional delivery in order to provide engaging learning experiences for children (Dias, 1999). In their work with the Apple Classrooms of Tomorrow study, Sandholtz, Ringstaff, and Dwyer (1997) divide the stages of the integration continuum into five categories: *Entry*, *Adoption*, *Adaptation*, *Appropriation*, and *Invention.*

Method

In alignment with constructivist thought, the TIM deemphasizes the actions of teachers and instruction while emphasizing the involvement of students in their own learning and the construction of meaning. In other words, the TIM is considered a student-centered framework versus a teacher-centered instructional tool. Consequently, this student-centered approach was incorporated into the language of the TIMQ, "Students in my class/classroom…" resulting in a draft instrument of 62 questions. The first 12 questions were designed to gather pertinent demographic data from teachers. The remaining 50 questions, intended to measure the 25 indicators as framed in the TIM, were developed based upon the researcher's review of the pivotal works on which the model was designed (Jonassen, Howland, Moore, & Marra, 2003; Sandholtz, Ringstaff, & Dwyer, 1997; FCIT, 2007).

Two expert panels were assembled to evaluate the survey questions. The first expert panel included original developers of the TIM, university professors, and technology leaders from selected school districts. The second expert panel consisted of two subgroups. One subgroup included Pre-K – 12 technology teacher-leaders from a participating school district. The second subgroup included teachers who were involved in a graduate program at a local university.

The first panel of experts established content validity providing feedback on the draft survey through discussions on a Moodle platform, through a Web-based prototype of the questionnaire, and within a WIKI environment also located on the researcher's Moodle site. Feedback was organized and examined according to each of the survey items and then modified accordingly. The 50 items were then modified to measure each indicator. The second panel members were asked to rate their level of understanding and their perception regarding other teachers' level of understanding for each question. After revisions were made to the items, the questionnaire was administered to a pilot sample of 498 teachers in Kansas and Florida. The purpose of the pilot was to establish reliability using Cronbach's alpha and parallel forms correlation analyses.

Results

The results included findings from content validity, item total reliability, and parallel forms reliability. In terms of validity, drafts of the instrument were consistently checked during each phase of the study regarding its content. A final check by the first expert panel indicated that almost all of the 50 items accurately and completely measure the corresponding indicators with the exception of some minor wording modifications to three items and accompanying examples.

Regarding item total reliability, because of the two-dimensional structure of the TIM, with each dimension containing five constructs, ten Cronbach's alpha coefficients were calculated from the data. The first five coefficients were generated for the integration level constructs as identified by the columns in the TIM: *Entry*, *Adoption*, *Adaptation*, *Infusion*, and *Transformation* (see Table 1). All resulting coefficients were well above the established standard of 0.8 (Howitt & Cramer, 2005) showing the measures for this dimension of the TIM to be highly reliable. The remaining five coefficients were generated for the constructivist characteristic constructs as identified by the rows in the matrix: *Active*, *Collaborative*, *Constructive*, *Authentic*, and *Goal Directed* (see Table 2). Once again, the resulting coefficients for these constructs were well above the established standard of 0.8 showing the measures for this dimension of the TIM to be highly reliable.

The final analysis of the data from the pilot consisted of the calculation of correlation coefficients for six parallel forms configurations of the TIMQ in order to address the reliability of each of the two items that measured each of the 25 TIM indicators. A Pearson product-moment correlation was generated to compare the parallel forms of the six A/B configurations. All of the correlations indicated that both of the items used to measure each of the indicators provided reliable measurement of that indicator (see Table 3).

Discussion

Based on the results, the TIMQ was proven a reliable measure of technology usage frequency in terms of levels of integration in conjunction with characteristics of the constructivist learning environment as framed in the TIM. Such an instrument could provide school leaders and, more importantly, teachers themselves with a tool for reflecting upon individual practice and for enhancing school and district improvement efforts. Because the TIMQ tool gauges deeper kinds of learning through activities ranging from basic to complex, the results can serve as a roadmap for those who are uncertain as to where to begin.

Other uses of the TIMQ could include assessing the technology practices of prospective teachers in field experiences. The instrument could be of benefit to graduate programs in education that include a technology component or have a complete emphasis on educational technology. The TIMQ could also be used by program coordinators to determine if there is a difference in candidates' practices at the beginning of the program and the end of the program.

Overall, the findings appear to indicate little to medium frequency levels of usage for most of the activities described by the 25 indicators in the Matrix. These data seem to corroborate Cuban's belief that a small percentage of teachers incorporate technology into instruction (Hargadan, 2006). Though it was not significant in determining the validity and reliability of the TIMQ, a low inter-item correlation within one construct prompted a recommendation for the FCIT regarding the revision of wording for one of the indicators in the TIM model. In conclusion, the TIMQ fills a niche that does not currently have measurement tools for assessing levels of integration within constructivist environments from a student-centered perspective.

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Table 1

Integration Construct Correlations (N = 498)

Construct	Items	α
Entry	Q1, Q2, Q11, Q12, Q21, Q22, Q31, Q32, Q41, Q42	0.83
Adoption	Q3, Q4, Q13, Q14, Q23, Q24, Q33, Q34, Q43, Q44	0.90
Adaptation	Q5, Q6, Q15, Q16, Q25, Q26, Q35, Q36, Q45, Q46	0.93
Infusion	Q7, Q8, Q17, Q18, Q27, Q28, Q37, Q38, Q47, Q48	0.93
Transformation	Q9, Q10, Q19, Q20, Q29, Q30, Q39, Q40, Q49, Q50	0.91

Table 2

Constructivist Characteristic Construct Correlations (N = 498)

Construct	Items	α
Active	Q1 - Q10	0.88
Collaborative	Q11 – Q20	0.91
Constructive	Q21 - Q30	0.86
Authentic	Q31 - Q40	0.93
Goal Directed	Q41 - Q50	0.89

Table 3

Parallel Forms Correlations (N = 498)

Form	*R*
A1/B1	0.96
A2/B2	0.96
A3/B3	0.97
A4/B4	0.96
A5/B5	0.96
A6/B6	0.96

Characteristics of the Learning Environment	Levels of Technology Integration into the Curriculum				
	Active Entry	**Active Adoption**	**Active Adaptation**	**Active Infusion**	**Active Transformation**
	Collaborative Entry	**Collaborative Adoption**	**Collaborative Adaptation**	**Collaborative Infusion**	**Collaborative Transformation**
	Constructive Entry	**Constructive Adoption**	**Constructive Adaptation**	**Constructive Infusion**	**Constructive Transformation**
	Authentic Entry	**Authentic Adoption**	**Authentic Adaptation**	**Authentic Infusion**	**Authentic Transformation**
	Goal Directed Entry	**Goal Directed Adoption**	**Goal Directed Adaptation**	**Goal Directed Infusion**	**Goal Directed Transformation**

Figure 1. Technology Integration Matrix

From: FCIT. (2007). *Technology integration matrix.* Retrieved December 16, 2008, from http://fcit.usf.edu/matrix. Adapted with permission of the Florida Center for Instructional Technology.

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