

**Determining Educational Technology and Instructional Learning
Skill Sets (DETAILS):
A New Approach to the LoTi Framework for the 21st Century**

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Introduction to the Original LoTi Framework

In keeping with the requirements of the federal *No Child Left Behind* law (U.S. Department of Education, 2002), administrators and educators are attempting to integrate technology more systematically and comprehensively into their students' classroom learning experiences. At the same time, *No Child Left Behind* requires the use of evaluation tools and techniques that are rooted in scientifically based research principles. This presents an additional challenge to overburdened school districts, as they must now accurately measure how well, and for whom, their technology integration efforts are working.

The original Levels of Technology Implementation (LoTi) Framework (Moersch, 1995) sought to address these concerns by providing a structured way of assessing the degree to which teachers are using technology in the classroom—and, most importantly, whether such efforts lead to noticeably improved teacher instructional practices and student learning outcomes. Initially developed by Dr. Chris Moersch, Director and Co-Founder of the National Business Education Alliance, the LoTi Framework views technology as a highly interactive form of learning with potentially significant and sustainable effects on both teachers and students. The fact that this learning format is often difficult to put into practice and subsequently evaluate suggested the need for a standardized approach to measuring classroom technology implementation with greater accuracy—an objective that has defined the LoTi Framework from the very beginning. (For more detailed background information, refer to <http://www.loticonnection.com/whatisloti.html>).

Within the LoTi Framework, there are six separate surveys for the following personnel: (a) higher education faculty; (b) school administrators; (c) media specialists; (d) instructional specialists; (e) inservice teachers; and (f) preservice teachers. The inservice teacher survey is the original instrument developed by Dr. Moersch and subsequently used to create the remaining five versions, each containing

slight wording adjustments to reflect the different professional roles. Given that the inservice teacher survey represents the initial design, it will hereafter be referred to as the LoTi Survey.

In its originally conceptualized format, the LoTi Survey attempted to measure three distinct areas of classroom technology practices among teachers: (a) Level of Technology Implementation (LoTi); (b) Personal Computer Use (PCU); and (c) Current Instructional Practices (CIP). The Level of Technology Implementation (LoTi) category consisted of 40 questions divided among seven discrete levels ranging from Nonuse (Level 0) to Refinement (Level 6), with Level 4 (Integration) divided into two subtypes (Mechanical and Routine). Each LoTi level was constructed to reflect different stages of classroom technology implementation. As teachers progressed to higher levels, their instructional curriculum would ideally reflect this forward movement from a largely teacher-centered to a more learner-centered orientation (e.g., computer technology becomes a central tool in helping students become actively engaged in their learning through such strategies as authentic hands-on instruction). In addition to the LoTi category, the Personal Computer Use (PCU) and Current Instructional Practices (CIP) categories each contained five items, with items in the CIP category designed to assess the extent to which teachers' instructional practices are student-centered, collaborative and constructivist (Moersch, 1995).

According to the LoTi website (<http://www.loticonnection.com/lotiresearch.html>), the LoTi Framework's six separate surveys have thus far been implemented in 20 states and numerous school systems around the world. In addition, the LoTi Survey is aligned with various state and national standards, including the Texas STaR Chart, Florida STaR Chart, and ISTE's NETS and TSSA (C. Moersch, personal communication, September 30, 2004). Furthermore, the different LoTi survey versions have been utilized in over 30 current or impending dissertation studies nationwide, with abstracts available for viewing on the LoTi website.

The Next Step Forward: Targeting Teachers' Professional Development Needs

Clearly, the LoTi Framework has enjoyed a long and successful history of implementation, both for the purposes of conducting research and to meet school-based instructional goals. In this regard, the LoTi Framework has served an important role since its inception by helping teachers develop greater

awareness about their comfort level and perceived skill in implementing technology in the classroom. However, with the passage of time and the increasingly rigorous requirements imposed on schools to improve students' academic achievement, Dr. Moersch recognized the need to expand upon the original LoTi Framework by focusing more intensively on the content and format of teachers' professional development experiences relevant to their actual classroom technology implementation. Specifically, how might teachers better utilize the concepts expressed in the original LoTi Framework to prioritize their professional training needs and subsequently increase their implementation of technology in the most meaningful, student-centered ways possible?

The answer to this question lies in an updated approach to the original LoTi process: the DETAILS Survey (Determining Educational Technology and Instructional Learning Skill Sets.) According to Dr. Moersch, "The new DETAILS for the 21st Century provides classroom teachers with a specific and individualized roadmap with which to improve their instructional curriculum in the classroom; sustain student interest and engagement in the learning process; elevate their use of technology in the classroom; and most importantly, prepare students for their successful emergence into a 21st Century world. DETAILS represents the next generation of LoTi."

With this objective in mind, the current study seeks to craft the DETAILS survey as a new professional development assessment framework based on empirically derived, reliable and valid constructs. The ultimate goal is that the DETAILS Survey will be better able to identify and categorize teachers' professional development priorities as they relate directly to teachers' instructional practices, thereby helping teachers reach a higher level of classroom technology implementation more quickly and efficiently than in the past.

Empirical Analysis of Survey Instruments: An Overview of the Critical Components

In order to carry out empirical analyses of survey instruments, there are specific statistical concepts pertaining to both reliability and validity that must be adequately addressed. One such concept is internal consistency (inter-item reliability), or the degree to which survey items reflect homogenous traits (Cohen & Swerdlik, 2004). Calculating internal consistency reliability is essential with instruments such

as the DETAILS Survey that claim to measure a common trait, behavior or other indicator (e.g., “technology implementation”). In contrast, other forms of reliability are less essential or relevant for the purposes of the DETAILS Survey. For instance, inter-rater/inter-scorer reliability is critical for measurement tools that may rely on the judgment of more than one person (e.g., observation rating scales) in contrast to self-reported instruments such as the DETAILS Survey. Additionally, test-retest reliability (or stability of scores over time) would not be applicable to the DETAILS Survey given its ultimate objective—to help teachers increase their technological skill level and subsequent classroom technology implementation over time through targeted professional development. In this case, teachers’ DETAILS Survey scores would ideally increase from one survey administration to the next, thereby negating the need for stability of scores. (For a detailed discussion of appropriate reliability analyses for different testing and assessment contexts, see Allen & Yen, 1979).

Regarding evidence of validity, three categories are considered essential for survey development and implementation: (a) content, (b) construct, and (c) criterion-related (Standards for Educational and Psychological Testing, 1999). Content validity represents the first step in the validation process and reflects a judgment about how well survey items appear to adequately sample the entire range of whatever trait or behavior is being measured (Cohen & Swerdlik, 2004; Standards for Educational and Psychological Testing, 1999). According to Dr. Moersch, formal development of the original LoTi Survey began in 1997, with the goal of designing a paper-and-pencil questionnaire that was easy to use, score and interpret. The LoTi Survey’s theoretical framework is grounded in the work of David Dwyer and Apple Classrooms of Tomorrow (ACOT). ACOT’s 13-year research efforts revealed that introducing technology into classrooms alongside new approaches to curriculum, instruction and authentic assessment can substantially increase students’ overall learning potential, particularly when such technology is used to promote collaborative partnerships, access to information, and students’ expression of thoughts and ideas (ACOT, 2004, ¶ 4,5).

The LoTi Survey’s format and item structure is reflective of the Concerns-Based Adoption Model, which asserts that people who are facing or experiencing change tend to move through

progressively more complex reactions and hierarchical behavioral levels as they explore how they might be affected by their altered circumstances. This model is based on the assumption that the process of learning inevitably brings about change, and that people must be supported throughout the change process in order for the learning to become more deeply rooted (Hall & Loucks, 1979). Using the model as a guide, the original LoTi Survey items were developed over two years in partnership with a panel of instructional technology educators employed by the Los Angeles Unified School District.

As described previously, the original LoTi Survey was subjected to an intensive, highly collaborative developmental and review process over time. Therefore, based on its theoretical framework and expert panel involvement, the original LoTi Survey appears to demonstrate acceptable content validity through a representative item sampling of the survey's different content domains.

An important accompaniment to content validity is construct validity, which refers to how accurately the survey measures a hypothetical construct of interest, including the accuracy of survey scores in reflecting a person's standing on the construct (Cohen & Swerdlik, 2004; Standards for Educational and Psychological Testing, 1999). While construct validity is essential to the relevance and meaningfulness of the actual survey items, criterion-related validity demonstrates how well a survey reflects one's standing on an objective, non-self-reported external criterion outside of the survey itself (e.g., a standardized test of technology skills) (Cohen & Swerdlik, 2004; Standards for Educational and Psychological Testing, 1999.) This type of validity is particularly important for self-report instruments that depend on participant responses.

Although both construct and criterion-related validity are essential components of the survey development process, the current study focuses on construct validity as the critical starting point for expanding the focus of the original LoTi Survey to better capture the depth of teachers' professional development needs and identified areas for targeted training. To this end, the current study will address the following two questions:

1. What is the resulting factor structure for the expanded version of the LoTi Survey (DETAILS) as revealed by large, randomly selected sample groups of teachers who completed the original LoTi Survey?
2. What is the internal consistency reliability for the expanded version of the LoTi Survey (DETAILS) within a large, randomly selected sample group of teachers who completed the original LoTi Survey?

Methodology for the DETAILS Survey Analysis

Participants

The sample group was derived from the comprehensive database of 47,956 pre-kindergarten, elementary and secondary inservice teachers who completed the original LoTi Survey during the 2003-2004 academic year. Of this total, approximately 21% were culled due to missing survey item data, leaving 37,698 for the final sample. From this group, a random subsample of 3,770 (approximately 10% of the culled sample) was selected for analysis.

Exploratory Factor Analysis: Procedure and Results

Exploratory factor analysis was conducted to determine the best structural fit for the DETAILS Survey. Determining the number of factors to extract occurred collectively through (a) Barlett's chi-square test (Geweke & Singleton, 1980), with rejection of an identity matrix outcome ($p < .0001$) and suggestion of as many as 17 factors to extract; (b) parallel analysis using 100 replications of common factor analysis with random data (Buja & Eyuboglu, 1992), with a suggested 7 factors to extract; and (c) minimum-average partial correlation, a more conservative estimate of the number of factors based on common variance (Velicer, 1976), with a suggested 5 factors to extract.

Based on these combined procedural outcomes, different five-factor, six-factor and seven-factor models were subjected to common factor analysis (see Gorsuch, 1983, for detailed discussion of factor analytic techniques and their appropriate use). Squared multiple correlations represented the initial communality estimates, with the following three separate rotations conducted to maximize simple structure and obtain the highest hyperplane count, or amount of near-zero loadings on a factor: (a)

varimax (orthogonal) rotation; (b) equamax rotation (combines varimax and quartimax methods to disperse variance evenly across dimensions); and (c) promax (oblique) rotation (see Gorsuch, 1983, for more information about rotational methods). A five-factor promaxian solution ($k = 3$, 47.6% hyperplane count) based on initial equamax rotation yielded the most robust simple structure, with 12 of the original 50 items being eliminated from the final model due to multiple loadings on more than one factor, poor final communality estimates and salience $< .40$ —all of which act to reduce simple structure.

Table 1 displays the 38-item, five-factor promaxian model ($N = 3,770$) for the new DETAILS Survey with accompanying rotated factor pattern loadings. The fact that the DETAILS Survey's item structure is best reflected by a promaxian solution supports the obvious overlap between items in terms of their content. Conversely, a varimax or equamax solution would suggest that items are largely uncorrelated.

For reference purposes, the five new DETAILS Survey factors and their correspondence to the original LoTi Survey categories are listed below:

Name of DETAILS Survey Factor	Number of Items	Correspondence to Original LoTi Survey
Factor 1: Using Technology for Complex Student Projects Requiring Problem Solving, Critical Thinking and Real World Applicability	12	Level 2 (2 original items) Level 3 (4 original items) Level 4b (1 original item) Level 5 (3 original items) Level 6 (2 original items)
Factor 2: Teacher Proficiency with Using Technology	7	Personal Computer Use (PCU) category (5 original items) plus 2 additional items
Factor 3: Student Influences on Teachers' Current Instructional Practices	5	Current Instructional Practices (CIP) category with all 5 original items retained
Factor 4: Dependence on Resources and Assistance to Increase Comfort Level in Using Technology	7	Level 1 (1 original item) Level 2 (2 original items) Level 3 (1 original item) Level 4a (3 original items)
Factor 5: Challenges to Teachers' Use of Computers in the Classroom	6	Level 0 (5 original items) plus 1 additional item

Internal consistency for the resulting five-factor solution was computed using Cronbach's alpha. While all five factors reveal strong internal consistency values ranging from .66 - .93, the first factor clearly represents a unidimensional construct ($r = .93$). In other words, Factor 1's internal consistency is high enough to suggest that its item content reflects, in essence, the central focus of the new DETAILS Survey.

To determine each factor's relationship to the others, Table 2 presents the bivariate interfactor correlation matrix. Although the correlations between the first and second factor ($r = .68$) and between the first and third factor ($r = .61$) were moderately high, none of the correlations was high enough to rule out conclusively the possibility that unique and reliable variance existed within each factor. Therefore, exploratory higher-order factor analysis was conducted to explore the possibility of a second-order structure, yielding a two-factor solution that accounted for 72.4% of the total variance among all five first-order factors (refer to Table 2). This outcome further supports the contention that the DETAILS Survey domains are strongly intercorrelated, rather than representing highly distinctive and strictly independent measures of technology implementation.

Continuing with higher-order factor analysis, specificity (coefficient alpha - communality) was calculated to determine the proportion of variance unique to each scale. Specificity values that fell above error variance ($1 - \alpha$) were considered significant determinations of the proportion of both the unique and reliable variance within each scale (McDermott, 1993). Variance partitioning (common, specific, error) revealed that unique variance was greater than common variance for all five first-order factors, signifying that each factor represents a discrete, reliable dimension (although Factor 2 loaded saliently on both higher order factors—albeit less so on the second higher-order factor—indicating overlap in content). Therefore, although the DETAILS Survey clearly has validity as a unidimensional measure of teachers' levels of technology implementation, the results of higher-order factor analysis also suggest that the DETAILS Survey has validity in capturing five different (though somewhat interdependent) categories of technology implementation.

As additional confirmation of the five-factor promaxian solution, oblique, multiple-group,

principal-components cluster analysis (Harman, 1976) was conducted, whereby items were allowed to gravitate to empirically defined dimensions that better accounted for item variance. As Table 1 reveals, the multiple R^2 values indicate that all but one item fit best within their hypothesized dimension in contrast to the next-best dimension. However, as observed in Table 1, the single item that failed to fit best with its hypothesized dimension had a separation of only .09 between its best and next-best dimension fit—arguably a small enough value to lend support for the DETAILS Survey’s achieved five-factor structure as a whole.

Further confirmation of the DETAILS Survey’s five-factor solution occurred through invariance testing with random split halves ($n = 1,885$) as well as three random subsamples ($n = 1,200$, $n = 1,100$, $n = 1,000$) derived from the full participant group ($N = 3,770$). Table 3 reveals the results of invariance testing, which clearly indicates that the five-factor solution is replicable across multiple random subsamples of teachers who previously completed the original LoTi Survey.

Conclusions and Next Steps

Given that the new DETAILS Survey contains five reliable and valid constructs, teachers now have a powerful empirically based tool for better understanding and prioritizing their professional development needs and concerns regarding their classroom technology implementation.

In terms of the DETAILS Survey’s empirical outcomes, the domains that did emerge as statistically reliable and valid fall within one of two general categories: (a) confirmation of three of the original LoTi Survey categories (Loti Level 0, Personal Computer Use and Current Instructional Practices); and (b) establishment of two new conceptual frameworks for helping teachers understand their technology implementation practices. Regarding the two newly established constructs (Factor 1: Using Technology for Complex Student Projects Requiring Problem Solving, Critical Thinking and Real World Applicability; and Factor 4: Dependence on Resources and Assistance to Increase Comfort Level in Using Technology), there are both empirical implications and practical realities to consider. As suggested by its name, Factor 4 should certainly be used to help teachers better understand and more directly address their

discomfort with using technology for instructional purposes. However, Factor 1 is of greatest importance empirically, given its highly homogenous item content and resulting unidimensional structure—meaning that the DETAILS Survey’s central empirical focus lies in teachers’ use of technology to develop complex, higher-order student learning projects. From an instructional perspective, this area of focus comports with the more advanced levels of Bloom’s Taxonomy, a widely used instructional model that helps teachers construct learning activities reflecting different levels of human thinking and cognitive processing (Bloom, Engelhart, Hill, Furst & Krathwhol, 1956). Practically speaking, therefore, teachers’ Factor 1 scores could be applied in conjunction with Bloom’s Taxonomy to help teachers see how their technology implementation practices coincide with (or detract from) their efforts to instill higher-order thinking and problem-solving skills in their students. This option is just one of numerous examples illustrating how the DETAILS Survey can help make teachers’ professional development experiences more applicable and meaningful to their daily classroom activities.

While such outcomes and potential usages for the DETAILS Survey are certainly encouraging, it is important to recognize that this survey, like all measurement instruments of its kind, may be affected by such factors as the potential for bias in its self-report format and the representativeness of teachers who complete the survey. Regarding the latter issue, future DETAILS Survey administration should continue requesting information about participants’ school districts, grade levels and subject specialties, as well as begin collecting information about participants’ gender classification, racial/ethnic background and specific educational context (e.g., inner-city, suburban, rural). Because these and other demographic variables may have a significant impact on how teachers respond to survey items, it is recommended that such information be routinely gathered and analyzed for all future DETAILS Survey administrations in order to increase the survey’s generalizability to inservice teachers as a whole.

In addition, the DETAILS Survey’s empirical value will be further enhanced through ongoing construct validation efforts over time. For example, convergent validity (a subtype of construct validity) could be calculated to determine if DETAILS Survey responses correlate significantly with other reliable and valid measures of teachers’ technology implementation/integration that reflect similar constructs. As

another example, a randomized experimental study could be conducted to determine if teachers who receive targeted professional development in technology implementation strategies (treatment group) obtain higher DETAILS Survey scores than teachers who receive no such training (control group). If treatment group scores are significantly higher, the DETAILS Survey's construct validity would again be reinforced. (For more information about acceptable ways to establish construct validity, see Cohen & Swerdlik, 2004).

Furthermore, construct validation of the other five original LoTi Survey versions should ultimately occur to ascertain whether similar response patterns emerge. Specifically, it must be determined whether the five factors that appeared in the DETAILS Survey's inservice teacher version are replicable across large random samples of high school faculty, school administrators, media and instructional specialists, and preservice teachers. This multifaceted validation process is particularly important to ensure that all school personnel are given the chance to receive high-quality professional development assessment and subsequent prioritization of their technology implementation training needs.

Finally, the DETAILS Survey's criterion-related validity should eventually be established in order to complete the validation process. As noted in a previous section, criterion-related validity is particularly important when working with a self-report instrument. Ideally, the DETAILS Survey's empirical domains as determined through the current study would correlate significantly with a non-self-reported criterion (e.g., a standardized test or rubric) that reflects teacher proficiency with classroom technology implementation and subsequent student achievement.

In conclusion, the fact that the new DETAILS Survey has both empirical merit and practical utility makes it an especially useful tool for schools and districts as they seek to provide teachers with meaningful professional development experiences pertaining to classroom technology implementation. In this manner, the DETAILS Survey is well positioned to assist the entire educational community as a "new generation" approach to the LoTi Framework for the 21st century.

Table 1

Exploratory Common Factor Analytic and Confirmatory Cluster Analytic Structures for the DETAILS Survey (N = 3,770)

Original LoTi Survey Item	Rotated Loading		Confirmatory Cluster Analysis ^c		Loading
	Promax ^a	Item-total r ^b	R ² with own / next factor		
DETAILS SURVEY					
Factor 1: Using Technology For Complex Student Projects Requiring Problem Solving, Critical Thinking and Real World Applicability					
Item 1	.63	.75	.62	.32	.79
Item 4	.78	.74	.60	.25	.78
Item 5	.58	.69	.53	.34	.73
Item 8	.72	.77	.65	.31	.80
Item 10	.72	.75	.64	.30	.80
Item 14	.50	.73	.62	.33	.79
Item 21	.67	.67	.52	.19	.72
Item 22	.74	.63	.46	.16	.68
Item 36	.45	.66	.52	.29	.72
Item 38	.45	.61	.46	.24	.68
Item 40	.75	.73	.62	.24	.78
Item 47	.44	.60	.46	.21	.68
Factor 2: Teacher Proficiency in Using Technology					
Item 13	.53	.43	.25	.07	.50
Item 15	.88	.79	.72	.29	.85
Item 18	.87	.78	.72	.28	.85
Item 26	.72	.65	.56	.18	.75
Item 43	.69	.77	.72	.40	.85
Item 46	.63	.74	.67	.43	.82
Item 49	.67	.68	.60	.36	.77
Factor 3: Student Influence on Teachers' Current Instructional Practices					
Item 6	.52	.57	.57	.29	.75
Item 20	.56	.58	.56	.26	.75
Item 32	.63	.59	.55	.23	.74
Item 41	.67	.51	.47	.12	.69
Item 50	.64	.55	.51	.14	.72

Table 1 (continued)

Original LoTi Survey Item	Rotated Loading		Confirmatory Cluster Analysis ^c		
	Promax ^a	Item-total r ^b	R ² with own / next factor	Cluster Loading	
DETAILS SURVEY					
Factor 4: Dependence on Resources and Assistance to Increase Comfort Level in Using Technology					
Item 16	.41	.39	.29	.21	.54^d
Item 17	.61	.48	.43	.06	.66
Item 27	.45	.46	.36	.11	.60
Item 30	.45	.43	.36	.04	.60
Item 31	.55	.50	.44	.09	.66
Item 37	.53	.38	.37	.08	.61
Item 45	.64	.54	.52	.05	.72
Factor 5: Challenges to Classroom Computer Use					
Item 12	.42	.30	.25	.02	.50
Item 19	.57	.48	.52	.03	.72
Item 23	.53	.43	.48	.02	.69
Item 25	.44	.33	.27	.11	.52
Item 42	.50	.38	.37	.02	.61
Item 48	.45	.41	.39	.09	.63

Note: To maintain the integrity and confidentiality of the DETAILS Survey for future use, specific item content is not displayed.

^a Values are obtained from promaxian oblique rotation at $k = 3$ with equamax rotation representing the initial orthogonal solution. Only values with salient loadings ($\leq .40$) are displayed. Values are interpreted similar to factor loadings.

^b Item-total correlations are phi coefficients with the respective item eliminated from the total factor score.

^c Values are obtained from oblique, principal-components cluster analysis, where hypothesized item-factor membership is determined empirically. The multiple R^2 value for an item's own factor reflects proportion of item variance that is predicted by other items in the hypothesized correct factor. In contrast, the multiple R^2 value for an item's next factor reflects proportion of item variance predicted by items in the empirically determined best alternative factor, or where the item would fit most ideally. Cluster loadings are interpreted similarly to factor loadings (McDermott, 1993).

^d Item 16 migrated to a different cluster (that reflected by Factor 1) than what was initially hypothesized (that reflected by Factor 4). Therefore, the highlighted values represent Item 16's loadings for the cluster paralleling Factor 1 (R^2 with own factor) rather than Factor 4 (R^2 with next factor).

Table 2
Interfactor Correlations and Second-Order Principal Factors for the DETAILS Survey (N = 3,770)

Factor	Correlation ^a					Rotated Loading ^b		Communality	Specificity ^c
	F1	F2	F3	F4	F5	HOF1	HOF2		
F1	—					.77		.74	.19
F2	.68	—				.60	.43	.55	.34
F3	.61	.49	—			.67		.47	.31
F4	.43	.25	.35	—		.55		.32	.42
F5	-.26	-.23	-.07	.12	—		-.46	.22	.44
Eigenvalue						1.70	.60		
% variance									
Common						42.5	29.9		
Cumulative						42.5	72.4		

Note: F1 = Using Technology for Complex Student Projects Requiring Problem Solving, Critical Thinking and Real World Applicability; F2 = Teacher Proficiency in Using Technology; F3 = Student Influences on Teachers' Current Instructional Practices; F4 = Dependence on Resources and Assistance to Increase Comfort Level in Using Technology; and F5 = Challenges to Teachers' Use of Computers in the Classroom.

^a Intercorrelations are derived from unit-weighted factor scores obtained for factors resulting from first-order common factor analysis.

^b Varimax loadings $\geq .40$ are considered salient and are subsequently highlighted.

^c Communality indicates total proportion of common variance contained within a factor, while specificity reflects the proportion of variance that is reliable and unique to a given factor. Specificity is determined by subtracting a factor's communality from its alpha coefficient; specificity values that fall above error variance ($1 - \alpha$) are considered significant and are subsequently highlighted.

Table 3
Coefficients of Congruence for Replication of DETAILS Survey Factor Structure for Full Participant Group (N = 3,770) Across Multiple Random Subsamples

Factor	Invariance ^a			
	<i>n</i> = 1,885	<i>n</i> = 1,200	<i>n</i> = 1,100	<i>n</i> = 1,000
F1: Using Technology for Complex Student Projects Requiring Problem Solving, Critical Thinking and Real World Applicability	.99(.42)	.99(.42)	.99(.46)	.98(.46)
F2: Teacher Proficiency with Using Technology	.99(.37)	.99(.37)	.99(.41)	.99(.39)
F3: Student Influences on Teachers' Current Instructional Practices	.97(.46)	.99(.46)	.99(.50)	.99(.50)
F4: Dependence on Resources and Assistance to Increase Comfort Level in Using Technology	.99(.41)	.99(.41)	.99(.44)	.98(.45)
F5: Challenges to Teachers' Use of Computers in the Classroom	.99(-.17)	.97(-.17)	.99(-.26)	.98(-.20)
Average across all factors	.99(.30)	.99(.30)	.99(.32)	.99(.32)

Note: Values represent Wrigley-Neuhaus coefficients (Harman, 1976). Values outside the parentheses reflect the similarity of each factor obtained from the full participant group to the *counterpart* factor obtained for a random subsample. Values within the parentheses reflect average similarity of the factor to all other *noncounterpart* factors obtained from the random subsample.

^a Coefficients represent the factor solution for multiple random subsamples compared to the factor solution for the full participant sample (*N* = 3,770).

References

- Allen, M., & Yen, W. (1979). *Introduction to measurement theory*. California: Brooks/Cole Publishing Company.
- American Educational Research Association, American Psychological Association, & National Council on Measurement in Education (1999). *Standards for educational and psychological testing*. Publisher: Washington, D.C.
- Anastasi, A. (1988). *Psychological testing (6th ed.)*. New York: Macmillan.
- Apple Classrooms of Tomorrow (ACOT) (2004). *ACOT history*. Retrieved October 24, 2004 from <http://www.apple.com/education/k12/leadership/acot/history.html>.
- Bloom, B.S., Engelhart, M.D., Hill, H.H., Furst, E.J., & Krathwhol, D.R. (1956). The taxonomy and illustrative materials. In B.S. Bloom (Ed.), *Taxonomy of educational objectives, the classification of educational goals, handbook I: Cognitive domain* (pp. 62-197). New York: David McKay Company, Inc.
- Buja, A., & Eyuboglu, N. (1992). Remarks on parallel analysis. *Multivariate Behavioral Research*, 27, 509-540.
- Cohen, R. & Swerdlik, M. (2004). *Psychological testing and assessment: An introduction to tests and measurement (6th ed.)*. Boston: McGraw Hill.
- Geweke, J.F., & Singleton, K.I. (1980). Interpreting the likelihood of ratio statistic in factor models when sample size is small. *Journal of the American Statistical Association*, 75, 133-137.
- Gorsuch, R. (1983). *Factor analysis (2nd ed.)*. New Jersey: Lawrence Erlbaum Associates.
- Hall, G. & Loucks, S. (1979). *Implementing innovations in schools: A concerns-based approach*. Austin, TX: Research and Development Center for Teacher Education, University of Texas.
- Harman, H. H. (1976). *Modern factor analysis (3rd ed.)*. Chicago: University of Chicago Press.

- McDermott, P.A. (1993). National standardization of uniform multisituational measures of child and adolescent behavior pathology. *Psychological Assessment*, 5, 001-0012.
- Moersch, C. (1995). Levels of Technology Implementation (LoTi): A framework for measuring classroom technology use. *Learning and leading with technology*, 23(3). Retrieved September 5, 2004 from <http://www.learning-quest.com/software/LoTiFrameworkNov95.pdf>.
- U.S. Department of Education (2002). *Overview: Introduction*. Retrieved June 28, 2006 from <http://www.ed.gov/nclb/overview/intro/edpicks.jhtml?src=ln>.
- Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometrika*, 31, 321-327.