CHAPTER 4. FINDINGS

As stated in Chapter 1, the goal in developing the Education Technology Leadership Assessment (ETLA) was to produce a reliable and valid survey tool that can be used by individuals to self-assess their education technology leadership skills based on eight education technology leadership standards. The research questions for this study were concerned with the development of a reliable and valid survey as well as an interest in examining the underlying structures and inter-relationships of the data collected with the survey. In support of these research questions, methods were developed to assess the ETLA survey reliability and validity. Methods were also established to allow the researcher to examine the structure and inter-relationships of the data generated by the ETLA survey. The findings reported in this chapter provide evidence of the extent to which the ETLA in fact did contain reliable and valid survey items. Findings related to the observed data inter-relationships are also reported. The findings reported in this chapter will be grouped into four collections:

1. Evidence that ETLA items were aligned with the eight Technology Leadership (TL) Standards.
2. Evidence that the ETLA survey produced results that are statistically reliable.
3. Evidence that the ETLA survey produced results that are statistically valid.
4. Observations of ETLA item inter-relationships.

Results described in each of these sections were generated using descriptive statistics including measures of reliability and difference, and also from exploratory factor analysis (EFA). Data sets used in the statistical analysis were obtained from two sample populations: (1) a sample population of school technology coordinators serving as

education technology experts, and (2) a sample population of educators from an urban Iowa school district.

ETLA Item Alignment with Education Technology Leadership Standards

An expert judgment panel was used to help align ETLA items with technology leadership (TL) standard areas. This section of this chapter will describe the results used in the work to guide this item alignment.

The main source of data used in the task of item alignment was descriptive statistics that were generated using the Expert Ranking Data Set. Included in the descriptive statistics were the item mean score for each item. The mean scores for the items were an important descriptive statistic used in the analysis of the Expert Ranking Data Set. An analysis of the ETLA items' mean score was used to evaluate the alignment of each survey item with a TL Standard. On the five point rating scale used by the expert panel, the score of 4 was associated with "strong" alignment between the test item and the TL Standard area. Therefore, based on the scores from the expert judgment panel, items with mean scores of 4.0 and above were considered to be strongly aligned with the standard area that it was associated with. Twenty-three items had a mean score of 4.0 or higher. Items with a mean score below 4.0 were considered to have less than strong alignment with the TL Standard. These items were flagged for modification or removal from the survey. Twenty-one items had a mean score lower than 4.0. Item D.VII.3 had a mean score lower than 3.0.

The collection of items with an item mean score less than 4.0 was considered an important finding of the study, as those items were targeted for refinement as the draft version of the ETLA was refined into the final version. Table 6 provides a summary

Table 6. Expert Ranking Data Set descriptive statistics.

ETLA Items with an Item Mean Score >= 4.0				
D.VIII.4	D.VI.2	D.VI.3	D.VII.5	D.VIII.1
D.VIII.2	D.VIII.5	D.II.5	D.VI.4	D.III.4
D.III.6	D.V.5	D.VII.4	D.I.2	D.VI.1
D.I.1	D.I.3	D.I.4	D.III.3	D.V.1
D.V.4	D.VII.1	D.VIII.3		
ETLA Items with an Item Mean Score < 4.0				
D.II.1	D.II.2	D.II.3	D.II.4	D.IV.1
D.IV.2	D.IV.3	D.IV.4	D.VI.5	D.VI.6
D.III.1	D.III.2	D.III.5	D.I.5	D.VI.7
D.I.6	D.II.6	D.V.3	D.VII.2	D.V.2
D.VII.3				

list showing the items with mean scores greater or equal to 4.0 and those less than 4.0. Appendix G contains a complete listing of the descriptive statistics generated from the Expert Ranking Data Set, including item mean score, for each draft ETLA item.

Descriptive statistics were also generated using the Expert Assessment Data Set. The descriptive statistics associated with this data set can be found in Appendix H. This data set contained the experts' self-assessment results using the draft ETLA items. Again, the item mean score was an important statistic used in the analysis of the data. But given that number of observations obtained for each item from the expert pool was low (N=10) and the assumption that the experts would tend to rate themselves high on the five point scale, there was limited ability to draw findings from analysis of the descriptive statistics generated from the Expert Assessment Data Set. Given these limits, items D.II.6 and

D.VI.6 were found to produce the lowest item mean scores of all ETLA items. Both of these items had an item mean score of 3.90. On the rating scale used by the expert panel, the score of 3 indicated the extent to which the expert respondent provided the leadership function identified in the item was "somewhat". A score of 4 indicated they supported the task "significantly". Therefore, even the lowest item mean scores found in the Expert Assessment Data Set indicated the experts believed they were performing that item's associated leadership function to a significant extent.

Table 7 provides a listing of selected summary information from the mean score statistical analysis of the Expert Ranking Data Set and the Expert Assessment Data Set. The overall mean for the Expert Assessment Data Set indicates that the experts rated themselves high (> 4), in general. This finding suggests that the ETLA assessment identified expert technology leaders, but may not differentiate the education technology skill levels within a group of education technology leaders.

The findings from analysis of the Expert Ranking Data Set and the Expert Assessment Data Set provided evidence of the ETLA's face validity. And the analysis helped to indicate the degree to which both the TL Standards and the draft items were aligned. The analysis of the Expert Ranking Data Set and the Expert Assessment Data Set also helped to identify items that needed revision. Twenty-one items were identified based on their relatively low item mean score and were reviewed. Fifteen of those items were modified with the intention of producing a stronger alignment with the standard area they represented. Seven items were removed from the survey, and one item was added. Table 8 provides an inventory of the items changed from the draft version of the

Table 7. Expert Panel descriptive statistics summary.

Expert Reviewer Feedback (n=10)	Ranking Data Set	Assessment Data Set
Lowest Mean (single item)	2.40	3.90
Highest Mean (single item)	4.80	5.00
Lowest Std. Deviation (single item)	0.00	0.00
Highest Std. Deviation (single item)	1.150	0.738
Overall Mean	3.97	4.56

Table 8. ETLA item changes between draft and final ETLA versions.

Description	Item Identifier
Items not modified from draft to final	D.I.1, D.I.2, D.I.3, D.I.4, D.II.5, D.III.3, D.III.4, D.III.6, D.V.1, D.V.4, D.V.5, D.VI.1, D.VI.2, D.VI.3, D.VI.4, D.VII.1, D.VII.5, D.VIII.1, D.VIII.2, D.VIII.3, D.VIII.4, D.VIII.5
Items modified from draft to final	D.I.6, D.II.1, D.II.2, D.II.3, D.II.4, D.III.1, D.III.2, D.IV.1, D.IV.2, D.IV.3, D.IV.4, D.V.3, D.VI.5, D.VII.2, D.VII.4
Items deleted from draft to final	D.1.5, D.II.6, D.III.5, D.V.2, D.VI.6, D.VI.7, D.VII.3
Items added from draft to final	F.IV.5

ETLA survey to the final version. The final version of the ETLA survey contained thirty-eight items. A table showing a side by side comparison of the draft ETLA items and the final ETLA items can be found in Appendix I.

ETLA Survey Reliability

In this study a field test of the ETLA was conducted. A data set, referred to as the Field Test Data Set, was created during the field test. The information for the data set was

obtained using the ETLA with a sample of educators of an urban Iowa school district. To obtain this data set, the final version of the ETLA survey was distributed as a web-based survey to 275 educators. Participants included district elementary, middle school, and high school educators from the primary job groups of principals, teachers, and building technology specialists.

ETLA responses were returned from 214 participants (78% return rate). This was considered by the researcher to be a high return rate. The high return rate was attributed to the fact that the ETLA survey's field test was incorporated into the district's technology planning process and that technology funding was contingent with the completion of the survey.

Descriptive statistics were generated using the Field Test Data Set. Included in the descriptive statistics was the number of responses (N) obtained for the item along with statistics describing the distribution of responses for each item (mean, standard deviation, and variance). The correlation of the responses for each item with all other items was calculated. This statistic is known as the item-rest value. The Cronbach Alpha for the data set if the item was removed (Alpha if removed) was also included in the collection of descriptive statistics. Appendix J provides a listing of the descriptive statistics.

The framework of the ETLA was composed of item scales containing items placed by the expert review panel into eight separate sub-scales. These eight item scales were based on the eight TL Standards. Cronbach's Alpha analysis of these ETLA item scales showed high reliability for each of the eight sub-scales: Leadership & Vision (α = 0.80); Planning & Designing Learning Environments (α = 0.84), Teaching, Learning & Curriculum (α = 0.77), Assessment and Evaluation (α = 0.82), Technology Operations

and Concepts ($\alpha = 0.76$), Social, Ethical, Legal and Human Issues ($\alpha = 0.84$), Procedures, Policies, Planning & Budget ($\alpha = 0.80$), Productivity and Professional Practice ($\alpha = 0.71$). All item scales had Alpha scores higher than the acceptable cutoff of 0.60, which was interpreted as an indication of internally reliable item scales. It should be noted that although the alpha coefficients for each item scale are lower than the overall reliability ($\alpha = 0.97$), this is expected and is a function of an analysis on fewer items (Welkowitz et al., 2006).

An Alpha score was also generated for each item by removing the item's responses from the Alpha calculation. Variations in the resulting "Alpha if item removed" statistic could identify items influencing the Alpha calculation. No such indication was found from the Field Test Data Set, as "Alpha if item removed" remained at $\alpha = 0.97$ for all ETLA items.

Analysis of items within each ETLA item scale was conducted. Inter-scale correlations were considered an important indicator of an ETLA item's reliability in measuring the TL Standard it was aligned with. Strong correlation scores indicated strong reliability with the items in the scale.

To help summarize the data for analysis, the mean score for the inter-scale correlations was calculated for each standard area. These inter-scale scores could exist across a range of 0 to 1.0, with 1.0 indicating an extremely strong correlation. The Procedures, Policies, Planning & Budget (0.5080) and Social, Ethical, Legal and Human Issues (0.5146) standard areas had the highest mean scores. The ETLA items aligned with these standards showed the strongest inter-scale correlations. The Productivity and

Table 9. Means of inter-scale correlations from ETLA item scales

Item Scale	Mean
Overall	0.4644
Standard 1 – Leadership	0.4513
Standard 2 – Planning	0.508
Standard 3 – Teaching	0.4053
Standard 4 – Assessment	0.4695
Standard 5 – Operations	0.4351
Standard 6 – Social	0.5146
Standard 7 – Procedures	0.4885
Standard 8 – Productivity	0.33

Professional Practice (0.3300) standard area had the lowest inter-scale mean score. Table 9 lists the means of the inter-scale correlations for each standard area.

Item-rest correlations were used similarly to item-scale correlations as an indicator of ETLA item reliability. Item-rest correlations were generated by correlating each ETLA item with the rest of the ETLA items. These item-rest correlations showed how the item is correlated with a scale computed from all other items, minus the item under consideration. Using the Field Test Data Set, the range of item-rest correlations was $r = 0.32$ to $r = 0.82$. The generally accepted cutoff item-rest score for this analysis was 0.30 and so all items showed acceptable levels of internal reliability. Five items had item-rest scores less than 0.50 (F.III.1, F.III.2, F.V.1, F.VIII.2, and F.VIII.3).

The findings of this section contributed to evidence that ETLA items were performing reliably. Analysis of the reliability of the ETLA standard scales would be bolstered by additional items in each standard area. However, any analysis and conclusions based on a scale of 4 to 6 items must be approached with caution (Avolio & Bass, 2002). Generally, a sub-scale consisting of 20 or more items is necessary to draw

conclusions about a dimension's reliability (Hinkle et al., 2003; Rea & Parker, 2005). Additional trials of the ETLA would be required for a more rigorous evaluation and assessment of the ETLA's reliability.

ETLA Survey Validity

The Field Test Data Set was used in generating results designed to support the examination of the statistical validity of the ETLA survey. Three assessments designed to aid in the review of ETLA item validity were conducted: (1) a job group comparison of TL Standards item scale means, (2) a matched data set comparison, and (3) a review of Not Applicable responses for each ETLA item. Findings from these analyses are reported in this section.

Job Group Comparison Results

By the nature of their job, principals, technology specialists, and teachers would be expected to exhibit different levels of education technology leadership. If ETLA items generated responses indicating differences for these job groups a claim for construct validity of the ETLA would be supported. To explore this, an analysis was conducted using the Field Test Data Set. Respondents were classified into three job groups: teachers, technology specialists, and principals. Mean scores for each job group for each standard area were calculated. The results of the mean score calculations are listed in Table 10.

As indicated by the data in Table 10, Principals as a group had the highest overall mean scores for five of the eight TL standard areas. The Principals rated themselves the highest in the TL Standard area of teaching, which could correspond to their role as

Table 10. Field Test Data Set group means by standard area.

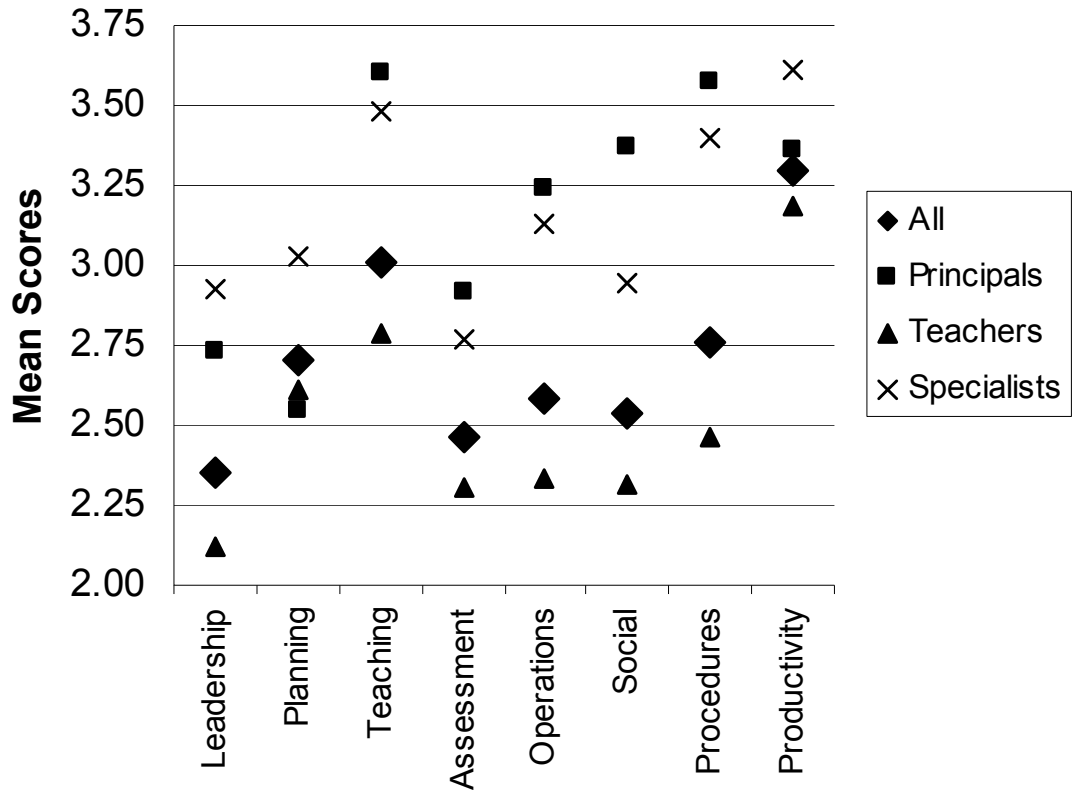
	Group			
Standard	All	Principals	Teachers	Technology Specialists
Leadership	2.35	2.74	2.12	2.93
Planning	2.70	2.54	2.61	3.03
Teaching	3.01	3.60	2.78	3.49
Assessment	2.46	2.92	2.31	2.77
Operations	2.59	3.24	2.33	3.13
Social	2.54	3.37	2.31	2.94
Procedures	2.76	3.58	2.46	3.40
Productivity	3.30	3.36	3.19	3.61

instructional leader. Building Technology Specialists as a group had the highest overall mean scores for three standard areas: Leadership, Planning, and Productivity. This could indicate the Building Technology Specialists had a relatively high sense of ownership for these technology leadership areas. Figure 5 provides a graphical representation of the job group mean score data.

Matched Data Results

Using results generated from the field test of the ETLA survey, a paired data set was generated. This data set contained matched ETLA responses from selected principals with responses from selected teachers. This data set was referred to in this study as the Matched Data Set. Twenty five Teachers from the field test population were paired with

Figure 5. Comparison of job group means by TL standard



their job supervisor; i.e. their Principal. The Teachers were asked to use the ETLA survey as a self-assessment of their education technology leadership skills. The Principals were asked to use the ETLA survey to assess the education technology leadership of the educator they were paired with. Nineteen paired samples (76% return rate) were collected and placed in the Matched Data Set.

Mean scores were calculated for each group (Principals and Teachers) for each TL Standard area. For all TL Standards, Principals had higher overall item scale mean scores. Table 11 lists the item scale mean scores for each group, and Figure 6 provides a graphical representation of the data.

The a priori hypothesis for the Matched Data Analysis was item mean scores for Principals and Teachers in the Matched Data Set would be correlated. The assumption was that, while the matched Principals and Teachers may not rate themselves identically on the six point ETLA rating scale, they would tend to consistently mark similar high and low ratings across the items, which would produce strong correlations for the items in the Matched Data Set. As can be seen in Figure 6, Principals did consistently have higher item scale mean scores for all eight TL Standard areas. However, when the correlation between each matched ETLA item was calculated, no strong ($r > .6$) correlations were found. Appendix K lists the paired item correlations.

This finding does not necessarily refute ETLA item construct validity. The results could be attributed to the small (N=19) Matched Data Set sample size, or to a lack of a common and shared understanding between the Principals and Teachers of the elements of education technology leadership. In summary, the consistency found in the item scale mean scores provided limited evidence of ETLA item validity. More analysis with additional data would be required in order to develop stronger conclusions.

Not Applicable Results

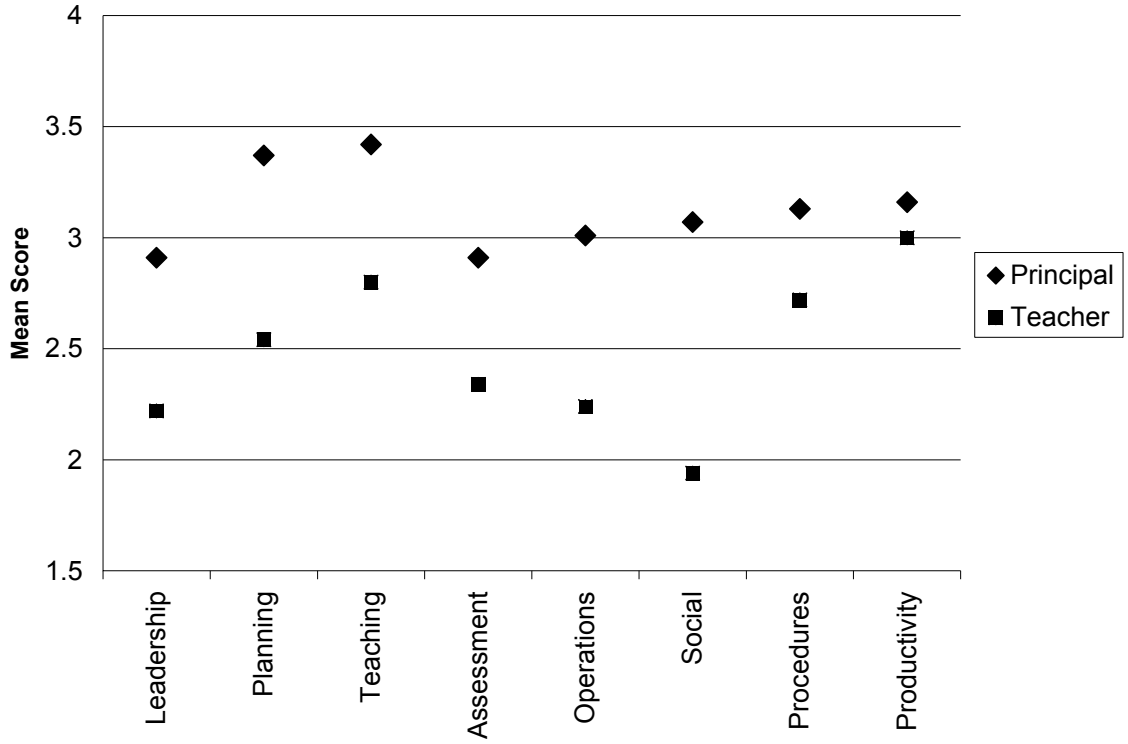
Respondents were provided the option of selecting a *Not Applicable* response on each ETLA survey item. These observations were coded as missing data in all SPSS statistical analysis used in this study. This resulted in a range of observations (N) for each item, from N=176 to N=214. This was a discrepancy of 38 (18%) of responses at the item level. The number of responses with no missing values was N=114.

The construct hypothesis for this analysis was that responses of Not Applicable for an ELTA item could indicate evidence of lower content validity for that item.

Table 11. Matched Data Set group means by standard area.

Standard	Principal	Teacher
Leadership	2.91	2.22
Planning	3.37	2.54
Teaching	3.42	2.80
Assessment	2.91	2.34
Operations	3.01	2.24
Social	3.07	1.94
Procedures	3.13	2.72
Productivity	3.16	3.00

Figure 6. Comparison of matched mean scores by TL standard



Participant demographics, such as job assignment, could also influence a respondent in marking an ETLA item Not Applicable. For example, Building Technology Specialists might be more inclined than Teachers to view the ETLA items applicable to their job responsibilities.

A threshold was set by the researcher to help establish high not-applicability. ETLA items that had five percent or more of the total Not Applicable responses for a job group (Principal, Building Technology Specialist, Teacher) were identified in this study as having high Not Applicable responses. Using this measure, seven items in the Principal job group, six items in the Building Technology Specialist job group, and four items in the Teacher job group were identified as high. ETLA items F.I.3 and F.V.3 were identified as showing high not-applicability for all three job groups. ETLA items F.V.3, F.VII.2, and F.VII.3 were identified as showing high not-applicability for two of the three job groups. Table 12 lists the items with high Not Applicable responses desegregated by job group.

Participant knowledge of the technology leadership elements measured by the ETLA survey was assumed to be inherent in the participants prior to the study. In other words, no effort was made in this study to coach or instruct participants about education technology leadership. Therefore, the results found in the Not Applicable analysis would support a claim for item construct validity. Participants' appeared to understand the items and apparently found the majority of education technology leadership indicators relevant to their job.

Table 12. ETLA items with high not applicable responses by job group.

Job Group	Item						
Principals	F.I.3	F.V.3	F.VI.1	F.VI.2	F.VI.3	F.VII.2	F.VII.3
Technology Specialists	F.I.3	F.II.1	F.V.3	F.V.4	F.VII.1	F.VII.2	
Teachers	F.I.2	F.I.3	F.V.3	F.VII.3			

Exploratory Factor Analysis

In behavioral science research factor analysis is typically used for data reduction and/or data structure detection (Kim & Mueller, 1978b). Exploratory factor analysis (EFA) is a form of factor analysis methodology that is generally used to discover the factor structure of a measure and to examine the measure's internal reliability. In this study EFA was used to help the researcher identify the inter-relationships inherent in the Field Test Data Set. EFA was also used to identify ETLA items that may not be contributing to the survey in a significant way. This section will report the findings from an analysis of EFA results.

In the EFA conducted for this study, statistics were generated to provide an indication of the suitability of the Field Test Data Set for factor analysis. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity results both provided evidence of the suitability of the data set for EFA. KMO tested whether the partial correlations among items were small. High values (close to 1.0) would generally indicate that a factor analysis may be useful for the data set (Kim & Mueller, 1978b). If the value is less than 0.50, the results of the factor analysis would be less useful. The KMO value generated for

the Field Test Data Set was 0.920. This indicated the data set might be useful for factor analysis.

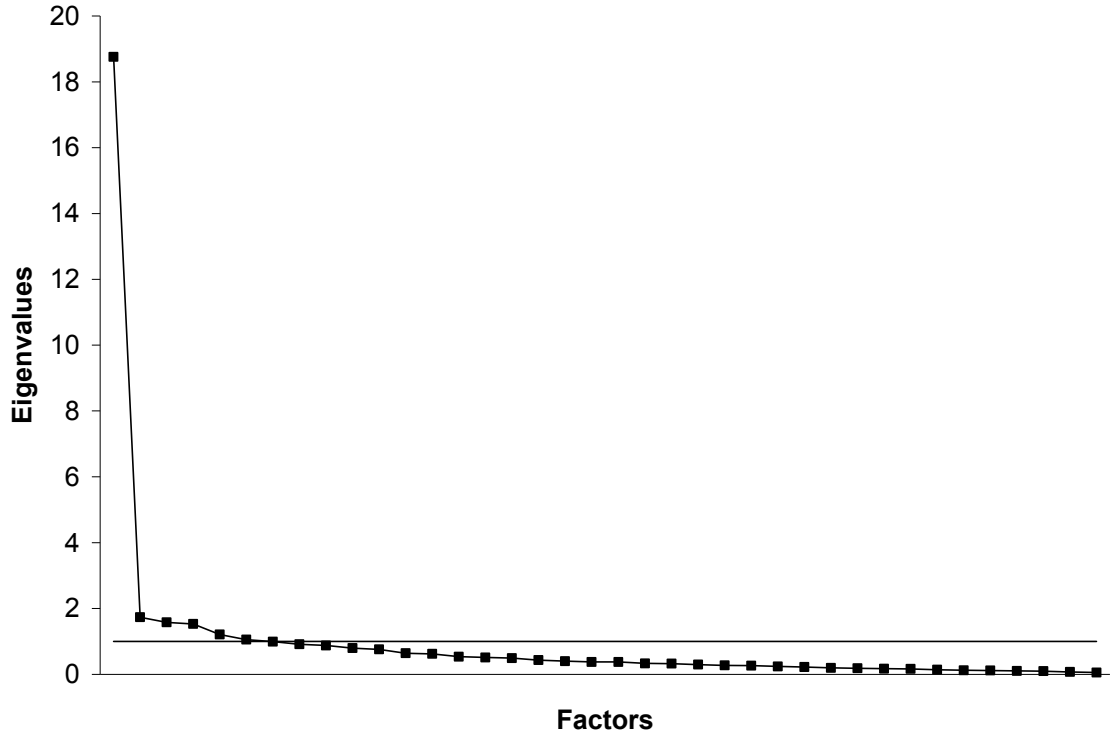
The Bartlett's Test of Sphericity tested the hypothesis that the correlation matrix was an identity matrix (Kim & Mueller, 1978b). If the correlation matrix was an identity matrix, this would have indicated that the variables are unrelated and therefore unsuitable for structure detection. Small values (less than 0.05) of significance would indicate that a factor analysis may be useful with the data set. The Bartlett's value generated for the Field Test Data Set was 0.000. This indicated the data set might be useful for factor analysis.

An a priori theory in this study related to data inter-relationships was identified in the literature review of work by the authors of the TL Standards. The authors speculated that themes coexisted within the TL Standards. EFA methods are useful in detecting structure in data, and so EFA methods lent themselves to the task of exploring the inter-relationships between the TL Standards. The factors that emerged from the EFA would represent potential education technology themes of interest.

For this study, factor analysis was performed using the SPSS program, using the SPSS Data Reduction selection with the settings of Principal Axis Factoring and Varimax rotation. These settings generated six factors with eigenvalues greater than 1, as can be seen in the Scree plot shown in Figure 7. These top six factors accounted for 68% of the variance in the Field Test Data Set. Using the Kaiser-Guttman rule described in Chapter 3, these six factors were carried forward for further EFA examination.

The next step in the EFA methodology was to label the factors. This was done by examining the factor loadings with the greatest absolute value scores for each factor. The

Figure 7. ETLA Field Test Data Set Scree plot.



items with the greatest absolute value score are said to "load high". Items that loaded high were used as indicators of the nature of the factor, and a descriptive label for the factor was created by the researcher using the high loading items as a guide.

For this study, the score of 0.40 was used as the mark for the identification of high factor loadings. The factor loadings for the factors generated with the SPSS statistical program were reported in a table called the Rotated Factor Matrix. A copy of this matrix is found in Appendix L.

Factor 1 generated by the factor analysis had 15 items that loaded with an absolute value score greater than 0.40, and 5 of these items loaded with an absolute value greater than 0.60. Table 13 lists the items, scores, and item descriptions that loaded high on Factor 1. The high loading variables seemed to share the characteristics of resource

allocation and budgeting. The highest loading items on this factor were items that had been aligned with TL Standard 7 (Procedures) and TL Standard 5 (Operations). Many of the high loading items were related to resource and procurement planning, which are typically elements of the budgeting process. Factor 1 was labeled "Budgeting".

Figure 8 is a diagram designed to depict the relative strength of the TL Standard item loadings on the Budgeting factor. The thickness of the arrowed lines connecting a TL Standard with the factor indicates the number of items that loaded on the item. The thicker lines indicate more items from that TL Standard area loading high on the factor. The identifiers for the high loading items are listed in each TL Standard oval. For example, in Figure 8, TL Standard 1 (Leadership) has two items, F.I.1 and F.I.3, which load high on the Budgeting factor.

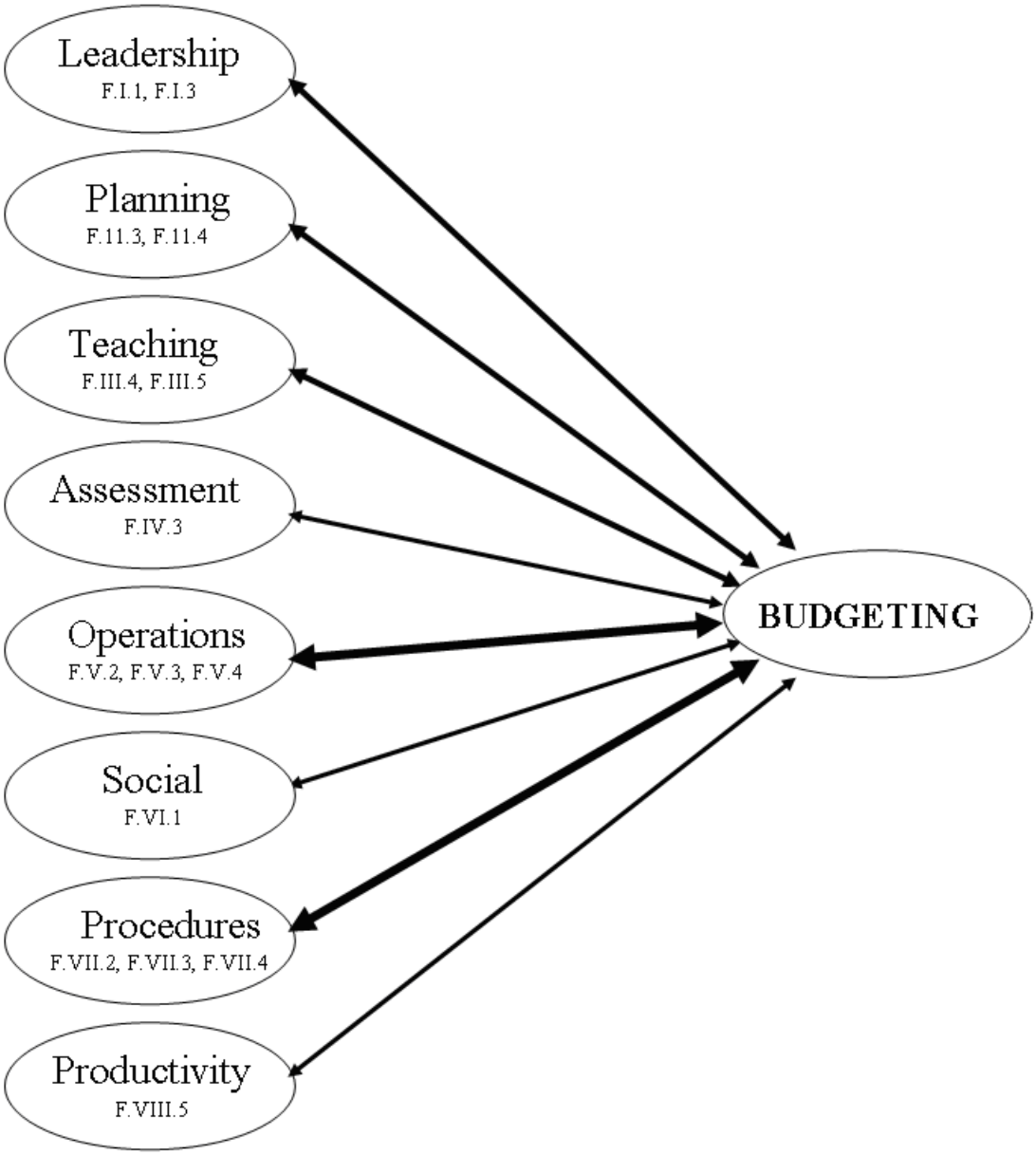
The high loading items form the item scale that represents the Budgeting factor. By definition, the responses for these items were highly correlated in the Field Test Data Set. As can be seen in Figure 8, all TL Standard areas had at least one item that loaded high on the Budgeting factor, indicating the factor is multidimensional in relation to the TL Standards. TL Standard 5 (Operations) and TL Standard 7 (Procedures) tied with the most number of items loading on the Budgeting factor, with three each.

Factor 2 generated by the factor analysis had 15 items that loaded with an absolute value score greater than 0.40, and 3 of these items loaded with an absolute value greater than 0.60. Table 14 lists the items, scores, and item descriptions that loaded high on Factor 2. The high loading items shared the characteristics of classroom instruction development and planning. The highest loading items were items that had been aligned with TL Standard 2 (Planning) and TL Standard 3 (Teaching). Because many of the high

Table 13. ETLA items with high factor loadings on Budgeting factor.

Item	Item Loading	Item Description
F.VII.2	0.748	Procedures - Contribute to technology budget plan.
F.VII.4	0.710	Procedures - Participate in building technology planning.
F.V.3	0.681	Operations - Ensure upgrade efforts.
F.VI.1	0.623	Social - Ensure equity of technology access.
F.IV.3	0.602	Assessment - Evaluate existing systems.
F.I.3	0.599	Leadership – Promote participation of others.
F.V.4	0.583	Operations - Advocate for technology support resources.
F.III.5	0.486	Teaching - Support professional development.
F.III.4	0.485	Teaching - Receive collaboration from colleagues.
F.VII.3	0.484	Procedures - Follow technology related rules.
F.VIII.5	0.457	Productivity - Evaluate technology for own job suitability.
F.II.3	0.443	Planning - Locate new technology resources.
F.II.5	0.429	Planning - Plan management of learning with technology.
F.I.1	0.424	Leadership - Participate in district technology planning.
F.V.2	0.413	Operations - Pursue added funding.

Figure 8. Diagram of TL Standards and Budgeting factor relationships.



loading items for this factor were associated with elements of instructional planning, Factor 2 was labeled “Planning”.

Figure 9 depicts the relative strength of the TL Standard item loadings on the Planning factor. As can be seen in Figure 9, six TL Standard areas had at least one item that loaded high on the Planning factor. In terms of the TL Standards, this factor would be considered multidimensional. TL Standard 2 (Planning) and TL Standard 4 (Assessment) tied with the most number of items loading on the Planning factor, with four each.

Factor 3 generated by the factor analysis had 11 items that loaded with an absolute value score greater than 0.40, and 1of these items loaded with an absolute value greater than 0.60. Table 15 lists the items, scores, and item descriptions that loaded high on Factor 3. The high loading variables shared the characteristics of rulemaking and planning related to policy development. The highest loading items were items that had been aligned with TL Standard 6 (Social) and TL Standard 4 (Assessment). Many of the high loading items for this factor had ties to policy development, and so Factor 3 was labeled “Policymaking”.

Figure 10 depicts the relative strength of the TL Standard item loadings on the Policymaking factor. As can be seen in Figure 10, six TL Standard areas had at least one item that loaded high on the Policymaking factor. In terms of the TL Standards, this factor would be considered multidimensional. TL Standard 6 (Social) had the most number of items loading high on the Policymaking factor, with four.

Table 14. ETLA items with high factor loadings on the Planning factor.

Item	Item Loading	Item Description
F.II.2	0.663	Planning - Apply research to tech instruction
F.III.3	0.636	Teaching - Collaboration with colleagues
F.II.4	0.609	Planning - Plan management of technology integration
F.II.5	0.560	Planning - Plan management of learning with technology
F.I.5	0.560	Leadership - Engage technology best practices
F.IV.2	0.553	Assessment - Evaluate instructional practice
F.III.4	0.553	Teaching - Receive collaboration from colleagues
F.VIII.4	0.533	Productivity - Advocate for technology in SIP
F.II.3	0.531	Planning - Locate new technology resources
F.IV.3	0.470	Assessment - Evaluate existing systems
F.IV.5	0.468	Assessment - Use measures to guide tech use
F.VII.1	0.465	Procedures - Use technology resources in instruction
F.IV.4	0.433	Assessment - Evaluate professional development
F.I.4	0.424	Leadership - Align technology plans with SIP
F.VI.5	0.403	Social - Support use of technology for all students

Figure 9. Diagram of TL Standards and Planning factor relationships.

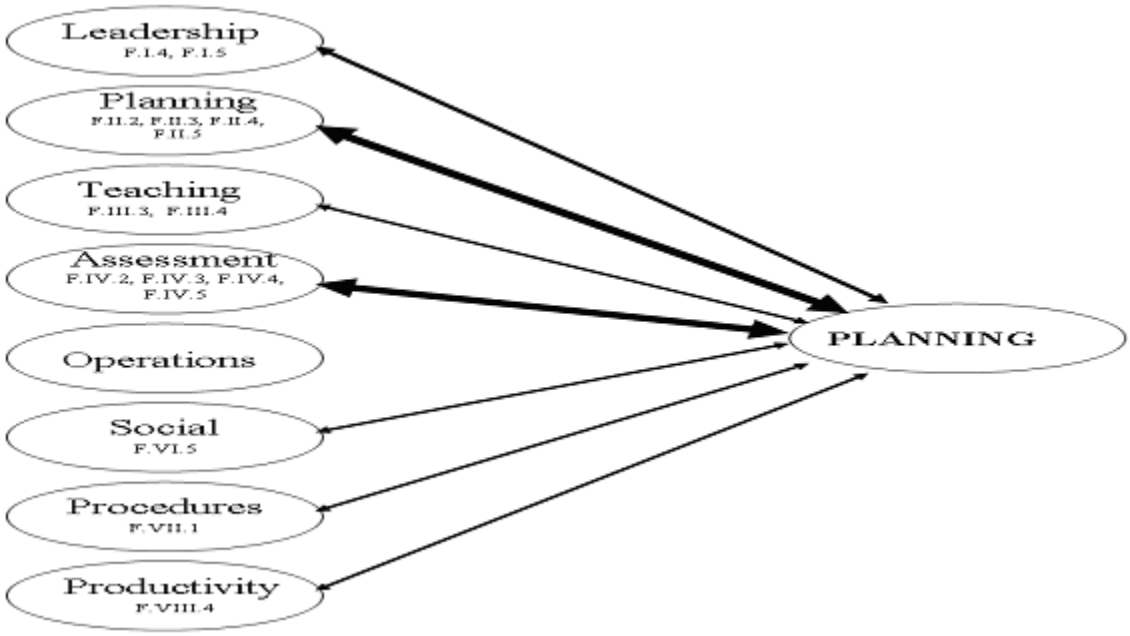
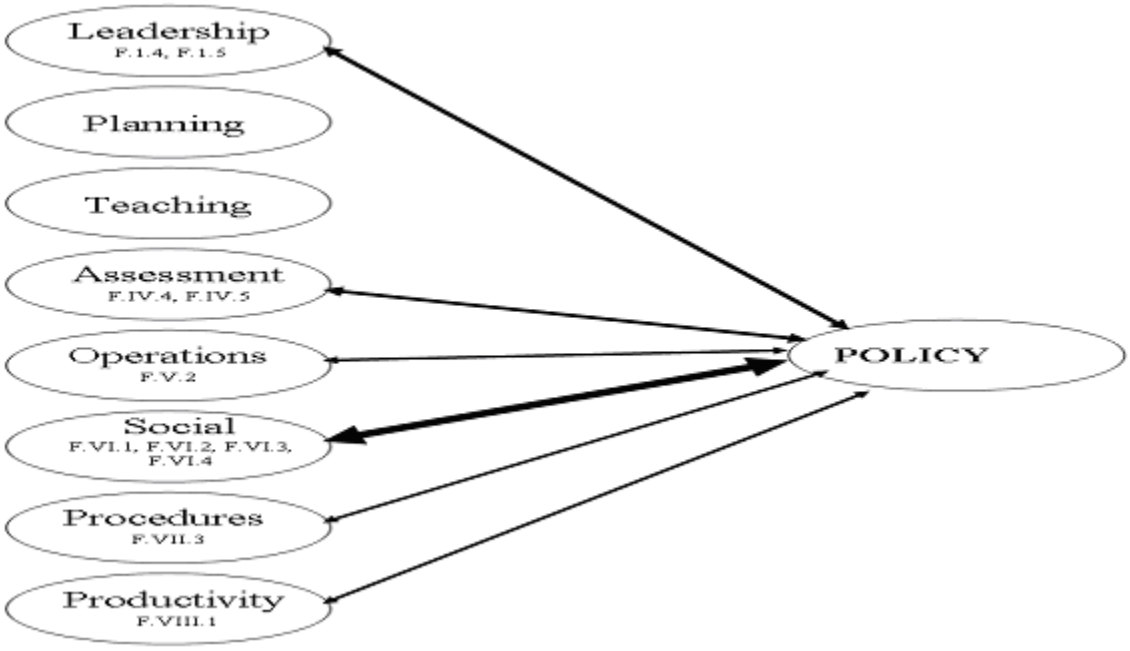


Table 15. ETLA Items with high factor loadings on Policy factor.

Item	Item Loading	Item Description
F.VI.4	0.689	Social - Involved in privacy and online safety.
F.IV.5	0.553	Assessment - Use measures to guide tech use.
F.VI.2	0.550	Social - Raise awareness of technology social issues.
F.I.4	0.506	Leadership - Align technology plans with SIP.
F.VIII.1	0.500	Productivity - Improve own technology knowledge
F.IV.4	0.468	Assessment - Evaluate professional development.
F.V.2	0.460	Operations - Pursue added funding.
F.VI.1	0.451	Social - Ensure equity of technology access in building.
F.VI.3	0.441	Social - Enforce copyright rules.
F.VII.3	0.426	Procedures - Follow rules related to tech use and procurement.
F.I.5	0.410	Leadership - Engage technology best practices.

Figure 10. Diagram of TL Standards and Policy factor relationships.



Factor 4 generated by the factor analysis had 5 items that loaded with an absolute value score greater than 0.40, and 2 of these items loaded with an absolute value greater than 0.60. Table 16 lists the items, scores, and item descriptions that loaded high on Factor 4. The high loading variables shared the characteristic of data-driven decision making to help inform instruction. The highest loading item was an item that had been aligned with TL Standard 3 (Teaching). Factor 4 was labeled "Data-driven".

Figure 11 depicts the relative strength of the TL Standard item loadings on the Data-driven factor. As can be seen in Figure 11, four TL Standard areas had at least one item that loaded high on the Data-driven factor. TL Standard 4 (Assessment) had the most number of items loading high on the Data-driven factor, with two.

Factor 5 generated by the factor analysis had 5 items that loaded with an absolute value score greater than 0.40, and 1 of these items loaded with an absolute value greater than 0.60. Table 17 lists the items, scores, and item descriptions that loaded high on Factor 5. The high loading variables share the characteristics of classroom efficiency and productivity. The highest loading item was an item that had been aligned with TL Standard 2 (Planning). Based on the researcher's observation that the high loading items for this factor were related to the use of technology to improve instructional efficiency, Factor 5 was labeled "Efficiency".

Figure 12 depicts the relative strength of the TL Standard item loadings on the Efficiency factor. As can be seen in Figure 12, five TL Standard areas had one item that loaded high on the Efficiency factor.

Table 16. ETLA items with high factor loadings on Data Driven factor.

Item	Item Loading	Item Description
F.III.2	0.688	Teaching - Assist others in using data to inform instruction.
F.IV.1	0.609	Assessment - Collect student data.
F.V.1	0.520	Operations - Support connecting to technology resources.
F.IV.2	0.445	Assessment - Evaluate instructional practice.
F.I.2	0.434	Leadership - Communicate technology plan information.

Figure 11. Diagram of TL Standards and Data Driven factor relationships.

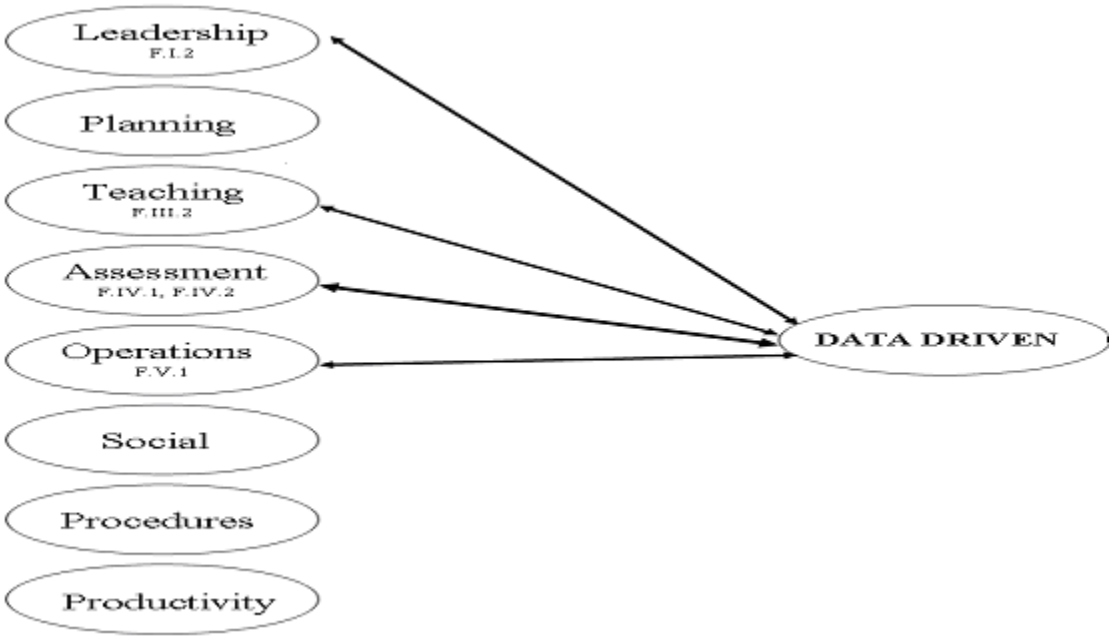
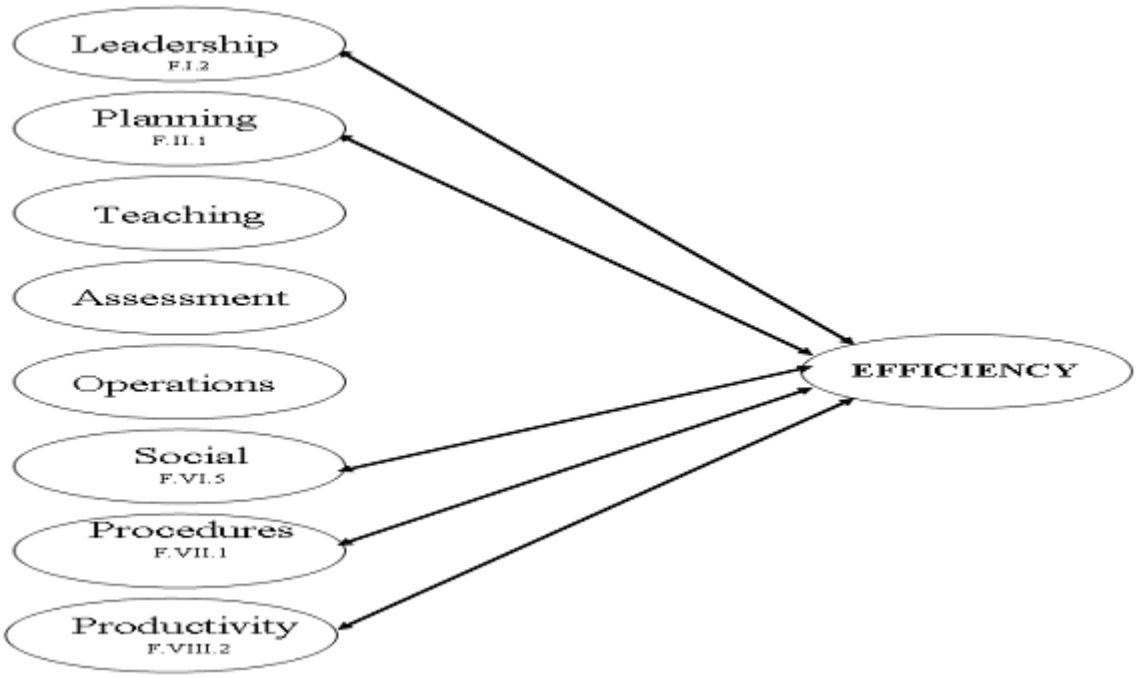


Table 17. ETLA items with high factor loadings on Efficiency factor.

Item	Item Loading	Item Description
F.II.1	0.618	Planning - Design technology integrated instruction.
F.VIII.2	0.577	Productivity - Use technology in day to day tasks.
F.I.2	0.515	Leadership - Communicate technology plan information.
F.VII.1	0.483	Procedures - Use technology resources in instruction.
F.VI.5	0.406	Social - Support use of technology for all students.

Figure 12. Diagram of TL Standards and Efficiency factor relationships.



Factor 6 generated by the factor analysis had 3 items that loaded with an absolute value score greater than 0.40. Table 18 lists the items, scores, and item descriptions that loaded high on Factor 6. The researcher's observation was that the high loading variables shared the characteristics of collaboration and communication. The highest loading items were items that had been aligned with TL Standard 8 (Productivity). Based on the observation of the common characteristics of the high loading items, Factor 6 was labeled "Communication".

Figure 13 depicts the relative strength of the TL Standard item loadings on the Communication factor. As can be seen in Figure 13, two TL Standard areas had at least one item that loaded high on the Communication factor. TL Standard 8 (Productivity) had the most number of items loading high on the Communication factor, with two.

EFA is commonly used to identify underlying structures in data based on correlations between data items. The EFA methods used in this study identified six factors, or themes. Figure 14 shows the interrelationships of TL Standards with the themes that emerged from the EFA. The figure demonstrates how multiple TL Standards contributed to multiple factors (themes).

EFA is also useful for data reduction purposes. The interest in pursuing data reduction is to determine if the assessment of education technology leadership could be done with fewer survey items with similar effectiveness. The previous observation that items associated with multiple TL Standards are loading on multiple factors would indicate the potential for education technology leadership to be assessed with similar effectiveness with fewer ETLA items. For this study, the consideration of the data reduction aspect of EFA methods relied on the examination of factor loadings to

Table 18. ETLA items with high factor loadings on Communication factor.

Item	Item Loading	Item Description
F.VIII.3	0.517	Productivity - Use technology to communicate.
F.VIII.5	0.411	Productivity - Evaluate technology for own use.
F.III.4	0.403	Teaching - Receive collaboration from colleagues.

Figure 13. Diagram of TL Standards and Communication factor relationships.

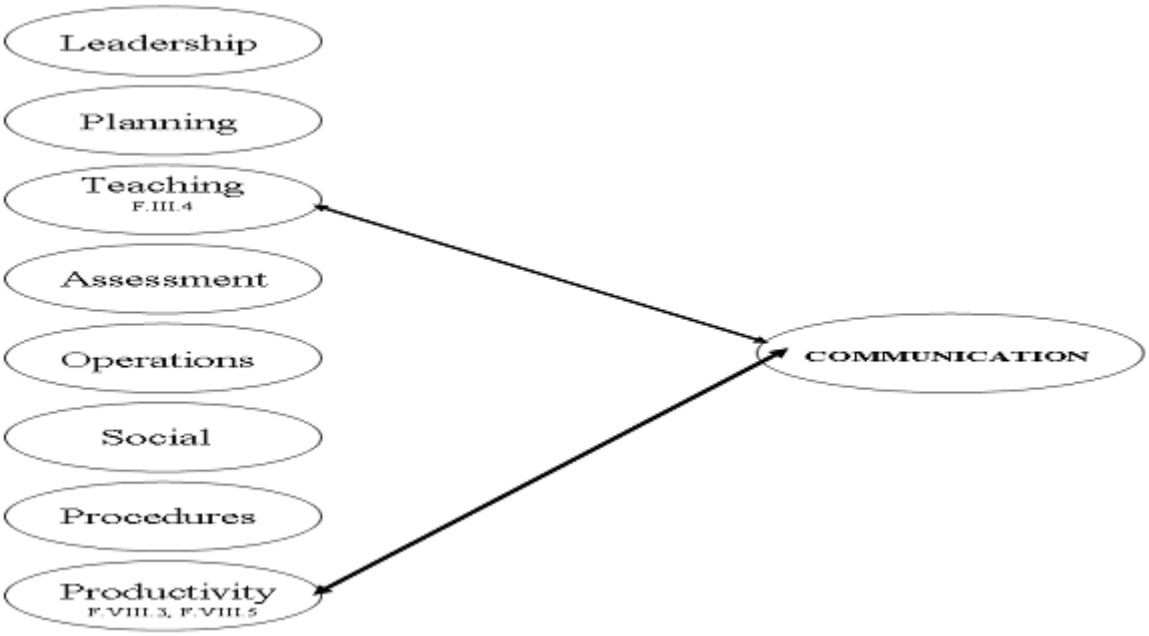


Figure 14. Diagram of TL standards and factor relationships.

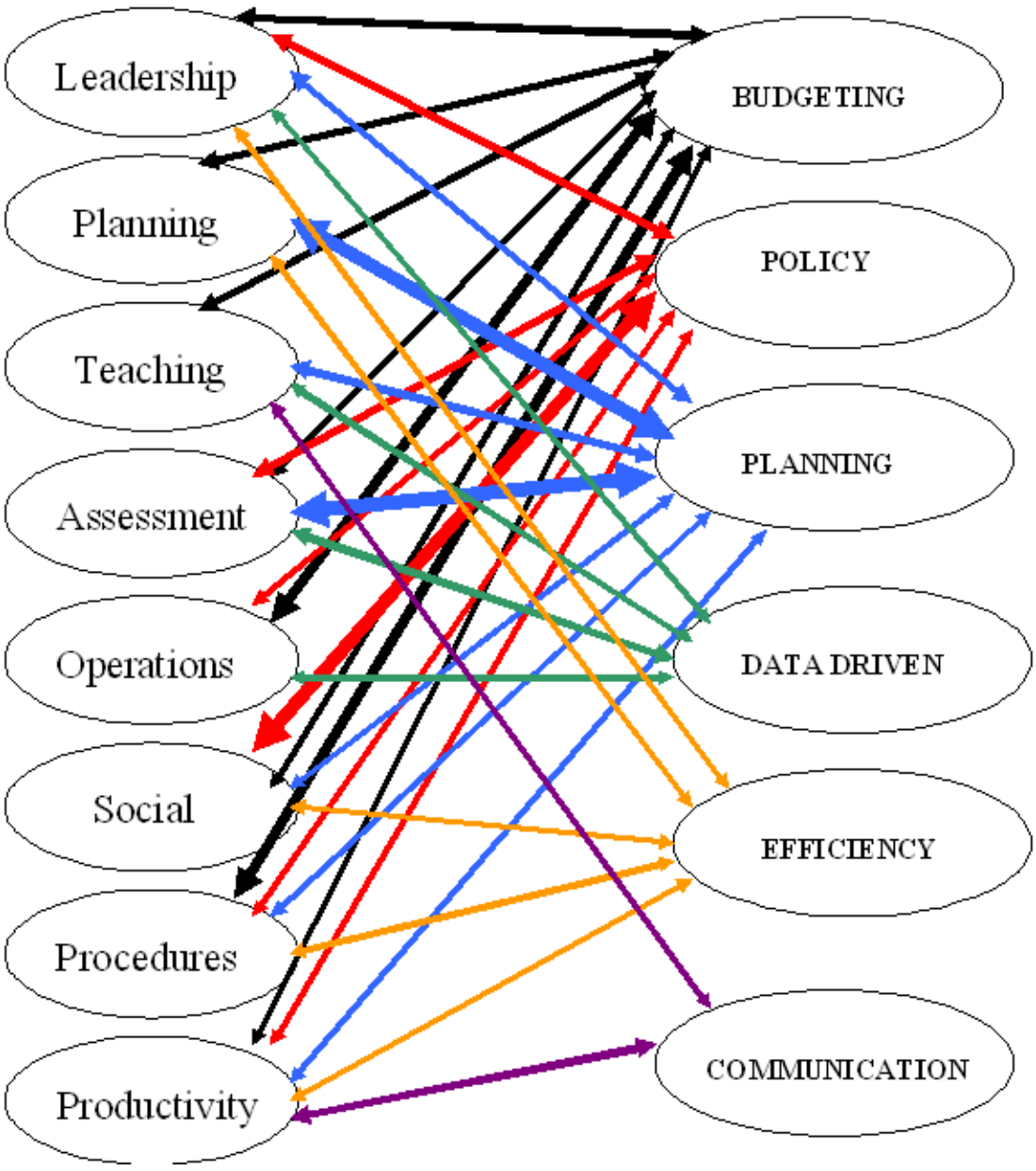


Table 19. Classification of ETLA items by their high factor loadings.

ETLA items loading high (>= 0.40) on multiple factors.					
F.I.2	F.I.4	F.I.5	F.II.3	F.II.5	F.III.4
F.IV.2	F.IV.3	F.IV.4	F.IV.5	F.V.2	F.VI.1
F.VI.5	F.VII.1	F.VII.3	F.VIII.5		
ETLA items loading high (>= 0.40) on only one factor.					
F.I.1	F.I.3	F.II.1	F.II.2	F.II.4	F.III.2
F.III.3	F.III.5	F.IV.1	F.V.1	F.V.3	F.V.4
F.VI.2	F.VI.3	F.VI.4	F.VII.2	F.VII.4	F.VIII.1
F.VIII.2	F.VIII.3	F.VIII.4			
ETLA items not loading high (< 0.40)					
F.VIII.5					

determine items that loaded high on one factor, items that loaded high on multiple factors, and items that did not load high on any factor. Table 19 provides a listing of ETLA item classification by these criteria.

As shown in Table 19, examination of the EFA results found 21 items that loaded high on only one factor. Sixteen (16) ETLA items were found with high loadings on multiple factors. One ETLA item, F.VIII.5, did not load high on any of the top six factors. This finding would indicate that this item should be reviewed for either revision or elimination in future versions of the ETLA survey. ETLA items that loaded high on only one factor were strong indicators for that particular factor. If a data reduction goal was to reduce the number of ETLA items and still measure each factor independently, the

items that loaded high on only one factor would be the strongest candidates for inclusion in the reduced collection of items.

In comparison, the ETLA items that loaded high on multiple factors would be strong indicators of education technology leadership in general. If a goal was to reduce the number of ETLA items and still measure overall education technology leadership, the items that loaded high on multiple factors would be the strongest candidates for inclusion in the reduced collection of items.

In the examination of factor loadings in this study it was important to recognize the limits of conducting factor analysis based on one data set (Kline, 1994). Rigorous EFA requires the analysis of multiple data sets. While the EFA methods used in this study produced evidence of inter-relationships in the data collected in the ETLA field test, additional data sets would need to be collected and analyzed using EFA methods to confirm (or refute) these initial findings.

Summary

Results for this study were collected in support of the two main phases of the study, the expert review phase and the field test phase. The expert review phase was designed to assist the researcher with the construction of ETLA survey items that would be valid measures of specific TL Standard areas. The field test phase was designed to collect data to be used in the analyses of the reliability and the validity of the ETLA survey items. Data collected in the field test was also examined for inter-relationships, using exploratory factor analysis (EFA).

Using feedback obtained from the expert judgment panel, the 44 draft ETLA items were refined, consolidated, and aligned with one of eight TL Standards. The result

at the conclusion of this editing process was the final version of the study's ETLA survey. The ETLA survey was based on a framework of eight dimensions (TL Standards). Each TL Standard area was represented by 4-5 ETLA items. There were a total of 38 items in the final ETLA survey. This version of the ETLA survey was used in a field test.

A Field Test Data Set and a Matched Data Set were created from a field test of the ETLA with a sample population of educators, and used to support quantitative statistical methods designed to study the reliability and validity of ETLA survey items. Item-scale correlation, item-rest correlation, Alpha if item removed analysis, and item mean score comparisons were the statistical methods used to generate the findings reported related to ETLA item reliability and validity. Analysis of the Field Test Data Set produced evidence that ETLA items were generating reliable and valid data.

Inter-relationships in the Field Test Data Set were explored using EFA methods. Reported EFA findings were centered on the identification of six factors. All ETLA items except item F.VIII.5 loaded high on one or more factors, indicating that most ETLA items were contributing effectively to the assessment.

Chapter 5 will contain a discussion of these findings. In Chapter 5 the findings will be connected to the review of literature. Action steps in response to the findings will also be explored.