SCALE PURIFICATION OF SKILL AND MARKETING KNOWLEDGE MEASURES: AN APPLICATION OF FACTOR ANALYSIS AND FACTOR MATCHING

Stuart Van Auken, Florida Gulf Coast University, College of Business,
South Fort Meyers, FL 33965-6565; (941) 590-7382
Shekhar Misra, and Richard Davis CSU-Chico, College of Business
Chico, CA 59929-0051; (530) 898-5666

ABSTRACT

As the importance of outcomes assessment increases, we need to look at ways of refining it. Factor Analysis provides one means of doing that. In addition to face validity of questions asked in assessment surveys, this approach provides a statistical basis. In our study we were looking to measure the perception of alumni regarding the relevance of various areas of skills and knowledge to their present jobs and how well the curriculum/program had prepared them for these tasks. Then a factor analysis was conducted to see if the "skills" and "knowledge" construct – based on face validity, did indeed hold up to statistical scrutiny. The results were very interesting and have implications for future research.

INTRODUCTION

Outcomes assessment is an important evaluative process in colleges of business, and part of the requirements of the AACSB – The International Association for Management Education accreditation and reaccreditation standards. Through such assessments continuous improvement and quality enhancement are facilitated. The AACSB points out (2000 p 2) that,"...the school should provide a total educational experience that emphasizes conceptual reasoning, problem-solving skills, and preparation for life-long learning. In addition to the AACSB requirements, the business community and some states require assessment of higher education (Eastman and Allen 1999). The continuous improvement process may result in changes to individual courses or the redesign of the marketing curriculum (Pharr and Morris 1997). There are a number of types of outcomes assessment, including test result measures, placement related measures, college performance measures, and long term satisfaction/achievement measures (Miller, Chamberlain and Seay 1991).

One type of assessment is a gap analysis in which the descriptive reality of a situation is compared against a benchmark or standard. One form of this is a comparison between a student's perception of emphasis in key instructional areas and the perceived importance of these emphases to one's current employment. As a result of such comparisons, areas of under- and over-preparation may be identified and adjustments contemplated. A recent study addressing this issue revealed an under-preparation in skills and an over-preparation in marketing knowledge among marketing alumni who were from three to five years beyond graduation (Davis, Misra, and Van Auken 2001). Other studies have looked at the topic of skills and knowledge (Floyd and Gordon 1998) or entry-level job skills (Scott and Frontczak 1996; Deckinger, Brink, Katzenstein, and Primavera 1990; These findings should prompt additional studies and explorations. For example, replications are necessary and measurement issues need to be addressed. With regard to the latter, insights need to be generated into scale development as applied to skill and marketing knowledge areas. By developing insights into scales, those desirous of the pursuit of gap analyses relating to emphases will have a firmer footing from which to work. This study, therefore, proposes to explore the data structure of instructional areas with respect to one's extent of preparation and also the perceived importance of these same instructional areas to one's current employment. By so doing, patterns in the data may be revealed and nonconforming variables may be altered or eliminated. The resulting purification recommendations in turn may serve to impact future data collection through measurement instrument modification and the confirmation of skill and knowledge constructs.

THE STUDY

The data for analysis as to structure came from a recent gap analysis of instructional variables (Davis, Misra, and Van Auken 2001). See Table 1 for an overview of 11 variables that were subjected to semantic differential readings. One data set was anchored to importance, while the other data set was anchored to preparation. The provision of two sets is significant because it offers a framework for scale comparison. The effective sample size for the study was 66 and it portrayed a 22.1 percent response rate from a survey of 298 alumni. It was this survey that revealed under-preparation in instructional areas that related to skills and over-preparation in instructional areas related to marketing knowledge. This research evidenced no *a priori* skill-versus-knowledge hypothesis development. It did result, however, in unique insights into skills and knowledge groupings.

THE FACTOR ANALYSIS

Factor Analysis is a term applied loosely to a category of multivariate statistical methods that help to define the underlying structure of a data matrix. It is particularly useful in analyzing the structure of interrelationships among a large number of variables, e.g., in an outcomes assessment instrument used to assess a curriculum or program as per AACSB directives. Two of the main uses of factor analysis are in data reduction and summarization.

Interestingly, factor analysis was first used almost a hundred years ago, in the area of education. Spearman (1904) used it to understand the link between performance in various courses and levels of intelligence. Unfortunately, contemporary literature in assessment has used factor analysis in a limited fashion. As one of the primary uses of factor analysis is to examine common underlying dimensions of a data structure, known as "factors," it has a significant role to play in the analysis and refinement of assessment instruments as it can give a better sense of what it is that we are measuring. In addition to face validity of the items, this can provide statistical validity, and can be helpful in refining the instrument.

In an effort to explore this data, a principal components factor analysis was employed. In this approach the analysis transforms a given set of variables into a new set of composite variables or principal components that are orthogonal (uncorrelated) to each other. It reveals the best linear combination of variables in the sense that the variable combination accounts for more variance in the data than any other linear combination of variables. The first factor extraction is therefore the best summary of linear relationships exhibited in the data, while the second factor is the second best linear combination, yet orthogonal to the first. The latter is important in analyses of data with a criterion variable and predictors that might be multicollinear. By reducing the data to orthogonal factors, the multicollinearity problem is substantially reduced. Additionally, the principal components analysis sheds additional qualitative insights into the data structures and provides a framework for assessing the latent variable that is holding a set of variables in a factor pattern.

Since the data had resulted in a skill-versus-knowledge discrimination, it was decided to set the initial factor analysis to a factor extraction solution equal to two. This is important because variables that do not relate to the expected skill-versus-knowledge factor can be eliminated or altered in future research. Thus, scale purification is facilitated (Churchill 1999).[1] To prompt this desired result, a varimax rotation option was selected. This rotation results in a factor-loading pattern that is distinguished by both high and low factor loadings.[2] It is not mathematically superior or inferior to an oblique or quartimax or other rotation pattern.

The factor analysis results as applied to student perceptions of the extent of importance of 11 instructional areas to their current employment are presented in Table 1.

(Insert Table 1 about here: Results Of Principal Components Factor Analyses With Vavimax Rotations: A Study Of Sills And Knowledge As To Importance And Extent Of Preparation)

This solution accounted for 57.3 percent of the variance in the data and it matches the variance extraction for an acceptable factor analysis solution (Malhotra 1999). As can be seen, the two-factor solution has revealed knowledge and skill factors; that is, the first factor denotes instructional variables that appear to be a function of marketing knowledge, while the second factor reveals variables that appear to be a function of skills. The outlying variable is instructional variable 1, which appears to portray a composite of skills and knowledge.

The results of factor analyzing the 11 instructional variables that related to the extent of student preparation are also found in Table 1. As before, the same two-factor solutional procedure was followed. The varimax rotation produced a similar factor pattern and a 54.5 percent variance extraction. Again, factor one denotes knowledge as the latent dimension holding the variables in the factor pattern and factor two reveals skill. As was the case with the importance data set, the first instructional variable did not load. Further, instructional variable 9 evidences a bi-loading pattern, thus suggesting a weakness with respect to knowledge and skills.

IMPLICATIONS

Indeed the two-factor solution reveals that knowledge and skills are separate orthogonal factors and that scale refinement or purification is possible. Future researchers might want to eliminate nonconforming variables or they could combine knowledge and skill variables for a third factor solution. At any rate, instructional variable 1 could be altered by deleting the reference to a marketing context. This should result in a skill assignment. Instructional variable 9 could also be modified by dropping the reference to communication. It could be replaced with the "ability to correctly use the language of marketing." This should result in a knowledge assignment in future analyses. Leaving them as is prompts a third factor dimension that combines knowledge and skills.

CONVERGENCE

Given two factor solutions (i.e., importance and preparation data sets), Cliff's F match procedure can be utilized to assess their convergence (Smith 1990). In this approach, factor matching performs an orthogonal rotation of two matrices to assess congruence. The results of matching the two factor studies are seen in Figure 1.

(Insert Figure 1 about here: Factor Matching: Results* Of Orthogoral Rotation Of Factor Aanalysis Of Importance And Preparation Data To Congruence)

The goodness-of-fit between the two matrices is equal to .936 and the correlation of distance vectors is equal to .814. By assessing the map, one will find skill variables on the left and knowledge variables on the right. Basically, the variables in the two studies have been paired in a multidimensional space and the results denote a constructive replication (Lykken 1968). In turn, these findings support theory development for skills and knowledge being concepts worthy of exploration in future research. What remains is the application of confirmatory factor analysis to support an evolving *a priori* theory. In this approach, one hopes to estimate population parameters from sample statistics. The objective is generalizability (Stewart 1981). Still, exploratory factor analyses are logical precursors and factor matching provides a form of theory validation.

CONCLUSION

Given the growing importance of outcomes assessment, measurement issues like scale refinement and validation, have become more important. Our research sought to evaluate two data sets of instructional variables using gap analysis. One data set was composed of alumni perceptions of importance of 11 instructional areas, while the other pertained to their perceived extent of preparation in each of the same areas. A principal components factor analysis revealed knowledge and skills as separate factors, which converged in the factor-matching procedure. Our analysis also revealed the variables that were nonconforming and which may eliminated or their wording modified in future research involving skills and knowledge. This would lead to a more purified scale. Further, this study also suggests that skills and knowledge may indeed be theory-based constructs, which are open to further testing and confirmation. Thus principal component analysis can lead to better and more valid outcomes assessment instruments. In turn, this should lead to greater acceptance of the findings from these assessments by stakeholder groups, including faculty.

COMMENTS

Tables and figures are available from the first author on request.

NOTES

1. The emphasis on factor analysis in scale development is particularly evident in semantic differential scaling (Churchill 1999).

2. According to Kachigan (1982), factor loadings of .3, .4, and .5 are most often used as lower bounds in factor interpretations.

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