

A PATTERN MATCHING APPROACH TO ASSESS THE CONSTRUCT VALIDITY OF AN EVALUATION INSTRUMENT

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ABSTRACT

Pattern matching is an approach for determining the correspondence between program theory and the observations or data collected from a program based on that theory. For each major component of an evaluation—program, participants, measures, and outcomes—there are theoretical and observed patterns, and the degree of correspondence between the theoretical and observed patterns is called the pattern match. This chapter describes a measurement pattern match and its use to provide evidence for the construct validity of an instrument developed for a program evaluation. The evaluation context is a study of the effects of a child care program provided by a hospital on employees' work-related attitudes and behaviors. The inter-correlations from the questionnaire administered to employees provide the observed pattern. The structured conceptualization method was used to develop the theoretical pattern from the perspective of administrators of hospitals that provide child care assistance. Results are presented of both visual and quantitative assessments of the match between the theoretical and observed patterns.

Pattern matching is used here to mean the "fit" or correspondence between theory, however well articulated, and the observations or data collected to bear on that theory—that is, the "pattern matching of the conceptual and operational domains" (Trochim, 1985, p. 575). This approach builds on Campbell's (1966) idea that pattern matching between theory and data is a way of achieving scientific understanding. The value of the pattern match is that the validity of the conclusions drawn is strengthened if the pattern predicted by the theory is found in the data, because the likelihood that such a pattern of results could have occurred by chance is small.

Trochim (in press) has proposed a model based on pattern matching principles that assists the researcher in articulating theory and in integrating theory more directly into the research process. His pattern matching model is based on the interplay between the theoretical realm (which is conceptualized as the theoretical pattern of a program and includes theories, ideas and hunches about a program), and the observational realm (which is considered the observed pattern and is operational-

ized as the observations, measures, and data from the program). As applied to program evaluation, the expected *outcomes* are contingent on (a) the nature of the *program*, (b) who the *participants* are, and (c) what is *measured*. Thus, for each major component of the evaluation—program, participants, measures, and outcomes—there are theoretical and observed patterns, and the degree of correspondence between the theoretical and observed patterns is called the pattern match.

This paper illustrates one type of pattern match—the measurement pattern match—and shows how it can be used as a framework to provide evidence for the construct validity of an evaluation instrument. In order to show evidence for construct validity, it is necessary to have (1) a theory or conceptualization of the expected relationships between the constructs of interest and related constructs from which they must be distinguished (the theoretical measurement pattern); (2) observed interdependence between purported measures of the constructs of interest and of related constructs (the observed measurement pattern); and (3) a "match" between these two patterns (Trochim, 1985).

The structured conceptualization method (Trochim, 1986; Trochim & Linton, 1986) was used to develop the pattern of expected relationships among the constructs, as represented by the graphical display or "concept map" from the multidimensional scaling analysis. Measures of the observed relationships were obtained from the data collected on the variables in the program evaluation. The "match" or correspondence between these respective theoretical and observed patterns can then be assessed both visually and quantitatively.

This pattern matching framework for construct validity is applied to an evaluation of a child care program provided by a large medical complex. The study assessed the effects of the employer-sponsored program on employees' work-related attitudes and behaviors, as well as their opinions about other work and family issues.

The framework for this study is provided in Figure 1. The theoretical measurement pattern was developed from the perspective of administrators of hospitals that provide child care assistance to their employees. Administrators were chosen for the theory development because they have a total organizational framework and are usually the decision makers responsible for authorizing such programs. Health administrators, in particular, are a relevant group because hospitals and other health care institutions, more than any other type of company or organization, have been in the forefront of providing child care programs for employees.

The observed measurement pattern was obtained from employees' responses to a questionnaire about the variables of interest. The employees were all working parents with preschool or school-aged children, who

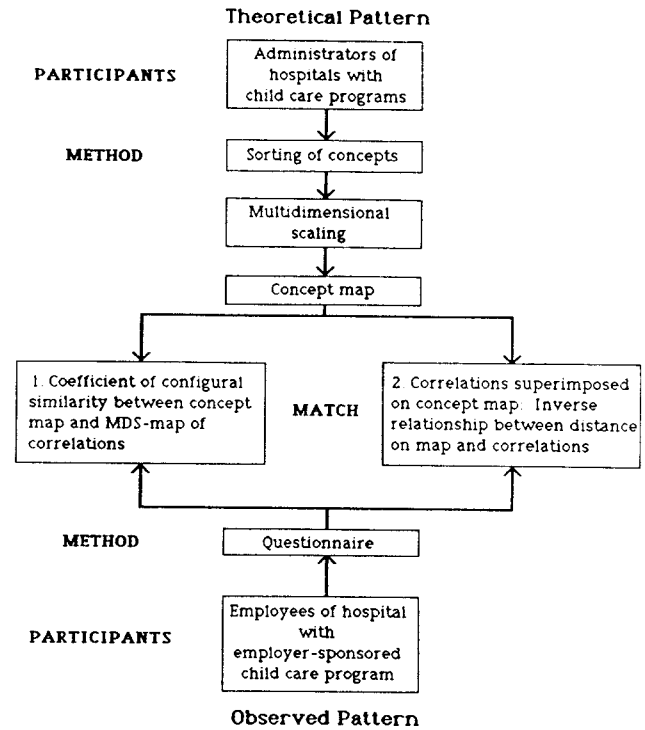


Figure 1. Framework for measurement pattern matches.

used either the employer-sponsored program or other child care arrangements.

The methods for generating the theoretical and observed measurement patterns and for assessing the match between the two patterns are further explained in the next section.

METHODS

Theoretical Measurement Pattern

Nine volunteers were recruited from the health administrators attending the 1986 annual Health Executive Development Program (HEDP).¹ Two of the nine participants in the conceptualization activity were female and the rest were male. They worked for public and private hospitals, and all geographic areas of the country were represented. A wide range of child care assistance was also represented, including on-site centers (3), information and referral services (2), subsidy or voucher programs (1), in-kind contributions—space (1), and a combination of assistance (2). The majority of the participants considered themselves somewhat or very familiar with issues related to employer-sponsored child care.

¹HEDP is an annual professional conference of health administrators sponsored by the Sloan Program in Health Administration, Department of Human Service Studies, Cornell University.

Concepts. The concepts used in the conceptualization activities were selected by the evaluator based on the variables investigated in the child care program evaluation. They included attitudinal, behavioral, and organizational concepts related to employer-sponsored child care. Specifically, they were: (a) *attitudinal*: recruitment, job satisfaction, organizational commitment, satisfaction with child care arrangement, stress in balancing work and family, and stress regarding child care; (b) *behavioral*: absenteeism and turnover; and (c) *organizational or structural*: organization's personnel policies, supervisor's personnel practices, and employer-sponsored child care.

Data collection and analysis. Two data collection sessions were held with the administrators: the first at the beginning of the conference, and the second, one week later.

At the beginning of the first session, the investigator

explained that she was interested in obtaining their opinions and ideas about employer-sponsored child care programs from their perspectives as administrators in hospitals that sponsor or have considered such programs. A sorting procedure (Rosenberg & Kim, 1975) was used to obtain data on how the health administrators perceived relationships among the concepts, and was adapted from the structured conceptualization method (Trochim, 1986; Trochim & Linton, 1986). Each volunteer was given a list of the concepts along with an envelope containing a set of eleven 3" x 5" index cards, with each concept name typed on one card. The investigator read through the list of concepts, and asked if there were any questions about the meaning of any of them. She clarified for one participant that all the attitudinal and behavioral concepts referred to the employee (or were employee-level) while the others were organizational-level.

The participants were then instructed to sort their cards into piles based on which ones seemed to "go together." They were told that this similarity could be based on any factors that seemed important to them; also, the number of piles was up to each of them, as long as they made more than one pile and less than eleven. When finished, each volunteer clipped each pile together, and put all the piles back into the envelope with his/her name.

At this point, the investigator asked if any other important concepts seemed to be missing. Productivity was suggested by one participant, although another group member pointed out that productivity may encompass some concepts already on the list, for example, not being absent, being satisfied with your job, and so on.

The card sorting exercise was repeated at a second session one week later. The same directions were given verbally, and the participants quickly sorted their cards and returned the envelopes. Several participants commented that the sorting task seemed easier and faster the second time because they were more familiar with the concepts and procedure. A microcomputer software program called the Concept System (Trochim, 1986) was used to enter and analyze the sort data. The algorithm for the nonmetric multidimensional scaling is contained in the program to produce the pictorial representation of the sort data, which is called a concept map (see Trochim, this volume).

Observed Measurement Pattern

The evaluation summarized here was of a child care program provided by a large medical complex in the midwest. The employer-sponsored program has two components: an on-site center, and an information and referral service to a network of family day care homes that are screened by the center staff.

A quasi-experimental design was used to compare the two groups of employee users of the company-sponsored child care program and two other groups of employees—one with preschool children and the second with school-age children—who were not using the company program. A survey questionnaire concerning employees' child care arrangements and attitudes about work and family issues was sent to all study participants approximately one year after the employer-provided program began.²

A correlation matrix was obtained from the survey data using Pearson Product-Moment correlations. The correlations were from the total sample of respondents ($n = 346$) to the survey questionnaire. The overall sample is comprised of technical and professional employees in their thirties. Roughly three-fourths of the respondents are female, and 85% are married. Just over 70% are full-time hourly or salaried employees. The predominance of female employees and the presence of a relatively high percentage of part-time employees are characteristic of hospitals and make them somewhat different than other employers.

Measurement Pattern Match

Because the concept map represents perceived relationships among the concepts and correlation coefficients are a way to measure the strength of relationships, it seems reasonable to link the correlations from the evaluation data with the concepts on the map to assess the match between the theoretical and operational domains. Two ways of assessing this measurement pattern match are then possible.

First match. It is possible to produce a map of the evaluation data by conducting a multidimensional scaling (MDS) analysis of the correlations between the variables on the questionnaire, and then to assess the pattern match between the concept map from the health administrators and the MDS-map of the correlation matrix. A visual, as well as a quantitative, assessment of the similarity between the two maps can be made. For the quantitative assessment, a correlation coefficient can be calculated from the distances between the concepts on the two maps (see Davis, this volume). This correlation is called here the coefficient of configural similarity, and represents the degree to which distances between points on the two maps are similar. A higher coefficient would indicate greater spatial correspondence and, thus, greater configural similarity between the theoretical and observed measurement patterns.

For the operationalization of this pattern match, a

²Data on absenteeism and turnover were collected from personnel records but are not included in these analyses (see Marquart, 1988).

concept map was obtained with the eight attitudinal and organizational variables for which correlations could be calculated from the questionnaire. This concept map was produced by conducting a multidimensional scaling analysis of only those eight variables from the two sortings by the administrators. A correlation matrix was then obtained on those variables from the questionnaire, and a map was produced using the absolute values of the correlations. These values were used, just as the sort data, as input for the Concept System to produce the map. For the qualitative assessment of this pattern match, a visual comparison of the placement of the concepts on the two maps was made. For the quantitative assessment, the distances between points on the two maps were correlated.

Second match. Using the principles of convergence and discrimination from the multitrait-multimethod approach to construct validation (Campbell & Fiske, 1959), one might expect that the variables that are located closer together on the concept map would be more highly correlated, or conversely, the greater the distance between variables, the lower the correlation would be. That is, there should be an inverse relationship between distance on the map and the correlations from the evaluation data.

To test this idea, the correlations between each pair of variables from the questionnaire were superimposed on the concept map. A visual assessment was then made of the expected inverse relationship between distance on the map and the strength of the correlations.

RESULTS

This section presents (a) the perceived relationships among the concepts related to employer-sponsored child care as portrayed in a concept map (theoretical pattern); (b) the correlations among the variables obtained from the survey questionnaire (observed pattern); and (c) the match or degree of correspondence between the theoretical and observed patterns.

Theoretical Pattern

The concept map shown in Figure 2a depicts the results of the multidimensional scaling analysis of the attitudinal and organizational concepts by the health administrators. This map is a two-dimensional solution, which is chosen for its ease of interpretation, and represents the theoretical measurement pattern. The horizontal dimension is exaggerated by the plotting routine; however, the actual coordinate values are preserved.

Since location on the map is a function of perceived similarity, the concepts that were most frequently

sorted together are closest to each other, and those that were seldom or never sorted together are farthest apart or on opposite sides of the map. Based on their similarity, three groups of concepts stand out on the map: one with the concepts referring to work attitudes (job satisfaction and organizational commitment), a second with the concepts pertaining to child care issues (the two stress concepts and child care satisfaction), and a third linking recruitment with personnel policies and practices.

Observed Pattern

The correlation matrix of the variables from the survey questionnaire is presented in Table 1. This matrix represents the observed measurement pattern. The absolute values of the coefficients are used in assessing the pattern match because the strength of the relationship is of primary interest in this case.

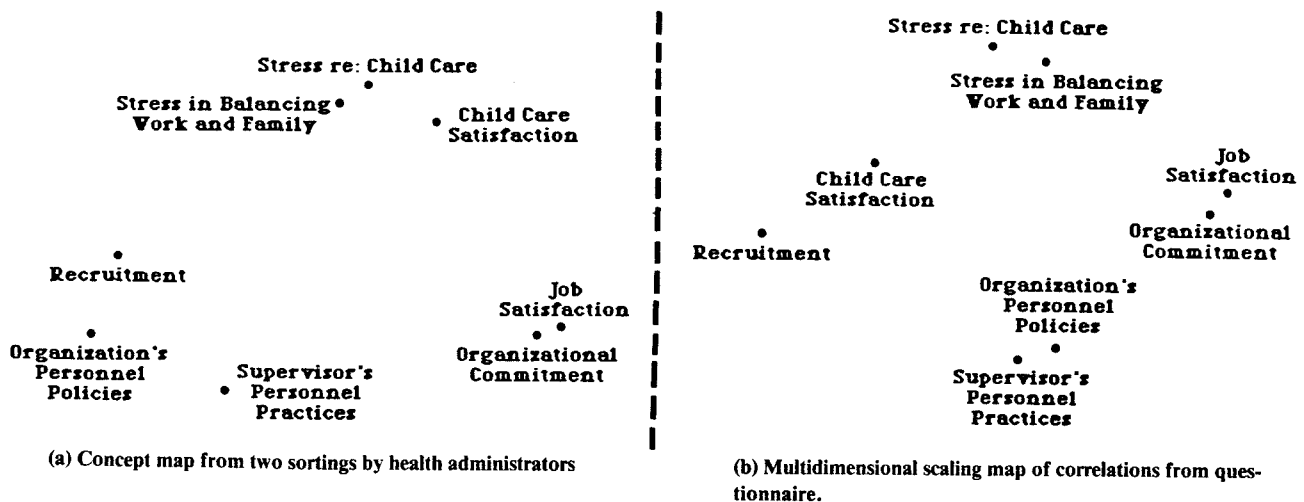


Figure 2. First measurement pattern match: Coefficient of configural similarity between theoretical (a) and observed (b) patterns, $r = .76$.

TABLE 1
OBSERVED MEASUREMENT PATTERN: CORRELATION MATRIX OF VARIABLES FROM QUESTIONNAIRE

Variables	Rec.	Job Satis.	Org. Comm.	Stress re: Child Care	Stress in Bal. Work & Family	Org.'s Pers. Pol.	Supr.'s Pers. Prac.	Satis. with C.C. Arr.
Recruitment	1.00							
Job Satisfaction	.14	1.00						
Organizational Commitment	.10	.52	1.00					
Stress re: Child Care	.15	-.08	-.11	1.00				
Stress in Balancing Work & Family	.13	-.24	-.14	.44	1.00			
Organization's Personnel Policies	.17	.16	.21	-.03	-.05	1.00		
Supervisor's Personnel Practices	.16	.19	.12	.01	-.03	.59	1.00	
Satisfaction with Child Care Arrangement	.11	.08	.10	-.23	-.21	.18	.09	1.00

Pattern Match

First match. A multidimensional scaling analysis was conducted on the correlational data to produce the map shown in Figure 2b. This map represents another way of depicting the observed measurement pattern. The map showing the theoretical pattern (Figure 2a) is placed beside the observed pattern in Figure 2b for visual comparison.

The map from the evaluation data in Figure 2b shows three distinct groups of variables—those pertaining to stress, work attitudes, and personnel issues; the two other variables—recruitment and child care satisfaction—are separated from the others. The pairs of variables that were most highly correlated with each other separated into their own groups. Child care satisfaction, which was most strongly correlated with the two stress variables and organization's personnel policies, was placed at roughly an equal distance from those concepts. Recruitment, which was correlated about equally with the rest of the variables, was placed on the far left of the map.

The coefficient of configural similarity, or spatial correspondence, between the revised theoretical map and the map obtained from the evaluation data was .76. This correlation indicates that there is a relatively high degree of configural similarity between the two maps, that is, between the perceptions of the health administrators of the relationships between the concepts and the actual correlational pattern found in the evaluation data.

Second match. Figure 3 shows the correlations superimposed on the concept map from the administrators. In order to visually differentiate the strength of the correlations, lines of different widths are used—the widest line for the highest values, a medium line for moderate values, and a thin line for the lowest values. This figure represents another way of portraying the correspondence between the theoretical and observed measurement patterns.

In general, the variables that are located closer to each other on the map are more highly correlated, and the variables that are located farther apart have lower correlations. For example, the three most highly correlated pairs of variables are organization's personnel policies and supervisor's personnel practices ($r = .59$), job satisfaction and organizational commitment ($r = .52$), and stress related to child care and stress in balancing work and family ($r = .44$). For the most part, these three pairs of variables are located closer to each other than to any other variables. Also, the three variables within the group pertaining to child care issues are more highly correlated with each other than with variables in the other two groups. Conversely, the two personnel variables have the lowest correlations with the two stress variables, and these two sets of variables are located farthest apart on the map (taking into account the artificial elongation of the map).

The only exceptions to this confirmatory pattern of relationships are between job satisfaction and stress in balancing work and family ($r = .24$), and between organizational commitment and personnel policies ($r = .21$). The placement of recruitment on the map is also interesting to note. Although recruitment is correlated rather weakly and about equally with all the other variables, it is most highly correlated with organization's personnel policies (.17) and supervisor's personnel practices (.16), and recruitment is also located closer to those two variables on the map than to any others.

The inverse relationship between distance on the map and the correlations can be observed in this figure. In general, the greater the distance between variables, the lower the correlation was, and vice versa. Overall, a fairly high degree of correspondence was found between the administrators' perceptions of the relationships between the concepts related to employer-sponsored child care and the correlations among the variables on the questionnaire.

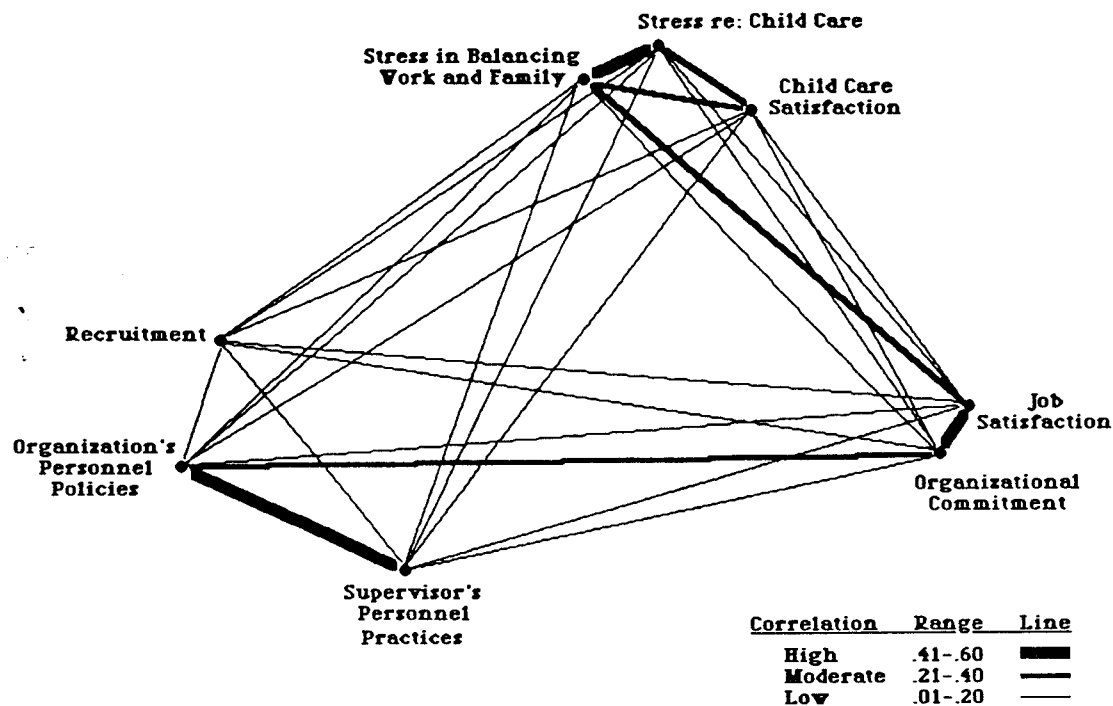


Figure 3. Second measurement pattern match: Evaluation correlations superimposed on concept map.

CONCLUSIONS

A fairly high degree of correspondence was found between the health administrators' perceptions of the relationships between the concepts related to employer-sponsored child care and the correlations from the child care program evaluation, that is, between the theoretical and observed measurement patterns. This claim is supported both by the high coefficient of configural similarity ($r = .76$), and by the inverse relationship found between the distances between the concepts on the map and the correlations. These two successful matches between the theoretical and observed measurement patterns provide substantial evidence for construct validity of the survey instrument.

Although this study represents a first step in using the pattern matching approach to assess the correspondence between theory and data, it suggests other ways in which such a framework might be used in program evaluation. The approach could be used to guide the entire instrument development and validation process by involving the program constituents in conceptualiz-

ing the major concepts of interest, using those concepts to construct an instrument, and then using the data collected to provide evidence for the construct validity of the instrument as well as to assess program outcomes (for example, see Marquart, 1987, and Valentine, this volume.)

On the methodological side, the approach offers an alternative to methods commonly used to assess the validity of an instrument. It has an advantage over factor analysis for scale development in that multidimensional scaling does not impose the same constraints on the level of measurement. As was illustrated in the examples, because of the flexibility of the multidimensional scaling procedures, the sorting data as well as the scaled data from the questionnaire could be analyzed and compared. With further application, the pattern matching approach will be refined so that its potential for improving the development and use of theory in program evaluation can be determined.

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William M.K. Trochim
Guest Editor

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William M.K. Trochim
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CONTENTS

INTRODUCTION

- William M.K. Trochim** 1 An Introduction to Concept Mapping for Planning and Evaluation

THEORY DEVELOPMENT

- Kathleen Valentine** 17 Contributions to the Theory of Care
- Rhoda Linton** 25 Conceptualizing Feminism: Clarifying Social Science Concepts

MEASUREMENT, CONSTRUCT VALIDITY, AND PATTERN MATCHING

- James E. Davis** 31 Construct Validity in Measurement: A Pattern Matching Approach
- Jules M. Marquart** 37 A Pattern Matching Approach to Assess the Construct Validity of an Evaluation Instrument

OUTCOME ASSESSMENT AND INTERNAL VALIDITY

- Valerie J. Caracelli** 45 Structured Conceptualization: A Framework for Interpreting Evaluation Results
- Patrick F. Galvin** 53 Concept Mapping for Planning and Evaluation of a Big Brother/Big Sister Program

METHODOLOGICAL ISSUES

- Leslie J. Cooksy** 59 In the Eye of the Beholder: Relational and Hierarchical Structures in Conceptualization
- Marc Mannes** 67 Using Concept Mapping for Planning the Implementation of a Social Technology

(Continued on next page)

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(contents continued)

Douglas Keith	75	Refining Concept Maps: Methodological Issues and an Example
Jeanne Dumont	81	Validity of Multidimensional Scaling in the Context of Structured Conceptualization
		<i>CONCLUSION</i>
William M.K. Trochim	87	Concept Mapping: Soft Science or Hard Art?
	111	Issue Contributors
	I	Software Survey Section
Inside back cover		Instructions to Authors