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ABSTRACT

The purpose of the present study was to determine how two different data collection techniques would affect the Q-factors derived from several factor analytic procedures. Faculty members (N=146) from seven middle schools responded to 61 items taken from an instrument designed to measure aspects of an idealized middle school culture; the instrument is the Middle School Description Survey (MSDS). In three of the schools, the data were collected using conventional Q-sort procedures. In the remaining four schools, data were collected using an unmarked graphic scale. Separate principal components Q-technique factor analyses were used with the data collected in each school, and results were rotated to the varimax criterion. For each of the seven Q-technique analyses, factor stability was assessed by consulting the magnitude of the eigenvalue of the first factor extracted, the mean eigenvalue of all extracted factors, the average squared communality value, and the mean factor structure coefficient. Results indicate that the data collected via the unmarked graphic scale produced more stable and reliable Q-factors than did data collected via traditional Q-sort procedures. The 61 items included in the MSDS are listed. (Author/TJH)

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STABILITY OF Q-FACTORS ACROSS TWO DATA COLLECTION METHODS

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Paper presented at the annual meeting of the Mid-South Educational Research Association, Little Rock, AR, November 8-10, 1989.

ABSTRACT

The purpose of the present study was to determine how two different data collection techniques would affect the Q-factors derived from several factor analytic procedures. Faculty members from seven middle schools responded to 61 items taken from an instrument designed to measure aspects of an idealized middle school culture. In three of the schools, the data were collected using conventional Q-sort procedures. In the remaining four schools, data were collected using an unmarked graphic scale. Separate principal components Q-technique factor analyses were utilized with the data collected in each school, and results were rotated to the varimax criterion. For each of the seven Q-technique analyses, factor stability was assessed by consulting the magnitude of the eigenvalue of the first factor extracted, the mean eigenvalue of all extracted factors, the average squared communality value, and the mean factor structure coefficient. Results indicate that the data collected via the unmarked graphic scale produced more stable and reliable Q-factors than those data collected via traditional Q-sort procedures.

STABILITY OF Q-FACTORS ACROSS TWO DATA COLLECTION METHODS

Factor analysis has been defined as ". . .a variety of statistical techniques whose common objective is to represent a set of variables [or other factored entities] in terms of a smaller number of hypothetical variables" (Kim & Mueller, 1978, p. 9). All factor analytic techniques are based upon matrices of association among all variables or other factored entities (e.g., persons, occasions of measurement) within a given data set. In a given factor analytic procedure, the matrix of association is statistically analyzed, and factors are extracted which maximally account for the interrelationships among the factored entities (Kerlinger, 1986).

Social scientists (e.g., Cattell, 1952, 1966; Rummel, 1970) conceive of a three-dimensional model (often referred to as a "data box" or "data cube") for measuring and describing any given psychological or ideological phenomenon. These three dimensions (called modes) are generally considered to be persons, variables, and occasions of measurement (Cattell, 1952). Factor analytical techniques usually involve two of these three modes, one of which is factored across the other. In R-technique, the most commonly-used technique, variables define the columns and persons define the rows of the raw data matrix used to create the factored matrix of associations. In Q-technique, the most commonly-used alternative to R, the same two dimensions are used although they are reversed (Comrey, 1973). Consequently, Q-technique factor analysis has been referred to as "transposed" analysis (Nunnally, 1967) and as "inverse analysis" (Comrey, 1973).

R-technique factor analytic methods are frequently used to identify which items within a data set identify or measure certain theoretical constructs. Hence, these methods allow for testing the validity of constructs. Q-methodology, on the other hand, provides for the grouping or clustering of individuals according to the similarity of their responses on a given set of variables (Stephenson, 1953). It is a useful technique when the researcher wishes to identify or confirm the existence of person-prototypes or certain groups of subjects (or "persons factors"--Kerlinger, 1979) who respond differently from others (Lorr, 1983). For example, Thompson (1980a) used Q-methodology to identify distinct clusters of persons relative to a set of items designed to distinguish different orientations of educational evaluators.

In Q-methodology, individuals are asked to rank order a series of items according to some predetermined criterion. The most commonly used technique for collecting data for Q-technique factor analysis is the Q-sort. The most common Q-sort strategy, which has been termed the "conventional-sorting strategy" (Thompson, 1980b) has been described by Kerlinger (1979):

> . . .the Q-sort [is] a deck of from 40 to about 100 cards on which items are typed or otherwise depicted. (Drawings and abstract figures, for example, have been used.) Individuals are instructed to sort the cards into six to ten or even more piles according to various criteria: like-dislike, approval-disapproval, like me-not like me, and so on. Different values are assigned

> to each pile--usually 0 through 7, 8, 9, or 10--and these numbers are used to intercorrelate the sets of responses of different individuals with each other. [p. 200]

Generally, it is recommended that the sorter be instructed to place varying numbers of cards in each of the several piles so as to obtain a normal or quasi-normal distribution (Kerlinger, 1986). In other words, once the stack of cards is sorted, the extreme piles will normally contain few cards, while the piles nearer the middle of the attitudinal continuum will contain more cards. As an alternative to the use of a quasi-normal distribution, some Q-sorts have incorporated a rectangular distribution, i.e., a distribution in which each pile of cards contains an equivalent or nearly equivalent number of cards. Kerlinger (1986) argues, however, that the use of a quasi-normal distribution in Q-sorts is generally superior due to various statistical properties of such a distribution.

One of the shortcomings of conventional Q-methodology data collection is that the procedure throws away information about differences among the items within a given category (Thompson, 1980b). For instance, all of the cards sorted into an ipsative category termed "most like me" would be scored the same despite the fact that the sorter may not feel equally about each of the items. To remedy this problem, Thompson (1980b) recommended a "mediated-ranking procedure" in which all of the cards sorted according to the conventional procedure are then rank-ordered within each given category. Once these rank-ordered cards are

hierarchically aggregated by categories, items will be fully rank ordered, and therefore each card can receive a unique ranking.

Although the mediated ranking approach to collecting Q-methodology data is superior to the conventional approach, it requires a rather lengthy commitment of time on the part of the subject. A more time-economic alternative has been suggested by Thompson (1981) and empirically employed in a study by Townsend (1987). This technique, termed the "unnumbered graphic scale," (Thompson, 1981) consists of an unnumbered continuum between two bipolar adjectives or descriptors (e.g., "agree" and "disagree"; "most like me" and least like me"). An example of this response format is shown in Figure 1. Subjects are instructed to read each item and respond by placing a vertical line through the continuum at the point which best represents their opinion on the item. When scoring items, the scorer can divide the continuum into more or fewer scale steps based on the amount of variance in scores that is desired. Another advantage of this procedure is that subjects' ratings of the items on a questionnaire may be easily converted to item rankings with the leftmost mark receiving a rating of one and the rightmost mark receiving a rating equivalent to the number of items on the instrument. Hence, when comparing this unmarked scale to traditional numeric Likert-type scales, it can be concluded that the unmarked scale allows for scoring of items including more score steps resulting in larger standard deviations, higher reliabilities of items, and ultimately greater reliability of factors (Thompson, 1981)

INSERT FIGURE 1 ABOUT HERE

Considering these purported advantanges of the non-conventional unmarked graphic scale over conventional Q-sorting data collection strategies, the purpose of the present study was to determine whether data collected using the unmarked graphic scale would produce more reliable Q-factors in an actual research situation. Consequently, data were collected by both of these methods, and results were compared. A similar study comparing the merits of various Q-methodology data collection procedures was conducted by Carr (1989). The analyses presented herein are part of a larger work which was purposed to establish instrumentation for studying the nature of organizational culture in middle-level schools (Daniel, 1989).

Sample Selection

The sample consisted of all full-time faculty members and administrators from seven selected public middle-level schools located in three school districts in southern Louisiana. Four of these schools (A, B, C, and D) were suburban schools each serving a predominantly white student clientele. The other three schools (E, F, and G) were inner-city schools each serving a predominantly black student clientele. The numbers of subjects responding in Schools A through G were 28, 27, 20, 18, 17, 14, and 22, respectively, with the total number of subjects employed in the present study being 146.

Instrumentation

An instrument called the Middle School Description Survey (MSDS) (Daniel, 1989) was used to measure teachers' and

administrators' perceptions of the presence of elements of an "ideal type" middle school culture in the middle-level schools in which they work. The MSDS consists of 61 Likert-type items designed to measure elements of an ideal-type middle school culture as espoused by middle school advocates. Items included in the survey may be found in Appendix A. Results of procedures to establish the reliability and construct validity of the MSDS are reported by Daniel (1989).

In three of the selected schools (Schools A, B, and C), data were collected using a conventional Q-sort procedure, with the 61 items printed on cards which the subjects sorted into nine hierarchical agree-disagree categories. The number of items sorted in the "1" to "9" stacks were 3, 5, 7, 9, 10, 9, 7, 5, and 3, respectively. In the remaining four schools (Schools D through G), data were collected using a printed instrument with an unmarked graphic scale (Thompson, 1981) provided for the subjects' response to each item. Respondents' ratings of the items were converted to ranked data, with the leftmost mark receiving a rank of "1" while the rightmost item received a rank of "61."

Data Collection and Analysis

The instruments were hand delivered to a contact person at each of the seven schools, and were, in turn, distributed to faculty members and collected at the end of one week. Total anonymity of persons and schools was assured. Following the initial collection of the instruments, a letter of reminder was distributed, requesting that faculty members return the

instruments to their building representative if they had not previously done so. One additional week was allowed for completion of the instrument.

A separate Q-technique factor analysis was performed for each school in which the data were collected. The purpose of these analyses was to attempt to identify clusters of persons (person factors) within each school relative to the middle school culture construct assessed using the 61 items from the Middle School Description Survey (MSDS). Factor structures across the two cohorts of schools were compared to determine the usefulness of each of the two data collection strategies employed. The analyses presented in the present study are limited to an assessment of factor stability across the two data collection methods. Readers interested in the nature of the identified clusters relative to the organizational culture construct are referred to the larger work from which the present study was adapted (Daniel, 1989).

As previously noted, Q-technique factor analysis (Cattell, 1966) factors people across variables, creating clusters of people who represent prototypes of individuals who respond differently than others on a given set of items. Unlike R-technique factor analytic methods, Q-technique analyses are "small sample" techniques. In R-technique analysis it is desirable to have several times more people than there are factored variables. In Q-technique, however, it is desirable to have <u>more items</u> than there are factored people. In general, the upper bound on the number of people who can be factored in a Q-

technique is taken to be (v/2) - 1, where v is the number of variables. Thus, since the largest number of subjects responding in any one of the selected schools was 28, the seven subsamples utilized in the present study were considered to be of appropriate size to be factored across the 61 MSDS variables.

The seven Q-technique factor analyses were performed using the SPSSx FACTOR procedure. Factors were extracted using the principal components method, and results were rotated to the varimax criterion. From three to seven components were extracted across the seven schools, and person factors were determined based upon a minimum factor-structure coefficient criterion of $\pm$0.40 in Schools A through C, and $\pm$0.45 in Schools D through G. Different criteria for salience were employed since the two response formats yielded different amounts of variance.

Once person factors were determined in a given school, standardized regression factor scores were utilized to determine which items contributed to the emergence of each of the person factors in the school. Since factor scores are z-scores, the scores indicate the degree to which individuals within a given sample deviate from the mean response on a given item where these deviations help to differentiate the clusters of persons. Hence, for the purposes of interpreting person factors obtained in the analyses performed on the data from the seven selected schools, only items with factor scores greater than |1.5| were examined.

Analysis of the Data in Schools A through C

As previously noted, data were collected in Schools A through C using conventional Q-sort procedures, with items given

a score from one to nine based upon the pile into which the respondents sorted the cards. In general, the responses of individuals within these schools were heterogeneous, with a large number of person factors emerging in each of the schools. These results suggest a high level of fragmentation across the cultures in these three schools.

School A. The initial analysis of the data from School A yielded 11 factors with prerotation eigenvalues greater than one. An examination of the "scree" plot of the eigenvalues indicated the appropriateness of a seven-factor solution accounting for 56.2% of the explained variance. Twenty-one (21) of the 28 individuals in this school were classified into one of the five factors using a minimum factor-structure coefficient criterion of ±0.40. The remaining seven persons either failed to meet the factor-structure coefficient for any of the five factors, or else were substantially associated with more than one factor.

School B. Initial principal components analysis of the data from School B yielded 12 components with prerotation eigenvalues greater than one. An examination of the "scree" plot of the eigenvalues indicated the appropriateness of a six-factor solution accounting for 49.6% of the explained variance. Nineteen of the 27 individuals in this school were classified into one of the five factors using a minimum factor-structure coefficient criterion of ±0.40.

School C. The initial principal components analysis for School C indicated that there were eight factors having prerotational eigenvalues greater than one. Analysis of the

"scree" plot of the eigenvalues suggested the appropriateness of a five factor solution. These five factors accounted for 51.3% of the explained variance. Using a minimum factor-structure coefficient value of ±0.40, 16 of the 20 persons in the school were classified into one of the five factors.

Analysis of the Data in Schools D through G

Q-technique factor analytic data were collected in Schools D through G using a printed format of the Middle School Description Survey, with responses for each item indicated by the respondents' marking on an unnumbered continuum. These response ratings for each item were converted into ranked data with each item receiving a rank from one to 61. In general, the response structures of individuals in these four schools were more homogeneous than the structures for individuals in Schools A through C, with a smaller number of factors accounting for a greater percentage of the explained item variance emerging in these schools. It was anticipated that this response format would create more systematic response variance which would be utilized to clarify factor structure such that fewer factors would tend to reproduce a larger proportion of the variance.

School D. The initial principal components analysis for School D indicated that there were five factors having prerotational eigenvalues greater than one. Analysis of the "scree" plot of the eigenvalues suggested the appropriateness of a three factor solution. These three factors accounted for 54.3% of the explained variance. Using a minimum factor-structure coefficient value of ±0.45, 13 of the 18 persons in the school

were classified into one of the three factors.

School E. Initial principal components analysis of the data from School E yielded five components with prerotation eigenvalues greater than one. An examination of the "scree" plot of the eigenvalues indicated a three-factor solution accounting for 52.7% of the explained variance. Fifteen of the 17 individuals in this school were classified into one of the three factors using a minimum factor-structure coefficient criterion of ±0.45.

School F. The initial analysis of the data from School F yielded four factors with prerotational eigenvalues greater than one. An examination of the "scree" plot of the eigenvalues indicated the appropriateness of a three-factor solution. These three factors accounted for 50.5% of the explained variance. Thirteen of the 14 individuals in this school were classified into one of the three factors using a minimum structure coefficient criterion of ±0.45.

School G. Initial principal components Q-technique analysis of the data from respondents in School G yielded seven factors with prerotational eigenvalues greater than one. A five-factor solution was selected based upon the "scree" plot of the eigenvalues, and results were rotated to the varimax criterion. These five factors accounted for 54.6% of the explained variance. Of the 22 persons in this school, 20 were classified into one of the five factors.

Comparison of Two Q-technique Data Collection Techniques

As previously noted, Q-technique factor analytic data

collected using the unmarked graphic scale tended to yield fewer, more reliable, and more interpretable person factors. A summary of the differences in the number of factors extracted, the average communality of the persons, the magnitude of the prerotation eigenvalues for the first factors, the average value of the eigenvalues of the factors extracted, and the average of the absolute values of the factor structure coefficients in the factor matrices for the selected solutions across the two data collection strategies, are presented in Table 1. These data indicate that the unmarked graphic scale is a method for collecting data for Q-technique factor analysis that is noticeably superior to the traditional Q-sorting procedure.

INSERT TABLE 1 ABOUT HERE

Discussion

The foregoing results serve as a confirmation of methodological assumptions proposed by Thompson (1981) and previous empirical evidence provided by Carr (1989) that traditional Q-sort data collection strategies may not produce Q-factors that are maximally stable. Summary factor analytic statistics across the two cohorts of schools indicate that Q-factors based upon data collected using the unmarked graphic scale tended to account for a greater amount of the variance among subjects' responses, indicating that the unmarked graphic scale is the superior method for collecting Q factor analytic data. These statistical advantages to using the unmarked graphic scale are especially promising when one considers the various practical advantages to using these data collection strategies.

Three such advantages will be addressed here.

First of all, the unmarked graphic scale is promising due to its ease of administration. By contrast, one problem with conventional Q-sorting is the cumbersome and time-consuming nature of its administration. Subjects who participated in the conventional Q-sort as part of the present study, for example, took about 35 to 45 minutes to complete the sorting of the 61 items into nine categories. On the other hand, subjects completing the MSDS featuring the graphic scale response format required only 15 minutes or so to complete the instrument. In addition, subjects tend to find it easier to respond using the unmarked graphic scale without the need for detailed administrative instructions.

A second practical advantage in collecting Q-factor analytic data using the unmarked graphic scale has to do with the versatility of the data collected. Since data collected using the unmarked graphic scale can be converted to ratings using any appropriate scaling metric (i.e., any predetermined number of scale steps), the data can also be used in other applications besides Q-factor analysis. For instance, a researcher might wish to use unmarked graphic responses on an instrument to determine the instrument's construct validity using R-technique methods and then use the same data to determine if the instrument proves useful in identifying person clusters using Q-technique methodology. Unfortunately, conventional Q-sorting procedures do not afford the researcher this versatility.

A third practical advantage to using the unmarked graphic

scale over conventional Q-sorting procedures is the degree to which it respects the integrity of subjects' responses. Conventional Q-sort procedures are ipsative in nature, forcing subjects to assign a predetermined number of items to each respective pile despite subjects' actual feelings about the items. Contrariwise, the unmarked graphic scale allows the respondents to choose the exact point on a continuum which best represents their reaction to an item without consideration for how they have responded to any other items included in the sort.

Perhaps the major disadvantage to using the unmarked graphic scale is the difficulty in scoring the items. This is problematic especially when the instrument employed has a multi-page format. However, physically separating the pages and placing them on a table where all responses may be easily seen may alleviate this problem. Townsend (1987) reports using a large artist's T-square to assist the scorer in differentiating ranks which are close to one another on the continuum. Although scoring may be somewhat time-consuming, the above disadvantages far outweigh this and other possible disadvantages.

Summary

The Middle School Description Survey (MSDS) was completed by 146 educators in seven different middle schools. Data from each of the schools were used in separate Q-technique factor analyses. In three of the schools, data were collected using conventional Q-sort procedures while in the remaining four schools, data were collected using an unmarked graphic scale format. Results of Q-technique factor analyses indicate that data collected using the

unmarked graphic scale tends to produce more highly stable Q-factors. Other advantages of the unmarked graphic scale include its ease of administration, its ability to generate data which can be used in a variety of analyses, and its potential for honoring the integrity of subjects' responses.

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Table 1
Average of Factor Analytic Statistics Across Schools and School Cohorts

School (n)	Eigenvalue of Factor I	Mean Eigenvalue of Extracted Factors	Average h^2	Mean |Structure Coefficient|	Explained Variance in Factors I-III
A (28)	5.0	2.2	.58	.21	33.1%
B (27)	4.2	2.2	.50	.24	31.8%
C (20)	3.3	2.0	.53	.24	35.8%
Cohort Avg.	4.2	2.1	.54	.23	33.6%
D (18)	6.3	3.3	.54	.36	54.3%
E (17)	5.3	3.0	.66	.34	52.7%
F (14)	3.7	2.4	.51	.31	50.5%
G (22)	4.1	2.4	.55	.25	38.3%
Cohort Avg.	4.9	2.8	.57	.32	49.0%

Figure 1
Example of Unmarked Graphic Scale Response Format

Students in my school make good grades.

STRONGLY DISAGREE ----------|---------- STRONGLY AGREE

(This response indicates that most students in the respondent's school make good grades.)

Appendix A
Items Included in the Middle School Description Survey

(1) In my school, teachers are encouraged to help other teachers evaluate the effectiveness of instructional strategies.
(2) In my school, a majority of the decisions regarding the school budget are made at the building level.
(3) In my school, there is a student advisement program that allows every student to receive regular, supportive counsel from a concerned adult.
(4) In my school, values are stressed that are consistent with those of the local community.
(5) In my school, teachers are discouraged from talking openly about any serious school matter.
(6) In my school, it is important for teachers to socialize informally with students outside the classroom.
(7) In my school, faculty and staff members show a lot of respect for one another.
(8) In my school, students at different grade levels are generally kept apart from each other.
(9) In my school, teachers are allowed to develop their own approaches to student discipline rather than conform to a school-wide plan.
(10) In my school, a healthy balance is maintained between competition and cooperation.
(11) In my school, the principal interacts with students.
(12) In my school, frequent adjustments in the school schedule are frowned upon by most people who work there.
(13) In my school, all classes meet the same number of times each week for the same amount of time.
(14) In my school, teachers believe that all students will become interested in school if learning is made appropriate to the students' interests and needs.
(15) In my school, each student has at least one adult who has a designated responsibility for that student's welfare.
(16) In my school, much planning is done to ensure the emotional security of students.
(17) In my school, considerable effort is devoted to getting parent, community, and business groups to participate in the school program.
(18) In my school, most teachers tend to reward students' curiosity.
(19) In my school, decisions are usually made based upon the needs of the students served rather than upon administrative concerns.
(20) In my school, most teachers are willing to experiment with new approaches to teaching.
(21) In my school, teachers view inservice workshops as a waste of time.
(22) In my school, most teachers regularly include physical activity and hands-on experience as a part of classroom instruction.
(23) In my school, it is common for teachers and administrators to share stories about students who are noted for their remarkable success in school.
(24) In my school, teachers expect students to behave as adults.
(25) In my school, curriculum and instruction decisions are primarily the work of the school administration.
(26) In my school, efforts are made both to communicate with and improve relations with the community.
(27) In my school, students are given opportunity for meaningful input into decision-making.
(28) In my school, teachers view the principal as an instructional leader.
(29) In my school, most of the students are happy the majority of time they are at school.
(30) In my school, scheduling is basically the job of the administration.
(31) In my school, a considerable amount of effort is devoted to improving faculty morale and school spirit.
(32) In my school, teachers like to involve students in the planning and evaluation of school programs.
(33) In my school, school spirit and unity are promoted by symbolic actions such as wearing school colors, promoting school mottoes, etc.

(34) In my school, the faculty and administration have high expectations of all students.
(35) In my school, the schedule allows for blocks of time to be allocated to more than one subject area.
(36) In my school, teachers tend to talk with students other than those they teach.
(37) In my school, the principal often rewards teachers who are doing a good job.
(38) In my school, teachers provide a supportive atmosphere for meeting individual student needs, welcoming wide ranges of student diversity.
(39) In my school, students are allowed certain periods of the day when they can be noisy and exert themselves physically.
(40) In my school, the principal tries to "buffer out" any influence by parents or community members.
(41) In my school, the principal may often be seen touring the school or visiting classrooms.
(42) In my school, the principal likes to share his/her vision of what the school should be.
(43) In my school, elective classes stress exploration rather than mastery of subject matter.
(44) In my school, teachers receive regular inservice training on early adolescent development.
(45) In my school, concerted efforts are made to match instruction to the individual needs of each student.
(46) In my school, the acquisition of skills is emphasized over the mastery of subject matter.
(47) In my school, students are actively encouraged to express and try out new ideas.
(48) In my school, teachers are encouraged to work together in interdisciplinary teams.
(49) In my school, teachers get opportunities to work closely and cooperatively with other staff members.
(50) In my school, students are encouraged to participate in competitive interscholastic activities such as team sports.
(51) In my school, teachers who teach the same subjects have their classrooms located close to one another.
(52) People who work in my school are out of touch with the reality of who students are today.
(53) People who work in my school enjoy working there.
(54) People who work in my school hold to a philosophy of education that is subject-centered rather than student-centered.
(55) People who work in my school are very much aware of the elementary program their students come from and the high school program to which they will be going.
(56) People who work in my school consult with the professional staff at other middle/junior high schools regarding common problems or concerns.
(57) People who work in my school interact frequently with their co-workers.
(58) People who work in my school have accurate perceptions of the family life of the students.
(59) People who work in my school think it is important to prepare early adolescent students for the amount of independence needed in high school.
(60) People who work in my school agree on the school's basic goals and mission.
(61) People who work in my school support the overall school program.